D4.3 Monitoring strategy in the FR interventions

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Author(s)	Saioa Zorita (Tecnalia), Igone Garcia Perez (Tecnalia), Nicola Murphy-Evans (GLA); Alessandro Arlati (HCU); Anne Rödl (TUHH); Emilia Barone (CDM), Stefano Casagrande (CDM)
Co-author(s)	Julita Skodra (UKE); Marlies Macher (G4C)
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CONTACT:

Email: **info@clevercities.eu**
Website: **www.clevercities.eu**

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Executive summary

This report falls under Work Package 4 of the CLEVER Cities project, which is focused on assessing Nature Based Solutions (NBS) impact by establishing and implementing a robust, long-term, integrated yet locally-adaptable co-monitoring framework and platform. As in D4.1, the approach for Key Performance Indicators (KPI) definition is underpinned by each city´s timeframe, co-design process and co-monitoring programmes. This guidance report is a living document which will be updated and iterated throughout the life of the CLEVER Cities, culminating in a final version for wider dissemination.

The use of KPIs constitutes the back-bone of the CLEVER cities Impact Assessment Framework which will monitor and evaluate the effectiveness of the chosen NBS the CLEVER Action Labs (CALs). The aim of having this monitoring framework is focused on three main goals: better informing decisions and planning processes, helping to track the progress of NBS interventions over time and contributing to better reporting in cities.

It builds on previous deliverables submitted that have described the monitoring and evaluation objectives, the process of impact assessment in the CLEVER Cities and use of Theory of Change (ToC) as method for developing a shared understanding of desired outcomes and activities.

1. CLEVER Cities KPI selection process. A seven step KPI selection process has been developed and the first six initial points have been addressed between thematic experts and city partners reaching the point to identify a preliminary list of suitable KPIs. These need to be checked (last step in the KPI selection process) to assure they meet the requirement to assess in an effective way the impacts of nature-based solutions (NBS).

2. Monitoring and assessment framework. A step has been taken towards the identification of those factors determining a successful impact of NBS (primarily in economic sustainable development and health and well-being). Furthermore, a preliminary cross-analysis has been performed to determine which KPIs are common or very similar among CLEVER FR Cities in order to determine which outcomes or effects can be evaluated in a harmonious way, that is in the most comparable manner.

3. Local monitoring plan. Work is currently being undertaken on the definition of key important aspect in the local monitoring plan such as the relevant stakeholders and their roles in the monitoring process, tools that will be applied for the KPIs evaluation and a preliminary schedule for the monitoring of the pre-greening scenario (before interventions). The first results are presented.

Although there has been good progress made, it must be recognised that there remains still work to do towards achieving the objective of having a finalized monitoring and evaluation strategy. Further work to complete this assignment is envisioned within the next months.

1. Introduction

In an increasingly urbanising world with pressures on finite resources, Nature based solutions (NBS) have been proposed as one of the ways that we can address and overcome some of the key challenges that cities face. These challenges have been recognised in the 2030 Sustainable Development Goals (SDG):

- SDG 3: Ensure healthy lives and promote well-being for all at all ages

- SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

- SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable

- SDG 13: Take urgent action to combat climate change and its impacts

It is recognised that the evidence base to support the use of NBS over more traditional 'grey' solutions, specifically in terms of solving social or economic problems needs further development. Indeed, the objective of contributing to the EU reference Framework is one of our core objectives for CLEVER Cities. As such, our proposed NBS interventions needs to be supported by measurable and robust data that assesses and validates the envisioned effectiveness and impact.

In the case of CLEVER Cities, the envisaged impact is to use NBS to regenerate the economic, physical, social and environmental conditions in urban neighbourhoods. The identified regeneration challenges within CLEVER Cities pursue the improvement of 1) health and well-being of residents, 2) sustainable economic prosperity, 3) social cohesion and environmental justice and 4) citizen security.

In order to evaluate and monitor the effectiveness of selected NBS a monitoring and evaluation plan is required. The monitoring and evaluation plan will help to assess the impact of the desired outcomes within the CALs in the Front Runner (FR) CLEVER Cities, during the life of CLEVER Cities and beyond.

The process of developing the monitoring and evaluation plan has been challenging for a number of reasons; one critical point is the limited financial and staff resources to carry out the ideal comprehensive monitoring plan. It was recognised that we must be strategic in developing the plan, and only apply resources to areas where we can clearly attribute change as a result of CLEVER Cities activity, and where we can enrich the current evidence base, and avoid repeating

evaluation of already known benefits. Furthermore, the broad range of potential NBS the cities will deploy require significant technical knowledge and specialist advice and support to define the most appropriate performance indicators.

CLEVER Cities is committed to tackling these issues by taking a co-creation approach to defining the KPIs; considering multiple stakeholder´s views and research partners guidance, by appointing Thematic Experts from within the project consortium. These experts have been working closely with the cities to start to develop a framework to better understand the impact of NBS in addressing urban challenges. Given that this thinking is still is relatively new[1], the complexity of this should not be underestimated

Thus, the basis on where, when and most importantly what and how is still blurred. The CLEVER Cities' KPI definition process is in itself relatively innovative and new indicators and methods of monitoring will be required and implemented. CLEVER FR Cities have, through the Theory of Change[2] (ToC), identified the objectives and outcomes of three regeneration labs (CALs) as a first step on KPI definition. This is important as FR Cities will define and create value by establishing the most appropriate KPIs based on the desired NBS impacts.

Apart from KPI definition the integration of CLEVER KPIs into the local monitoring strategy is vital. Relevant practical matters must be considered within each city such as how to involve stakeholders and agreeing roles, tools & schedules.

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[1] https://ec.europa.eu/research/environment/pdf/renaturing/eklipse_report1_nbs-02022017.pdf
[2] https://undg.org/wp-content/uploads/2017/06/UNDG-UNDAF-Companion-Pieces-7-Theory-of-Change.pdf

2. CLEVER Cities KPI definition framework

2.1. Framing the definition of monitoring criteria and indicators

In the course of the CLEVER Cities project monitoring and evaluation plays an important role to assess the effectiveness of the nature-based interventions and to provide guidance and advice for replication in the fellow cities. Furthermore, it facilitates decisions on upscaling measures beyond the scope of the project.

To be able to measure relevant outcomes and characteristics of the implemented interventions, appropriate and meaningful evaluation criteria and indicators have to be selected.

Since the finding of suitable criteria and indicators is often subjective their selection process has to be structured and rationalised. This helps to ensure the comparability of the NBS evaluation results, despite the wide variation of the starting points within the different cities in the projects. In addition, the replicability of the criteria and indicator selection process is increased. However, the complexity of NBS projects and the different contexts of their implementation makes it difficult to generalise the identification and selection of suitable assessment criteria and indicators. The number of variables is huge and case-dependent.

Nevertheless, attempts of overarching NBS evaluation frameworks have already been developed as part of other EU funded Horizon 2020 projects, e.g. the EKLIPSE consortium, UNALAB or Connecting Nature projects have worked or are still working such frameworks. Also, on the European level efforts are being pursued via the ThinkNature Taskforce. But up to now no generally accepted monitoring framework is existing. The CLEVER Cities project has revised the previously published results and further developed them to propose an advanced framework for the definition of monitoring criteria and indicators (see Section 2.2). In the following, this framework is presented in order to provide a theoretical basis and structure for the practical work on the definition of indicators done in the CLEVER Cities project.

In order to facilitate the understanding of the following descriptions, some important terms are defined below. First of all, it is clarified how the term "nature-based solutions" is understood in the

context of CLEVER Cities project. The term nature-based solution is here defined as given in the CLEVER Cities project deliverable D1.2[3]:

Nature-based solutions are systemic interventions that can be inspired by or support nature in addressing various societal challenges, such as climate change mitigation, water management, land-use and sustainable urban development. This entails planning and designing with natural features, such as trees, plants and green spaces, in a way that can help address the aforementioned urban challenges

Two further important terms that are essential for the following descriptions are "criteria" and "indicators".

We define the term "criteria" as a distinguishing feature or characteristic of a system, product or process that is considered to be important. Whereas "indicators" are measures that are specifying criteria. One criterion can have more than one indicator. An indicator shows the direction of change and can be a quantitative or a qualitative measure. The term "KPI - key performance indicator" is used in the following to point out very important indicators characterising the respective evaluation criteria. In the CLEVER Cities project KPIs will be used to monitor and evaluate the project related outcomes and processes. The framework attempts to provide a guide for the definition of the KPIs and can at the same time be used to observe the project development process. The project development process is as important as the results and there is the necessity to take record of it.

2.2. Framework development: how we got here

This framework looks at the work done within the project and proposes a way to structure it in a formal way. Thus, this section explains the steps of the framework development process. This information is included here for the sake of transparency and to keep track of the work done.

Starting from what described in Section 2.1, it was necessary for the CLEVER Cities project to develop a framework that structures the criteria and indicators definition for the evaluation of interventions. Especially due to the complexity of the project itself and the topic NBS in general. In the second half of the first year the team started to develop a framework to support the process of key performance indicators identification.

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[3] Knoblauch et al. (2019). Multi-level policy framework for sustainable urban development and nature-based solutions -- Status quo, gaps and opportunities. Deliverable 1.2, CLEVER Cities, H2020 grant no. 776604

The indicators list designed for the CLEVER Cities project touches several different aspects in regard to outcomes and process related indicators.

At this point, an extensive literature review was done, building on the work undertaken in Task 1.1 (and it is still ongoing) to firstly understand the concept of NBS and its components and to gather information on related indicators. The ToC method revealed itself to be extremely useful in providing a temporal and logical structure for the framework of CLEVER Cities KPI selection process.

CLEVER Cities KPI selection has followed a process containing seven steps as presented in Figure 3. Once the CLEVER urban regeneration challenges had been identified, a reflection process to determine desired changes in each CAL took place (step 2 to 4). ToC has been used to work towards the definition of KPIs creating an outcome-based framework or logic chain that helps identify what type of intervention or activities needs to happen to achieve the long-term goals or impacts.

The methodology behind ToC is briefly described in Deliverable D4.1 and the results of this process for KPI definitions are described within this deliverable. However, the co-creation of KPIs involves three additional steps: preparation of a list of general KPIs based on topics and outcomes by Thematic Experts (step 5) followed by bilateral meetings between the CLEVER FR Cities and Thematic Leaders to adapt them to the specific needs of each CAL (step 6). Step 7 promotes the assurance of KPIs to meet the requirements to assess, in an effective way, the impacts of NBS as well as the validation of KPIs. This dialogue shall primarily be held between the principal CLEVER FR Cities interlocutor and Local Monitoring Team (LMT) and/or other relevant key players.

For the identification of appropriate KPIs for the ToC outcomes (step 5 from Figure 3) various tasks were needed: specifically a proposal of KPIs by Thematic Experts combined with various forms of discussions (a workshop held in Bilbao as a starting dialogue followed by bilateral meetings between CLEVER FR Cities and Thematic Leaders of each challenge).
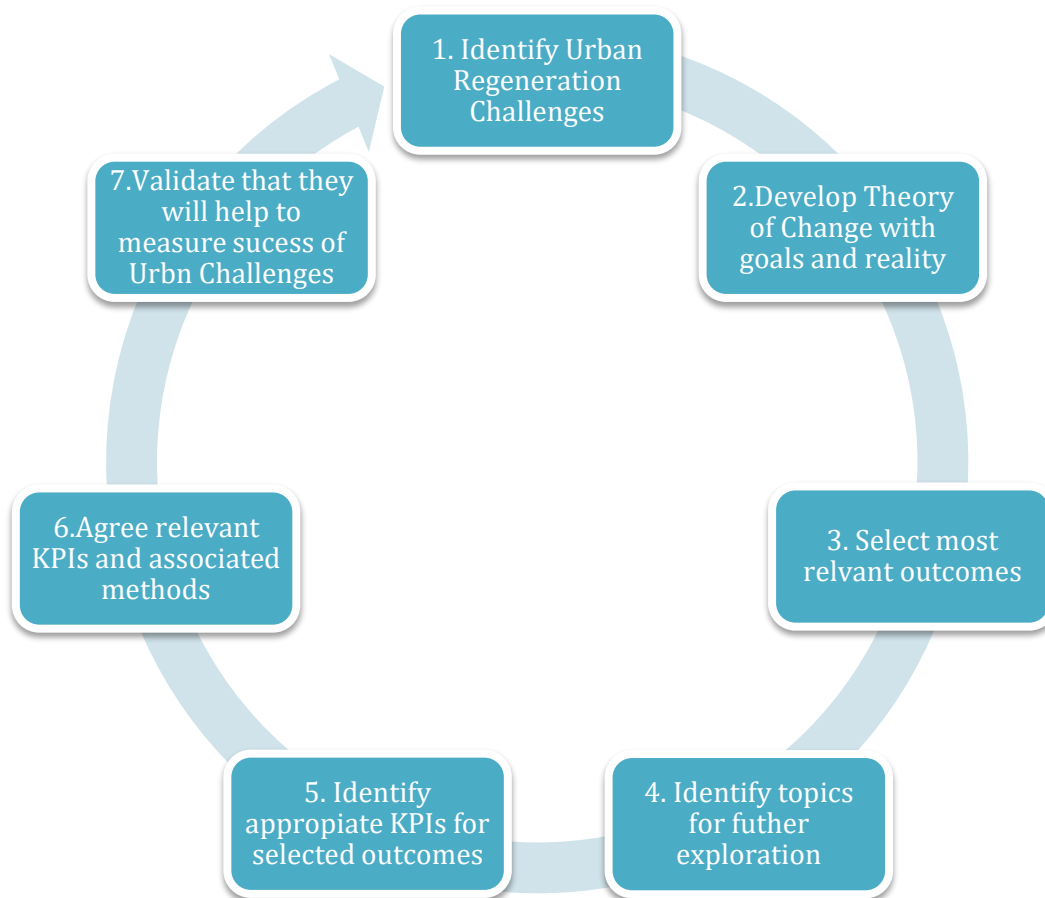
Figure 1. CLEVER Cities KPI selection process

2.3. Local workshop ToC outputs

This section presents the ToC outputs and includes key points discussed in the workshop held in Bilbao among CLEVER FR Cities and thematic experts regarding the expected outcomes.

2.3.1. HAMBURG

CAL 1, CLEVER Corridor, is intended to interconnect green infrastructure creating a network or corridor of NBSs. This corridor aims to be a hub for social interaction among different groups, both in the process of creating it and a legacy after the project ends. This regeneration challenge also envisions NBS as a key element in the redefinition of the connection between city and nature. Figure 4 depicts the outcomes that are sought for CAL 1. After the Bilbao workshop in April 2019 it became more evident that the use of green space, in terms of encouraging people to spend more time spent outdoors, should be reflected in the evaluation of the expected outcomes.

Group of active participants increases over time
• Residents participate actively in planning and implementation of CALs

Interconnection of people through nature (NBS)

Residents use the hubs as meeting points more frequently

Interaction between the different resident groups improves through the implementation of CALs

Residents can feel the improvement
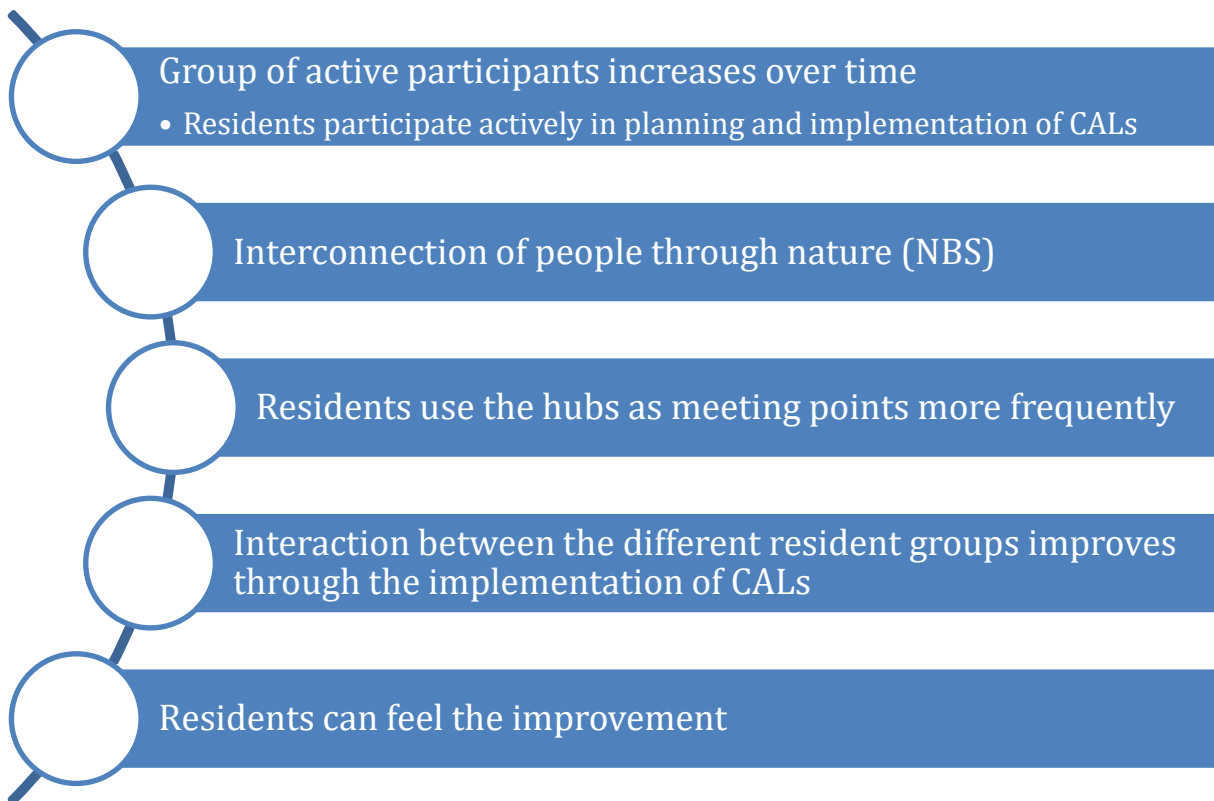
Figure 2. Desired outcomes highlighted in the ToC process for CAL1 (CLEVER Corridor) in Hamburg

CAL 2, green roofs and façades, is intended to be a crystallization project to experience green in a new dimension, for example, re-fitting buildings to become natural spaces. Green roofs and façades can improve the liveability of the districts and contribute to restore and enhance biodiversity or new habitats. Figure 5 depicts the outcomes that are sought for CAL 2. After the Bilbao workshop in April 2019 it became more evident that the ought to create a more liveable city for everyone including plants and animals should be reflected in the evaluation of the expected outcomes.

Use of created structures / green roofs and façades

Increased awareness and knowledge about the topic "urban green" among all population groups

Improvement of the microclimate

Increased well-being (self-reported)

Increased number of green spaces

Improved image of the project area

Load relief of sewer system
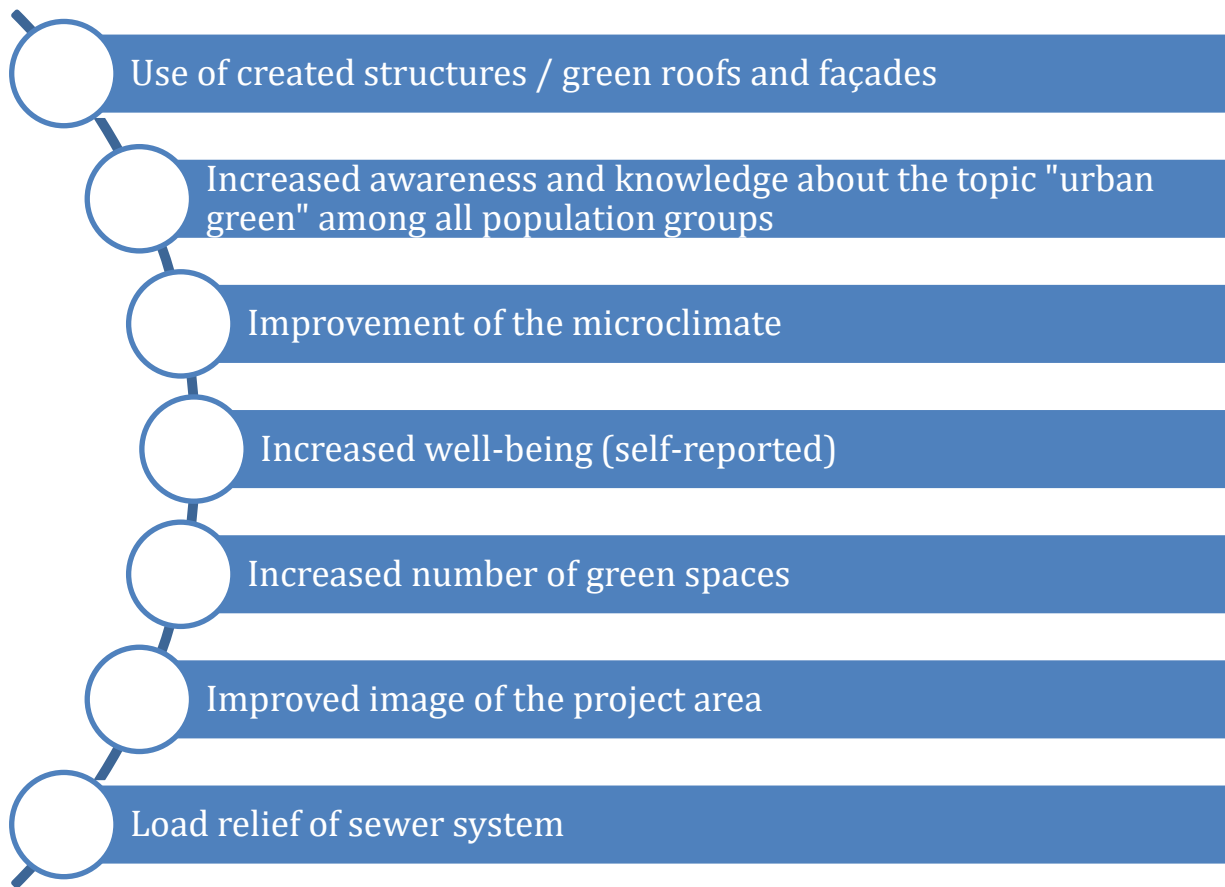
Figure 3. Desired outcomes highlighted in the ToC process for CAL2 (CLEVER Green roofs and façades) in Hamburg

CAL 3, CLEVER School edible gardens, is intended to enhance the sustainability of the schools by increasing the cohesion and involvement of the community, raise awareness and encourage behavioural change to improve overall well-being. The community cohesion is sought by linking school pupils and their families with elderly residents around the school creating spaces where people like to share and exchange experiences. This project aims to support pupils in their personal growth to become responsible, independent, self-reliant and self-aware in terms of sustainability. The project aims to act as a catalyst to encourage more sustainable living. The improved quality of green spaces and higher social cohesion may increase the well-being among residents in the neighbourhood. Figure 6 depicts the outcomes that are sought for CAL 3. After the Bilbao workshop in April 2019 it became more evident that the city also pursues competences in healthy food and food growing among the pupils. Thus, the increase of local food growing, and number of people involved in the food growing could reflect two of the desired outcomes.

Hamburg has identified several assumptions: Pupils are capable of influencing their parents

- There will actually be a green schoolyard and the discussion doesn't get stuck in detail

- families and neighbours open for cooperation

- Whole topic of greenery and plants is attractive for pupils and they have the power of endurance to actually wait for blooming plants and crop

- Critical mass for participation is reached

Spread of biodiversity - more diverse private gardens in the neighbourhood

More parents attending school events

New stable relationship and exchange of knowledge between mentors and mentees

Visitors to the space - both predetermined and voluntary

Commitment to digital participation tools

Share of green spaces

Local climate

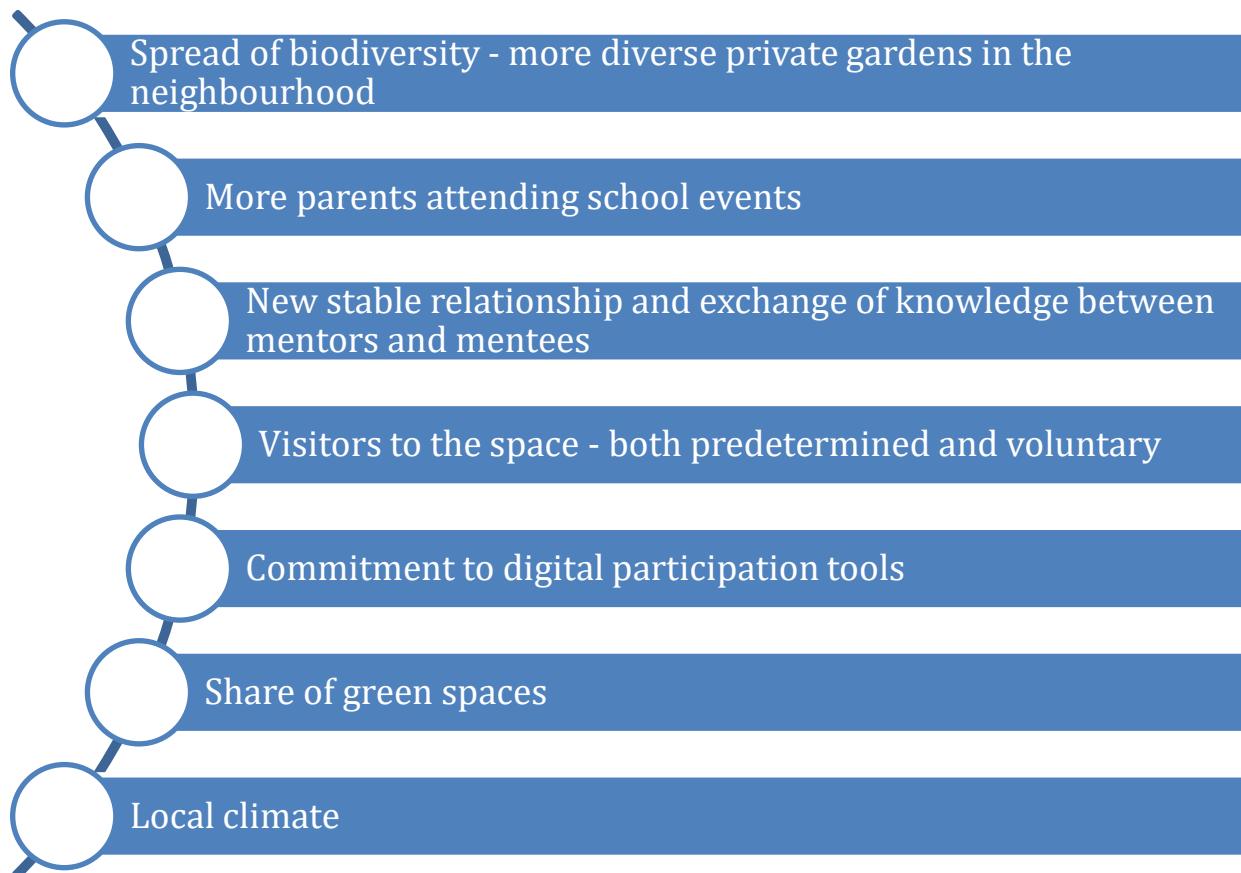*Figure 4. Desired outcomes highlighted in the ToC process for CAL3 (CLEVER school edible gardens) in Hamburg*

2.3.2. LONDON

CAL 1 - This CAL will undertake significant qualitative research to better understand how people use public spaces, the issues they face, the ideas they have to improve them and ultimately co-create solutions to common urban challenges. It will monitor how people move about the streets

and the types of activities that people undertake, and how this might change as the spaces are improved.

It is hoped that the creation of greened public spaces that are improved and connect better to form a network of pedestrian and nature-friendly spaces will help Thamesmead's residents to relate better to the wider landscape, including, for example, the extensive riverside of the Thames estuary which is currently unknown to most residents. In particular, it will help young people and children to attain a better understanding of the significant and extensive areas of greenspace in their part of the city which can provide Thamesmead a unique identity. Together with the other CALs and the many improvement projects underway in Thamesmead, the CLEVER Cities programme will work to co-create and to evidence how to use the natural world to support healthier and happier residents. Table 1 depicts the outcomes that are sought for CAL 1.

Table 1 - Desired short-term and long-term outcomes highlighted in the ToC process for CAL1 in London

Outcomes	
Short Term	**Long Term**
More active residents	Thamesmead has healthier Residents
Improved social networks	Thamesmead feels safer environment
More people from different background have positive experiences when using public spaces	Public spaces meet community needs
Communities are motivated to participate in civic action	More people are outside more often and for longer
Greenspaces more diverse and activated	Residents value the open space more
Increased knowledge of Thamesmead's nature	Improved sense of belonging
Use of greenspaces embed in everyday activities	Public spaces in Thamesmead are seen as desirable
Greater awareness of existing green and blue spaces	Reduced resident transience
People have capability (knowledge and skills) , opportunities and motivation to use greenspace	Evidence base to demonstrate value of regeneration
Easier to navigate and feel safer	Influence other projects to use more NBS

CAL 2 -Activating Southmere Lake will reach out to the wider community of Thamesmead with the aim of bringing Southmere Lake to the attention of residents of Thamesmead and into their day-to-day lives. Cultural and sports activities, that have wide appeal, will act as the principal catalysts for the collaborative design process for the lake and its surrounding area. Table 2 depicts the outcomes that are sought for CAL 2. After the Bilbao workshop in April 2019 it was evident that active mobility is a key element, together with social engagement and cohesion, in the regeneration of this CAL. CAL 2 also seeks to improve the environmental quality of the lake i.e. cleaner water.

Table 2. Desired short-term and long-term outcomes highlighted in the ToC process for Cal 2 (Activating Southmere Lake) in London.

Outcomes	
Short Term	**Long Term**
The lake and its surrounding areas provide recreation and leisure facilities to encourage more active residents	More commercial activity in area by lake
Swimming, boating and fishing are all easily accessible activities in Southmere	Land value in areas adjacent to the lake is increased
Residents have more civic pride in their neighbourhoods	Southmere lake is destination for people outside of Thamesmead
Residents are active in community events and	The lake is seen as a shared asset bringing old and new communities together
Residents feel included in decision making	New and old communities are integrated and cohesive
NBS supports better wayfinding in Thamesmead creating a more navigable neighbourhood	Improved wellbeing by daily contact with nature
New approaches to monitoring biodiversity are developed and proved	Biodiversity is improved
Residents are more engagement and aware of Thamesmead's wildlife	Resident care for NBS spots over the long term
Local residents are active in maintaining and improving the lake and its sounding areas	Reed bed water project is a success and is replicated in other places in London
Water quality in the lake is improved	Missed connections in the catchment area are resolved

CAL 3 -Greening unusual spaces is oriented to increase the green surface of the neighbourhood by greening spots such as walls, balconies, roofs, walkways, and the incidental spaces that are often underutilised. Greening unusual spaces aims at contributing to greener, more interesting, more active and safer, contributing to healthier, more connected communities by diminishing the

presence of the grey urban landscape and increasing daily contact with nature. Table 3 depicts the outcomes that are sought for CAL 3. After the Bilbao workshop in April 2019 it was evident that an increase in the engagement of community to improve the neighbourhood and in the sense of ownership of outdoor spaces is sought. Security issues should also be considered.

Table 3. Desired short-term and long-term outcomes highlighted in the ToC process for Cal 3 (Greening unusual spaces) in London.

Outcomes	
Short Term	**Long Term**
How to create green spots is better understood	Greening grey spaces is not considered onerous
Greening grey spaces is demonstrated through realistic solutions	Having green spots in neighbourhoods is valued by housing providers, businesses, residents
More NBS spots appear around Thamesmead making it feel more beautiful and cared for	NBS 'spots' can be rolled out at scale
	Residents train other community members to plant and maintain greened spots
Residents are confident to plant and maintain greened spots	Residents understand and value NBS
Residents have more civic pride in their neighbourhoods	Resident care for NBS spots over the long term
NBS supports better wayfinding in Thamesmead creating a more navigable neighbourhood	Improved wellbeing by daily contact with nature

2.3.3. MILANO

CAL 1 dedicated to increase the green surface of the city by augmenting green roof and green wall cover which aims at improving environmental quality of life and reduction of climate risks in a significant way. Figure 5 depicts the outcomes that are sought for CAL 1. After the Bilbao workshop in April 2019 it was evident that the climate risks to address correspond to urban heat island and pluvial flooding and at the same time increasing people well-being through the social and recreational use of the roof
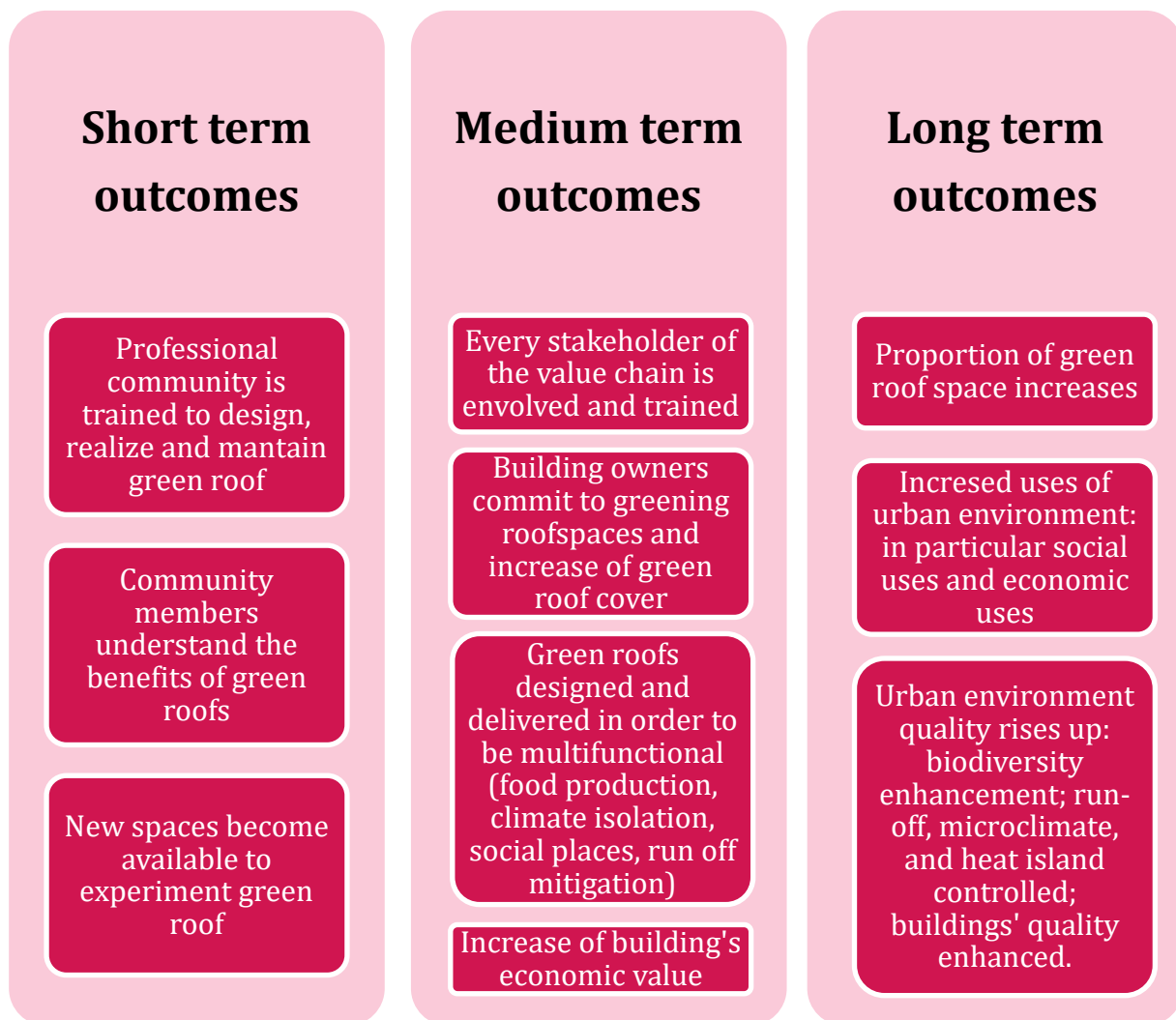
Short term outcomes

Professional community is trained to design, realize and mantain green roof

Community members understand the benefits of green roofs

New spaces become available to experiment green roof

Medium term outcomes

Every stakeholder of the value chain is envolved and trained

Building owners commit to greening roofspaces and increase of green roof cover

Green roofs designed and delivered in order to be multifunctional (food production, climate isolation, social places, run off mitigation)

Increase of building's economic value

Long term outcomes

Proportion of green roof space increases

Incresed uses of urban environment: in particular social uses and economic uses

Urban environment quality rises up: biodiversity enhancement; run-off, microclimate, and heat island controlled; buildings' quality enhanced.

Figure 5. Desired outcomes highlighted in the ToC process for CAL 1 (Green roofs) in Milano

CAL 2, Giambellino intervention, is intended to create new multifunctional green services that improves the sense of belonging to the area where innovation and social protection are boosted. The expected outcomes are highly linked to a change of the residents´ model where an increment of the attractiveness of the whole neighbourhood is pursued. Two key elements within this CAL are i) the change in perception of the area and ii) the typologies of uses in the space through new urban furniture's and NBS interventions that help visualize the change of uses, and particularly their multifunctional uses. Figure 6 depicts the outcomes that are sought for CAL 2. After the Bilbao workshop in April 2019 it became more evident that the health and well-being benefits are meant to be evaluated from the psychosocial perspective.
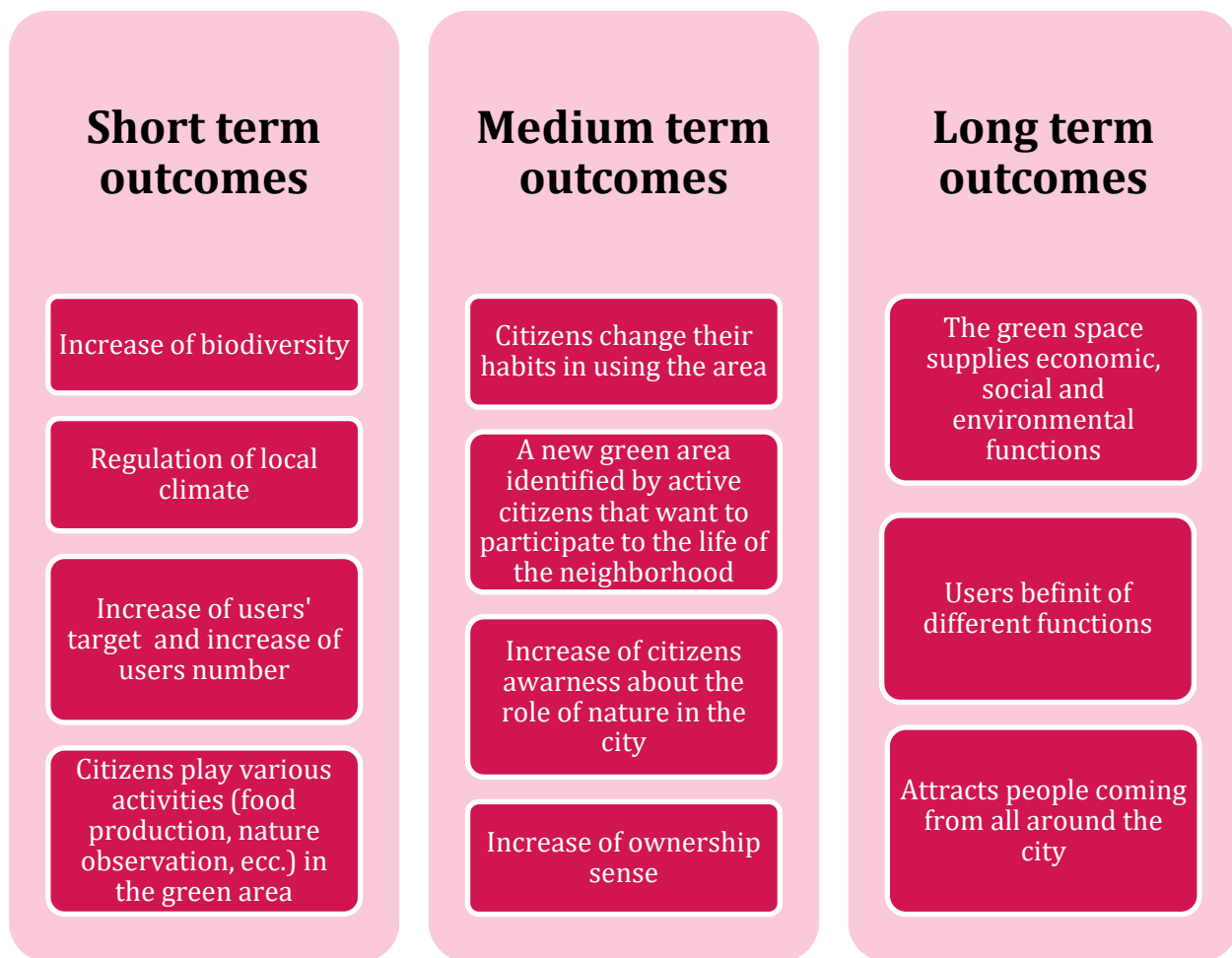
Short term outcomes

Increase of biodiversity

Regulation of local climate

Increase of users' target and increase of users number

Citizens play various activities (food production, nature observation, ecc.) in the green area

Medium term outcomes

Citizens change their habits in using the area

A new green area identified by active citizens that want to participate to the life of the neighborhood

Increase of citizens awarness about the role of nature in the city

Increase of ownership sense

Long term outcomes

The green space supplies economic, social and environmental functions

Users befinit of different functions

Attracts people coming from all around the city

Figure 6. Desired outcomes highlighted in the ToC process for CAL 2 (Giambellino) in Milano

CAL 3, Tibaldi train stop intervention, is envisioned to help change the environmental quality and social impact in the neighbourhood through the realisation of this new public infrastructure. The expected outcomes are proposed for two target population: passengers/ commuters and the residents nearby Tibaldi Station. As for CAL 1 and 2, Tibaldi train stop (CAL 3) aims at improving the quality of life by environmental regeneration and economic indicator improvement, respectively, through NBS. Figure 7 depicts the outcomes that are sought for CAL 3. After the Bilbao workshop in April 2019 it became more evident that the vision for Tibaldi Station included the following points:

- a public space with a relaxed atmosphere comes in as "visually improved, shared, green and well-perceived micro-climate' for both the local residents and the passengers in transit waiting for the trains with the possibility to monitor the trains flux.

- transform the problem of the train line as barrier into an opportunity to increase a quality of life in the neighbourhood in general

- environmental improvement as an outcome from regeneration of the train station and placement of noise barrier
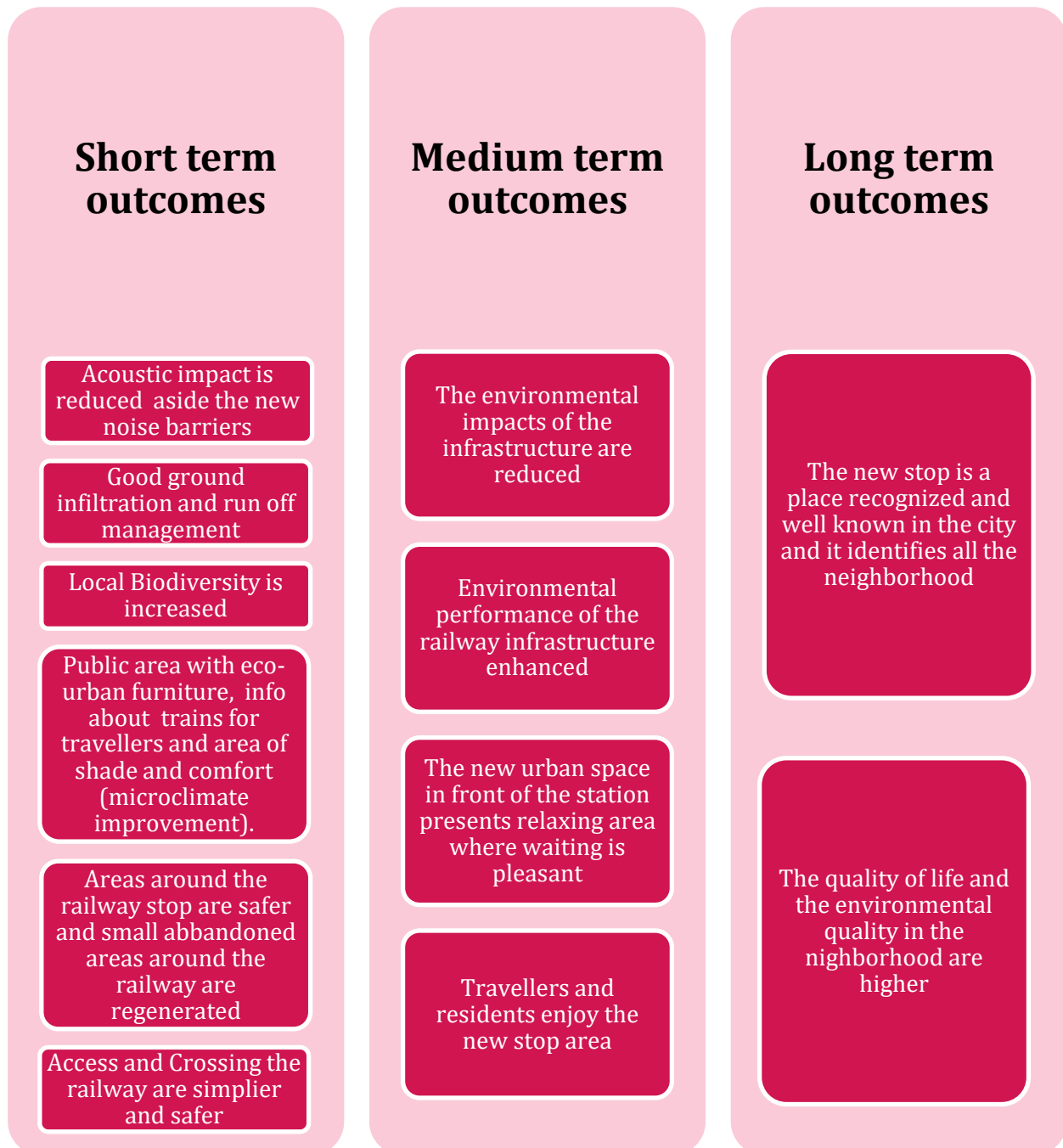
Short term outcomes	Medium term outcomes	Long term outcomes
Acoustic impact is reduced aside the new noise barriers	The environmental impacts of the infrastructure are reduced	The new stop is a place recognized and well known in the city and it identifies all the neighborhood
Good ground infiltration and run off management	Environmental performance of the railway infrastructure enhanced	
Local Biodiversity is increased		
Public area with eco-urban furniture, info about trains for travellers and area of shade and comfort (microclimate improvement).	The new urban space in front of the station presents relaxing area where waiting is pleasant	The quality of life and the environmental quality in the nighborhood are higher
Areas around the railway stop are safer and small abbandoned areas around the railway are regenerated	Travellers and residents enjoy the new stop area	
Access and Crossing the railway are simplier and safer		

Figure 7. Desired outcomes highlighted in the ToC process for CAL 3 (Tibaldi train stop) in Milano

2.4. Identification of KPIs for selected topic /outcomes

In order to identify and develop KPIs that assess the benefits of NBS to regenerate the selected urban areas, first, the Thematic Experts identified a set of topics related to our CLEVER Regeneration challenges. Then each FR city identified which topics were most relevant for each CAL and mapped a number of example indicators across. Finally, CLEVER FR Cities, selected the pertinent topics for each of their CALs (see Table 4 which is related to Challenge 1 as an example).

This exercise consisted of the selection of the topics that were relevant in each CAL (marking them with an "X"). London not only marked the topics to work on but prioritise them. As seen in Table 4 (A), where three examples are given, "healthy eating" topic was relevant to be evaluated in CAL 3 from Hamburg, but not in Milano. In the case of London (B), "healthy eating" was pertinent for the three CALs, but mostly for CAL 1.

Table 4. Example of key topics for regeneration challenge 1: Human health and well-being and their applicability to each CAL. "X" is marked for those topics relevant to CALs from Milano and Hamburg (A). On the other hand, London (B) prioritised the relevance of topics.

A		MILANO			HAMBURG		
		CALs					
CHALLENGE	**TOPICs**	*1*	*2*	*3*	*1*	*2*	*3*
Regeneration Challenge 1: Human health and well-being	Healthy eating/healthy food						X
	Physical health						
	Mental health (incl. stress, anxiety)			X	X		X

B		LONDON		
CHALLENGE	TOPICs	Priority 1 (most)	Priority 2	Priority 3 (least)
Regeneration Challenge 1: Human health and well-being	Healthy eating/healthy food	CAL 1	CAL 2	CAL 3
	Physical health	CAL 12	CAL 3	
	Mental health (incl. stress, anxiety)	CAL 123		

However, since all of the work that was developed during the ToC, which was devoted to achieving a transformation based on expected outcomes, the information was re-structured and topics were repurposed into desired outcomes (See example of outcomes related to Table 4 in Table 5). These tables (Annex A and an extended version of Table 5) with proposed KPIs were the basis for discussions in the workshops in Bilbao to start validating what to monitor and how to monitor. This is a challenging exercise that needs time to develop and fully understand the nuances related to the KPIs, especially those more linked to psychosocial aspects.

Table 5. Identified KPI list linked to outcomes related to topics from Table 4

Theme	Outcome	Example of KPI
Use of function	Increase in local food growing	Gardening space per area
Mental & Physical health	Improvements in fitness/ physical health	Physical activity in CALs
	Increase in walking	Number of individuals walking and cycling in and around areas of interventions
	Improvements to mental health	Self-reported mental health status
	Reduced stress and anxiety	Self-reported stress and anxiety

2.5. Preliminary list of KPIs

Bilateral meetings between cities and Thematic Leaders allowed the definition of a preliminary list of KPIs after revising the relevant ToC-outcomes and visions for all three CALs in cities. These bilateral meetings also helped to move forward on agreeing monitoring approaches and identification of related baseline data. However, it highlighted the need for additional scrutiny over the identified outcomes the selected KPIs. This work will continue in the next steps in the monitoring and evaluation process.

2.5.1. HAMBURG

Hamburg, in the CLEVER Cities urban regeneration projects, pays special attention to the enhancement of availability & accessibility of NBS and its use and function, economic impact, participation, environmental parameters and security. This focus is translated in more KPIs related to challenge 1 (human health and well-being) and challenge 2 (sustainable economic prosperity). Apart from the CAL specific KPIs, several other common topics have been identified among the three CALs giving CLEVER Cities project the possibility of comparing the results within the same city (once the KPIs are stablished). This will help to elucidate the ability of different NBS to reach the specified goals and the suitability of specific KPI to evaluate different types of NBS.

The common topics relevant for all CALs are the following:

- *Number of participants in actions, events etc.*

- *Area of newly established public green spaces*

- *Job opportunities (for volunteers)*

- *Economic value of green spaces*

CAL 1

CAL 1 aims at creating a safe green corridor that promotes the awareness and knowledge of NBS and that enhance the use of outdoor spaces. This indirectly will aid to achieve a healthier and more content population. Thus, well-being and security are the pillars of this urban regeneration project which is translated into higher number of KPIs associated to improvement of the availability and accessibility of NBS, green skills among residents and overall increase in security perception and run off reduction.

Table 6. Preliminary KPI selection for CAL 1 in Hamburg. * Not covered by any CLEVER Cities challenge but included in CH 4 as similar to run off reduction. TBD: To be determined

Challenge	Outcome	Preliminary selected KPI
Human health and well-being	Greater utilisation /frequency of use/visits of NBS areas	Number of visitors per day/month
		Number of users per month
	Visibility, awareness of CLEVER/ NBS	-Number of people knowing the intervention -Number of people participating in events
Citizen security	Increase in feelings of safety and security	TBD
	Saving resources; Rainwater management*	Saved potable water

CAL 2

Similarly, to the green corridors, green roofs and façades intends to increase resident's well-being, but from a different perspective. In CAL 2 this is achieved by reducing the noise levels, improvement of air quality and biodiversity. On the other hand, this CAL also pretends to boost local value chain. Selected KPIs are aligned with these topics. Within this CAL it is also desired to improve water saving which will help to adapt against droughts and pluvial flooding and translate into economical savings.

Table 7. Preliminary KPI selection for CAL 2 in Hamburg. * Similar to run-off reduction covered within challenge 4, but included in challenge 2 as related to environmental and economic co-benefits

Challenge	Outcome	Preliminary selected KPI
Human health and well-being	Improvement of biodiversity	Number of indicator species (e.g. soil macrofauna as indicator for soil quality)
	Reduction of noise	-Lnight -Lden

Challenge	Outcome	Preliminary selected KPI
	Improvements in air quality environment	-Non-spatial indicators of gross quantities: annual amount of pollutants captured/removed by vegetation - Concentration of PM10, PM2.5, NO2, Ozone
Sustainable economic prosperity	Improvement of the district	-Measures the price development for houses or apartments in the district -Energy savings** -Water fee savings**
	Saving resources; Rainwater management*	Saved potable water

CAL 3

For CAL 3, edible gardens, Hamburg intends to increase resident's well-being, community cohesion, and sustainable economic development. KPIs that cover different themes were selected. These themes reflect the desire to increase NBS use and function, awareness, participation and boosting local value chain.

Table 8. Preliminary KPI selection for CAL 3 in Hamburg. *** Included in Challenge 3 as it can promote cohesion among the population due to the participation in activities

Challenge	Outcome	Preliminary selected KPI
Human health and well-being	Increase in green skills amongst students	-Knowledge about gardening -Knowledge about food/ health aspects
	Promoting the awareness of children and associated people	-Knowledge of food growing
Sustainable economic prosperity	Boosting local value chain	-Number of new directly created positions per intervention; number of indirectly created positions per intervention

Challenge	Outcome	Preliminary selected KPI
Social cohesion and environmental justice	Increase in participation in events/ activities by diverse groups	-Number of « affected outsiders »
	Increase participation	-Number of pupils taking part in gardening

2.5.2. LONDON

London, in the CLEVER Cities CAL 1 urban regeneration project, is highly oriented to tackle health and well-being improvement within the residents CAL 1 pays special attention to the enhancement of availability & accessibility of NBS, NBS use and function, participation and security.

CAL 1

Table 9. Preliminary KPI selection for CAL 1 in London.

Challenge	Outcomes	Preliminary selected KPI
Human Health and Wellbeing	Parkview residents value their public spaces more	Number of people who believe spending time near nature is a good thing
		Number of people observed spending time outdoors
		% change of people who can describe the benefits of Parkview's natural environment
		number of incidences of criminal damage to new planting or equipment
		Number of NBS interventions (green walls, rain gardens, swales, trees)

Challenge	Outcomes	Preliminary selected KPI
Human Health and Wellbeing	Parkview residents experience improved health and wellbeing as a result of spending more times outdoors	% of people who report that they like spending time outdoors in Parkview's public spaces
		% of people undertaking physical activity (fitness, sport, active games) outdoors
		% of children who report regularly playing outside
		% of people who report improvements in personal wellbeing
		Children are observed using new play features in Parkview
		Number of steps children take in a day
Economic Prosperity	Increase in the economic value of Parkview's green spaces	More people using greenspace more frequently
		More people using greenspace for exercise
		% uplift in avoided health costs
	NBS interventions have a multiplier effect, increasing civic participation and leveraging funds for other local initiatives	% of new Peabody projects that integrate NBS into plans
		% increase in membership of local community groups
		% increase in value of expenditure on NBS in Thamesmead
		Number of non-CLEVER funded NBS interventions implemented locally
		£ levered in
		Parkview residents report feeling included in decision making

Challenge	Outcomes	Preliminary selected KPI
Social Cohesion and Environmental Justice	Parkview residents feel included in the regeneration of their neighbourhood	Parkview residents report being included in co-design has been a good thing
		Number of people who sign up to being part of the group
		The group remains established after lifetime of CLEVER (part of + 5 years evaluation)
	Parkview residents feel they have equitable access to the use of public space	Diverse groups of people observed in public spaces
		Parkview residents report community integration in shared spaces
		Number of events held
		Diversity of attendance at community events
		Report published
Citizen Security	Parkview residents believe that their surrounding areas are safe, welcoming and navigable	% of people who report their neighbourhood as safe
		% people feel happy about letting their children play in the streets and squares
		Observation of numbers of people walking on greened routes v non-greened routes
		Number of residents led walking tours to better understand local environment and issues

Challenge	Outcomes	Preliminary selected KPI
		Number of community events to map antisocial behaviour and how to use nature to solve them (e.g. pocket park where fly tipping occurs)

CAL 2

CAL 2 - Activating Southmere Lake will reach out to the wider community of Thamesmead with the aim of bringing Southmere Lake to the attention of residents of Thamesmead and into their day-to-day lives. Cultural and sports activities, that have wide appeal, will act as the principal catalysts for the collaborative design process for the lake and its surrounding area.

Table 10 - Preliminary KPI selection for CAL 2 in London

Challenge	Outcomes	Preliminary selected KPIs
Human Health and Wellbeing	Southmere residents value their public spaces more	Number of people who believe spending time near nature is a good thing
		Number of people observed spending time outdoors
		% change of people who can describe the benefits of Southmere's natural environment
		number of incidences of criminal damage to new planting or equipment
		M2 of green and blue space improved in Southmere

Challenge	Outcomes	Preliminary selected KPIs
Human Health and Wellbeing		Changes to biodiversity (bat population)
		Improved water quality in lake
		Number of co-design events held
		% of people who think that co-design has led to other benefits (skills, social cohesion etc.)
	Southmere residents experience improved health and wellbeing as a result of spending more times outdoors	% of people who report that they like spending time outdoors in Southmere public spaces
		% of people undertaking physical activity (fitness, sport, active games) outdoors
		% of children who report regularly playing outside
		% of people who report improvements in personal wellbeing
		Children are observed playing with nature and natural play
		Number of people who take part in CLEVER activities
		Number of people observed undertaking physical activities on or near Southmere lake
	Increase in the economic value of Southmere	More people using blue and green space more frequently

Challenge	Outcomes	Preliminary selected KPIs
Economic Prosperity		More people using blue and green space for exercise
		CBA of investment in water and lake improvements versus a control (rate of return?)
	Water quality in the lake is improved helping it become a destination for leisure activity	New lakeside commercial business established
		Numbers of visitors to the lake and park
		Increase in linger time observed
		Case study published
Social Cohesion and Environmental Justice	Southmere residents feel included in the regeneration of their neighbourhood	Southmere residents report feeling included in decision making
		Southmere residents report being included in co-design has been a good thing
		Number of people who sign up to being part of the group
		The group remains established after lifetime of CLEVER (part of + 5 years evaluation)
	Southmere residents are active in managing and improving green and blue spaces	Number of people who volunteer to improve or care for Southmere's natural environment

Challenge	Outcomes	Preliminary selected KPIs
Social Cohesion and Environmental Justice		Number of hours people volunteer to improve or care for Southmere's natural environment
		Observed behaviour such as dog fouling, littering, inappropriate feeding of animals
		Number of events held
		Diversity of attendance at community events
Citizen Security	Southmere residents believe that their surrounding areas are safe, welcoming and navigable	% of people who report their neighbourhood as safe
		% people feel happy about letting their children play in the streets and squares
		Number of residents led walking tours to better understand local environment and issues
		Number of community events to map antisocial behaviour and how to use nature to solve them (e.g. pocket park where fly tipping occurs)

CAL 3

CAL 3 *Greening Unusual and Underused Spaces* will work with specialists and residents to test new approaches to greening unusual spaces: walls, balconies, roofs, walkways, and the incidental spaces that are often underutilised. Taking both a top down and bottom up approach

to the co-design, implementation, and evaluation of interventions, the project will explore how to use smart and analogue systems to create new products and make greening the grey more effective and scalable in regeneration projects.

Table 11 - Preliminary KPI selection for CAL 3 in London CAL

Challenge	Outcomes	Preliminary selected Indicators
Human Health and Wellbeing	Residents appreciate and understand the value greened spaces	Number of people who believe spending time near nature is a good thing
		Number of people observed spending time outdoors
		number of incidences of criminal damage to new planting or equipment
		Number of NBS interventions (green walls, rain gardens, swales, trees)
		M2 of additional green
		Number of co-design events held
		% of people who think that co-design has led to other benefits (skills, social cohesion etc.)
		Number of changed design or process decisions due to community collaboration
		% of people who report that they noticed nature on their doorstep

Challenge	Outcomes	Preliminary selected Indicators
	Improved wellbeing by daily contact with nature on the doorstep	% of people who report improvements in personal wellbeing
		Number of people involved with Urban Mind
		Before, during and after report from Urban Mind
Economic Prosperity	Low cost NBS are proven to green and improve South Thamesmead's neighbourhood	Number of successful NBS interventions that are implemented at low cost
		Number of successful NBS interventions that are maintained at low cost
		Report or case studies published
	NBS interventions are used to support education and learning	% of Peabody grounds team feeling confident about maintaining NBS
		Number of school children involved in co-design of NBS
		% of people who feel they have learned new skills as part of CLEVER gardening group
Social Cohesion and Environmental Justice	Gardening group encourage more social interaction	Observed behaviour of volunteers interacting
		Self-reported benefits of participating in gardening groups
		Diversity of gardening group

Challenge	Outcomes	Preliminary selected Indicators
Social Cohesion and Environmental Justice	Strategic use of NBS improve spaces that suffer from environmental issues	Number of events held
		Feedback on success of events
		Number of community events to map environmental issues and how to use nature to solve them (e.g. surface flooding, poor air quality, low ecological value, overheating)
		Number of NBS interventions (green walls, rain gardens, swales, trees)
Citizen Security	Strategic use of NBS improve spaces that suffer from anti-social behaviour	Report or case studies published
		NBS interventions are used to support education and leaning
		Reduction in incidents of ASB
		% residents reporting incidents of ASB
		Number of young people involved

2.5.3. MILANO

Milano, in the CLEVER Cities urban regeneration project, pays special attention to the enhancement of quality of life and environmental parameters, social cohesion and improved urban environments. This focus is translated in higher number of KPIs tackling challenge 1 (human health and well-being) and 3 (social cohesion and environmental justice). Several KPIs

are shared among the three CALs giving CLEVER Cities project the possibility of comparing the results within the same city, due to the fact the similar types of NBS appear between CAL 1 and 3 (green walls) and between CAL 1, CAL 2 and CAL 3 (multifunctional garden or roof). This will help to elucidate the ability of similar NBS to reach the specified goals and the suitability of specific KPI to evaluate the same NBS in alternative locations.

CAL 1 – Green Roofs and walls (GRW)

For CAL 1, green roofs and walls, within challenge 1 Milano intends to increase resident's well-being by increasing the quality of life. KPIs that cover different themes were selected. These themes reflect the desire to increase NBS use and function, the availability and accessibility of NBS, the physical environment and social well-being. Sustainable economic development is only translated into evaluating housing value. On the other hand, challenge 3 related KPIs intend to assess the social well-being, availability, accessibility and management of NBS.

Table 12. Preliminary KPI selection for CAL 1 in Milano

Challenge	Outcome	Preliminary selected KPI
Human health and well-being	Greater access to green and blue space	Availability of parks and/or ecosystem services or green roofs with respect to density of housing Available green roof surface
		-Distance from green roof by household socioeconomic characteristics (e.g. degree of education, nationality, age)
		-Proportion (%) of key leisure and recreation opportunities on rooftop that:1. require payment, 2. have private access, 3. are free

Challenge	Outcome	Preliminary selected KPI
	Increase in green skills amongst residents/ students	N. of people trained or number of course for training on NBS
	Mitigation of Urban Heat Island effect	Records the temperature at a specific spot before and after the intervention and calculates the changes
	Improvements in thermal comfort	Thermal comfort score; Humidity index = (humidity x temperature)
	Improvements in air quality	Concentration of pollutants (PM10, NO2, Ozone)
	Increase biodiversity	Insects, pollinators (e.g. Shannon index) number of plants´ species on GR or GW
Sustainable economic prosperity	Boosting regional and local value chains	House and apartment prices per m2 (through Real Estate market models) Economics benefits for greening industry and supply chain
Social cohesion and environmental justice	Satisfaction with neighbourhood/ community	Percentage of people fairly or very satisfied with community /neighbourhood/ NBS with places they like and places they avoid
	Increase in participation in events/ activities and GRW topic communication by diverse groups	-Participation in events -Number of contacts in communication and social networks channels for GRW Topic
	Involvement of local people in decision making about green spaces	People involved in local decision making related to NBS
	Planners and developers integrate NBS into new plans	Number of new rules introduced after CAL
Citizen security	Reduction in flood risk, improvement of management	Run off coefficient, empirical measure of Green Roof extension and water reserves

CAL 2 – Community Garden

Similarly, to green roofs, community gardens intends to increase resident's well-being by creating high quality multifunctional green services that promote physical activity and sociability. KPIs within this CAL reflect the importance of regeneration linked to challenge 1 and 3. KPIs cover themes related to use, function, availability, accessibility and management of NBS, improved physical environment and social well-being.

Table 13. Preliminary KPI selection for CAL 2 in Milano

Challenge	Outcome	Preliminary selected KPI
Human health and well-being	Greater access to green and blue space	Availability of parks and/or ecosystem services with respect to specific individual or household socioeconomic profiles
		-Distance travelled to urban green space segregated by household socioeconomic characteristics (e.g. income, degree of education, ethnic background/nationality, age)
	Increase in green skills amongst residents/ students	N. of people trained or number of course for training on NBS
	Reduction in noise	Lnight; Lden Direct mesasure of Leq day and Leq nigh (indicators of italian legislation) with sensor
	Improvements of air quality	Concentration of pollutants (PM10, NO2, Volatile organic compound as ozone precursors, PN particle number)
	Increase biodiversity	Alternative with sentinel significant insects, insects, impollinators (e.g. Shannon index)

Challenge	Outcome	Preliminary selected KPI
	Increase in numbers of people using outdoor spaces	number of visitors per day/month
	Improvement to quality of life	Perceived quality of life
Sustainable economic prosperity	Effective and efficient management of green space	Number of people and groups working on maintenance on waged contract
Social cohesion and environmental justice	Inclusive management of green space (involving communities)	Number of people and groups working on maintenance voluntary
	Involvement of local people in decision making about green spaces	People involved in local decision making related to NBS
	Increase in participation in events/ activities by diverse groups	Inclusion of diverse groups in events
	Satisfaction with neighbourhood/ community	Percentage of people fairly or very satisfied with community/ neighbourhood/ NBS in the garden
	Increase in sense of ownership of outdoor spaces amongst people/ diverse groups	Perceived ownership of space by different groups
	Greater equality of access to green space	Demographics of people visiting the site
	Increase in participation in events/ activities by diverse groups	Perceived ownership of space by different groups
	Management of Green space	No. of persons involved in co-management

CAL 3 – Tibaldi train stop

CAL 3 aims at creating higher social and environmental quality for the neighbourhood and city in general and this is reflected in the selection of KPIs. Once more, well-being and social cohesion are the pillars of this urban regeneration project which is translated into higher number of KPIs associated to improvement of physical environment quality and conditions and overall increase in well-being.

Table 14. Preliminary KPI selection for CAL 3 in Milano. TBC: To be confirmed

Challenge	Outcome	Preliminary selected KPI
Human health and well-being	Improvement to quality of life	Perceived quality of life
	Greater access to green and blue space	Availability of parks and/or ecosystem services with respect to density of housing
		-Distance travelled to urban green space segregated by household socioeconomic characteristics (e.g. degree of education, background/ nationality, age)
	Increase in green skills amongst residents/ students	N. of people trained or number of course for training on NBS
	Reduction in noise	Lnight; Lden Direct mesasure of Leq day and Leq nigh (indicators of italian legislation) with sensor
	Mitigation of Urban Heat Island effect	Surface temperature; air temperature; thermal camera photos
	Improvements in thermal comfort	Thermal comfort score? Humidex index = (humidity x temperature)
	Increase biodiversity	Alternative with sentinel significant insects, insects, pollinators (e.g. Shannon index)
	Increase in numbers of people using outdoor spaces	Number of visitors per day/month using new public green (green waiting room)
	Improvement of landscape	Height of trees/ vegetation density/ visibility index
Social cohesion and	Increase in sense of ownership of outdoor spaces amongst people/ diverse groups	Perceived ownership of space by different groups

Challenge	Outcome	Preliminary selected KPI
environmental justice	Increase in participation in events/ activities by diverse groups	Participants in co-creation and co-management
	Changes to policy and practice	Number of NBS introduced in new railway infrastructure project Rules, tools or guidelines produced for NBS introduction in infrastructure
Citizen security	Reduction in crime	Safety perception
	Reduction in run off	Runoff Coefficient and peaks

3. Monitoring and assessment approach

As discussed earlier in this report, CLEVERF Cities recognise that effective monitoring and evaluation are of utmost importance. The selection of the objectives and KPIs that can evaluate the project are two vital pillars in any monitoring and assessment plans.

It is important to consider the purpose of the evaluation as well as the audience for the results and potential impact of the findings. This can help guide where to prioritise resources and decide which aspects are relevant. Within CLEVER Cities project the focus has been placed on the outcomes, outputs and process evaluation. To elucidate the KPIs related to outcomes and outputs, ToC has been employed within CLEVER Cities.

Furthermore, nowadays, SMART[4] criteria are well established in the field of monitoring and evaluation. SMART indicate the following:

S - specific – effectiveness/efficiency/acceptability/equity. The indicator should respond to: Does the indicator capture the essence of the desired result?

M - measurable -- The indicator has the capacity to be counted, observed, analysed, tested, or challenged. If one cannot measure an indicator, then progress cannot be determined.

A - achievable – The indicator is achievable if the performance target accurately specifies the amount or level of what is to be measured in order to meet the result/outcome.

R - relevant – The indicator is relevant when there is a relationship between what the indicator measures and the theories that help create the outcomes for the client, program, or system.

T - time- The indicator should contain the answer to: when do you want to achieve objectives by?

The SMART approach has been considered in the development of the KPIs in CLEVER Cities project and are aligned with the European Monitoring Framework.

3.1. Baseline and links with the ToC

Baseline monitoring is a significant component in an environmental assessment process. In CLEVER Cities, we refer to *baseline* as the data that recorded as standard in the city, while the

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[4] Doran, George T. "There's a S.M.A.R.T. way to write management's goals and objectives."
Management Review 70.11 (Nov. 1981): 35. Business Source Corporate. EBSCO . 15 Oct. 2008.

term ***pre-greening*** is the data that is to be collected specifically for CLEVER Cities and will be used to measure change attributable to CLEVER Cities NBS.

The three cities gathered numerous environmental, health, social and economic information. However, although useful for context, only a fraction of these data will be of use for the for the CLEVER Cities objectives. Nevertheless, we cannot fail to consider the existing relevant data as much as possible to be the most efficient in resource management. This will enable the project to focus resources on the topics not conventionally covered by the city´s management system or where evidence gaps have been identified. In the next Figures (Figure 8, Figure 9, Figure 10), a summary of each city´s baseline is shown. From a first glance, air quality, access to green space (greening mapping and distance to greening), housing price, demographics of population, noise levels and to less extent biodiversity and physical health information are among data most usable data to evaluate the desired outcomes.
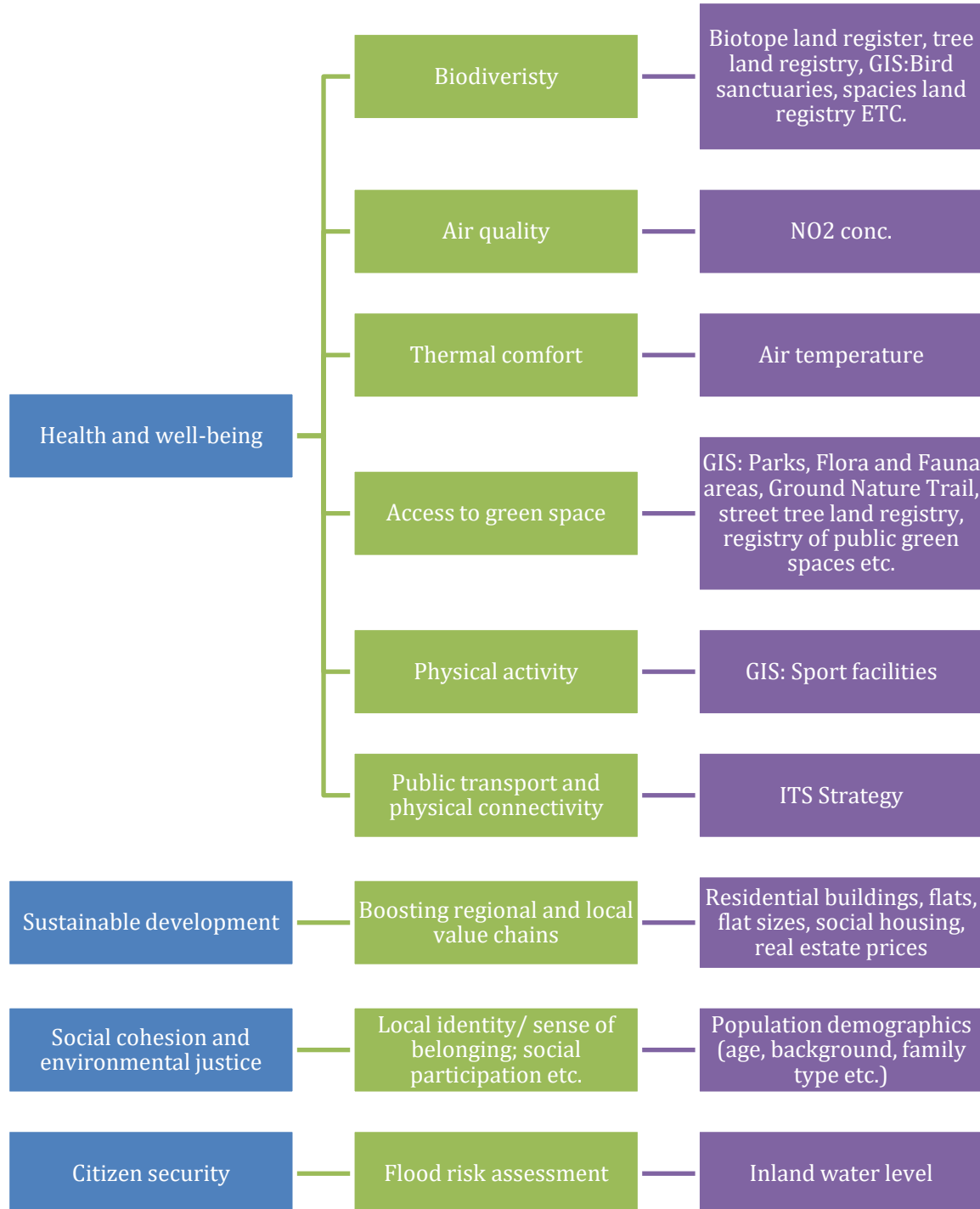
3.1.1. HAMBURG

Figure 8. Hamburg´s available baseline information. In blue: challenges; in green: topics; in purple: registered baseline information
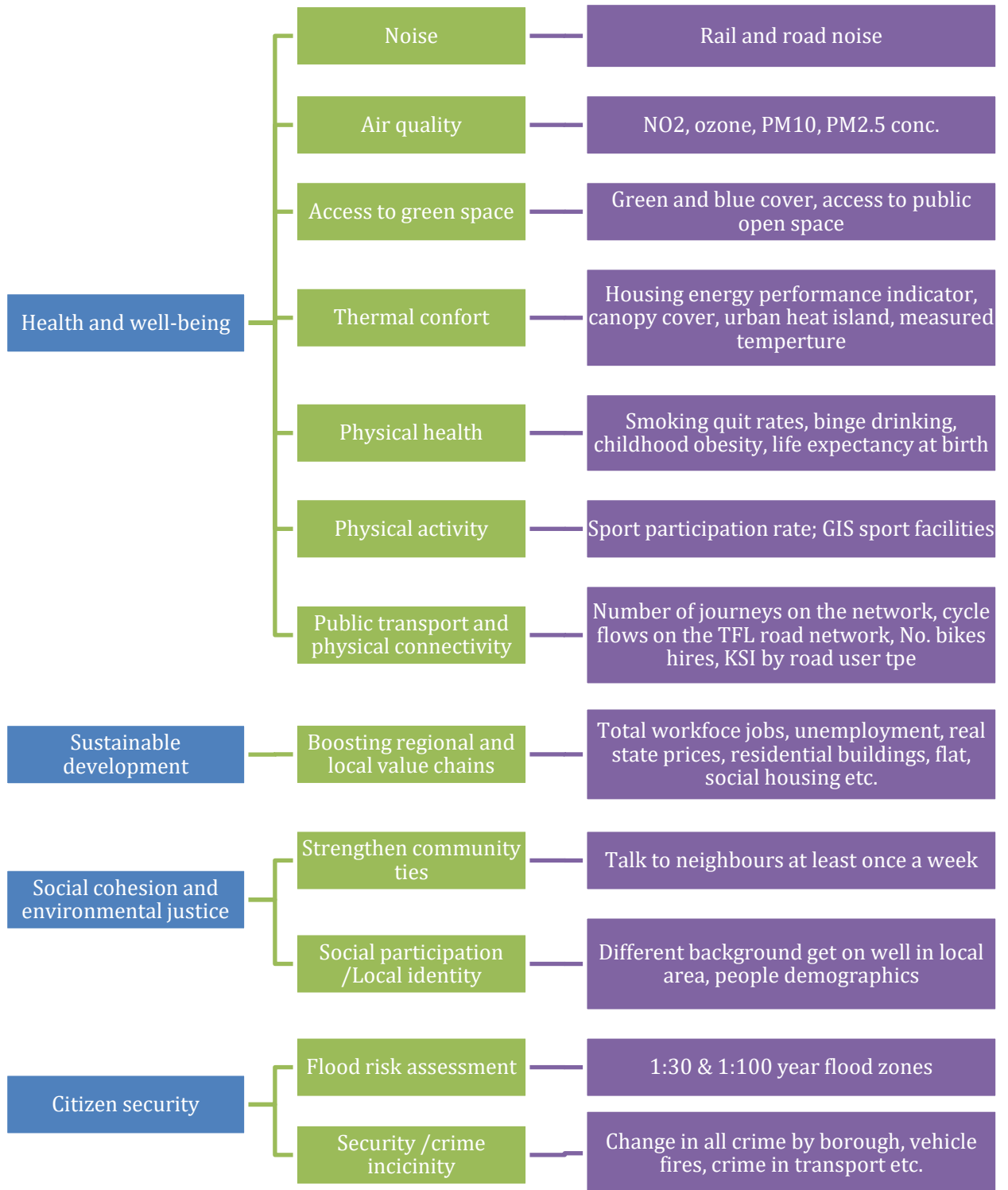
3.1.2. LONDON

Health and well-being	Noise	Rail and road noise
	Air quality	NO2, ozone, PM10, PM2.5 conc.
	Access to green space	Green and blue cover, access to public open space
	Thermal confort	Housing energy performance indicator, canopy cover, urban heat island, measured temperture
	Physical health	Smoking quit rates, binge drinking, childhood obesity, life expectancy at birth
	Physical activity	Sport participation rate; GIS sport facilities
	Public transport and physical connectivity	Number of journeys on the network, cycle flows on the TFL road network, No. bikes hires, KSI by road user tpe
Sustainable development	Boosting regional and local value chains	Total workfoce jobs, unemployment, real state prices, residential buildings, flat, social housing etc.
Social cohesion and environmental justice	Strengthen community ties	Talk to neighbours at least once a week
	Social participation /Local identity	Different background get on well in local area, people demographics
Citizen security	Flood risk assessment	1:30 & 1:100 year flood zones
	Security /crime incicinity	Change in all crime by borough, vehicle fires, crime in transport etc.

Figure 9. London´s available baselin information. In blue: challenges; in green :topics; in purble: registered baseline information
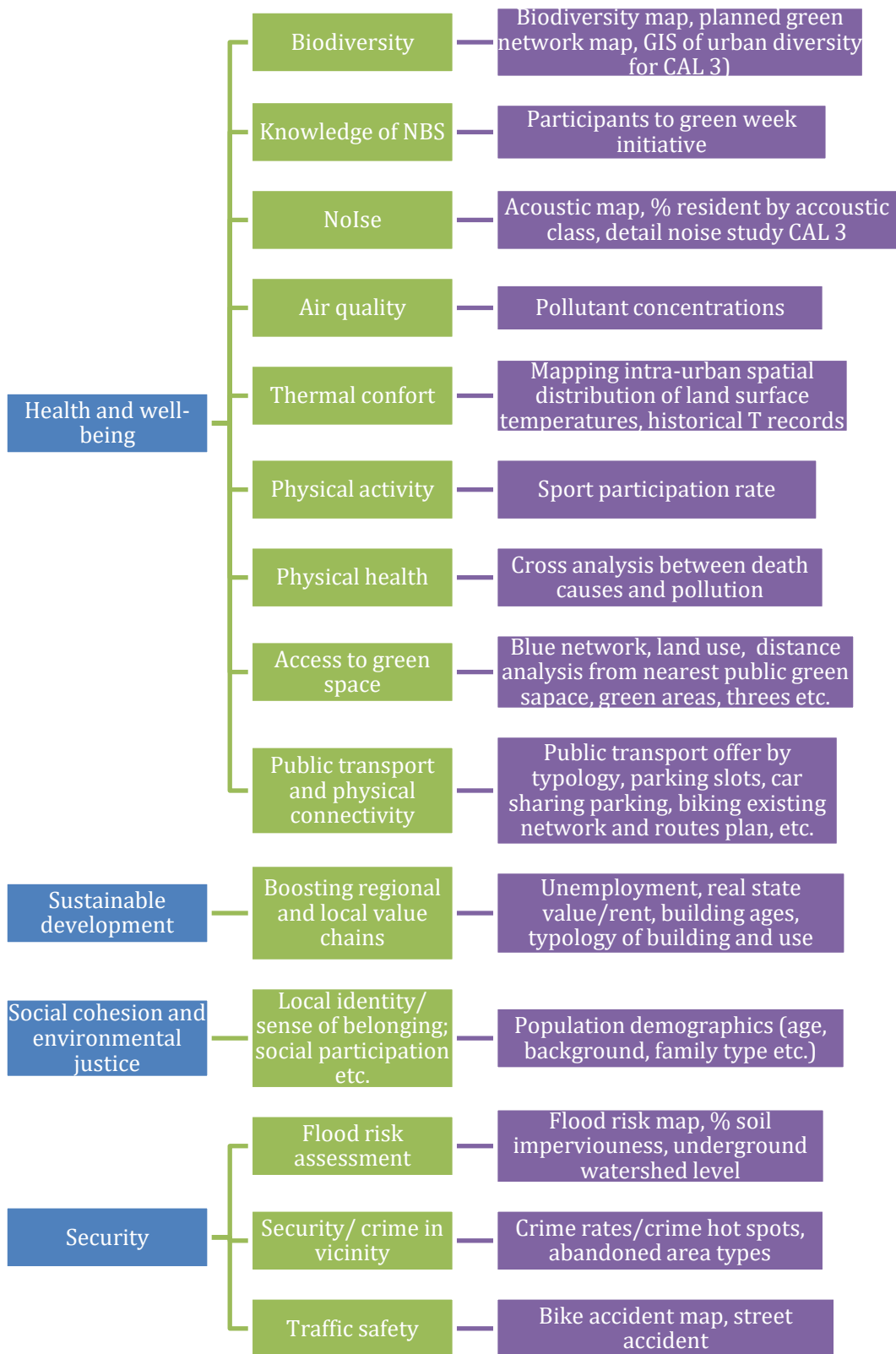
3.1.3. MILANO

Figure 10. Milano´s available baseline information. In blue: challenges; in green: topics; in purple: registered baseline information

3.2. Factors determining the assessment and monitoring the impact of NBS

Based on the roundtable discussions, all cities plan to apply a dual approach through which physical changes (such as creating new NBS or improving existing green space) are accompanied by social activities to ensure that any new NBS interventions are embraced by the local community Thus, the assessment and monitoring of NBS impact in the CLEVER Cities interventions require complex methods. In that sense, mixed monitoring methods were discussed and agreed to be the most suitable options:

- quantitative data collected through surveys, observations or measurements - provides valid and comparable information on use and impacts of NBS.

- qualitative data compiled through interviews and focus groups - helpful to explore the meaning of NBS to an individual/group, and to understand personal/group/community preferences and concerns.

A wide range of factors affect the impact of NBS on CLEVER Cities challenges. There is already knowledge on how specific factors impact on health & well-being and economic development. There are three main determining key points for the assessment and monitoring of NBS impact in CLEVER Cities project:

- target groups

- temporal factors

- spatial factors/scale

In the beneath text, a description of how these factors affect for two of our CLEVER Cities urban challenges.

3.2.1. Challenge 1: Human health and well-being

Target groups

Given the range of urban green space interventions and acknowledging the different functions green space provides to different population groups, monitoring and evaluation should not only investigate population-level outcomes but also consider equity for specific groups – especially disadvantaged or underrepresented demographics ore groups. Based on the CALs objectives

there are different target groups including: pupils and parents, migrants and refugees, elderly, etc. The assessment will differ for each of these groups.

Considering that urban green spaces are a local resource for the whole community, it is important not to exclude some user groups through e.g. monofunctional green space design. Thus, in addition to monitoring the use of the green space and the satisfaction among users it is also important to collect data from people who aren't using the green space and to understand what the related causes and potential barriers are.

Temporal factors

Considering the time frame for the project's outcomes to be realised it is important to emphasize that environmental impacts may occur more quickly than social or health impacts. In that sense, short-term immediately visible improvements are the initial outcome that can be assessed immediately after the intervention (urban green quality, aesthetic, amenities, etc.). Intermediate outcome is assessable after some period of time during the project (use and function, individual status and perception, social environment) while long-term health outcome (mortality rates, life expectancy, cardiovascular disease, obesity, etc.) will not be assessed during the project because it requires longer time span and it is influenced by many interweaving factors.

World Health Organization[5] emphasizes that 'unless there is professional support from health experts, local projects should be careful to use objective health parameters (such as body mass index or cardiovascular disease) to document the impact of their interventions'. However, based on scientific literature it can be argued that improvement of urban green space (NBS) characteristics has a positive impact on setting features, use and function as well as on environmental regulation services that influence pathways to health and result in improved health status and well-being (please see Figure 11).

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[5] WHO, 2017.Urban green spaces: a brief for action. http://www.euro.who.int/__data/assets/pdf_file/0010/342289/Urban-Green-Spaces_EN_WHO_web3.pdf?ua=1
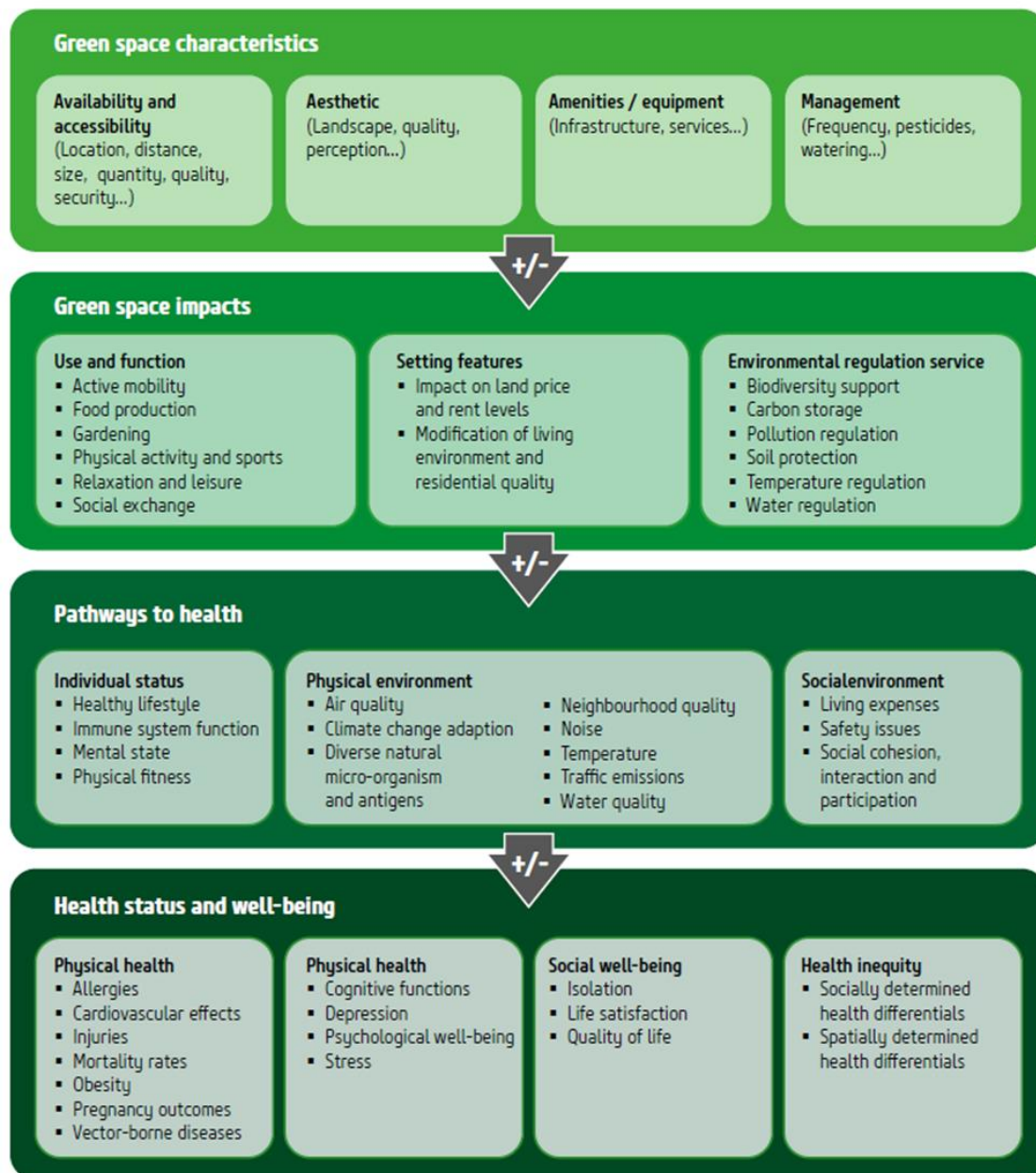
Figure 11. A casual model of the impacts of urban green spaces on health and well-being. Source: WHO

Although specific health outcome like decrease in obesity rates cannot be 'visible' during this project, it is possible to measure change in aspects that are root causes of obesity (e.g. little leisure space for physical activity or unhealthy eating habits).

Spatial factors/scale

Beside the temporal component, there are different geographic scales for the assessment of the performance of NBS:

a. on the NBS scale

- green space: characteristics (availability and accessibility, quality, aesthetics, amenities/equipment, management), use and function (physical activity, active mobility/connectivity, food production, gardening, relaxation and leisure, social exchange) – observations, measurements

- individual status and perception: life satisfaction/quality of life, self-reported health and well-being, perception of green space quality and perception of social actions – surveys, interviews

- social environment: social cohesion, interaction, participation, safety – surveys, interviews, focus groups

b. on the neighbourhood scale - to what extent NBS influences:

- neighbourhood quality, active mobility/connectivity/barriers, sense of belonging, living expenses

c. on the city scale

- replication of NBS in other neighbourhoods/city districts

3.2.2. Challenge 2: Economic development and opportunities

Temporal factors

As already known, the primary objective is to assess the change in the CAL areas before and after the implementation of the NBS interventions. Thus, the immediate change in the territories itself as well as a direct comparison with similar regions without any intervention is possible to measure.

This results in two temporal components:

- **Data before the intervention**

- **Data after the intervention**

Most of the pre-intervention status quo data can be obtained from existing databases and need to be re-evaluated only after the interventions.

Despite the tight timeframe between implementation and project end, it can be expected that some of the economic parameters related to NBS can be evaluated until the end of the project (e.g. Investment, Funding, Open Innovation).

However, there will also be factors that will be valuable as the first interim results at the end of the project but will continue to change over time (e.g. real estate price, job opportunities, number of start-ups, house market and neighbourhood stability, people knowing about NBS).

Functions such as the buffer effect of the NBS during heavy rain events reduce the load on the infrastructure and thus reduce costs. In addition, the positive impact of green spaces on health should not be ignored, which in the medium and long term also reduces the costs of the health system.

These are just a few examples of parameters that can be used to calculate cost savings caused by NBS only in the longer term and in the connection of lots of data. One study of note is London's Natural Capital Account that found that London's public parks have a gross asset value in excess of £91 billion.[6]

In general, it should be mentioned that indirectly determined costs - regarding value of green space, social and health impact - are more complex to gain than costs with regard to investment and suchlike.

Therefore, also see the graphic in Figure 12- Benefits and costs of street trees, which illustrates the positive and "negative" effects of street trees. Looking more closely at the individual factors, it can be seen that it is usually easier to measure the costs caused by trees (NBS). Whereas most of the economic benefits based on the positive impacts have to be gained over a longer period of time and indirectly in the merging of many data and factors.[7]

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[6] https://www.london.gov.uk/sites/default/files/11015viv_natural_capital_account_for_london_v7_full_vis.pdf

[7] Swinbourne and Rosenwax (2017): Green Infrastructure, a vital step to brilliant Australian cities.
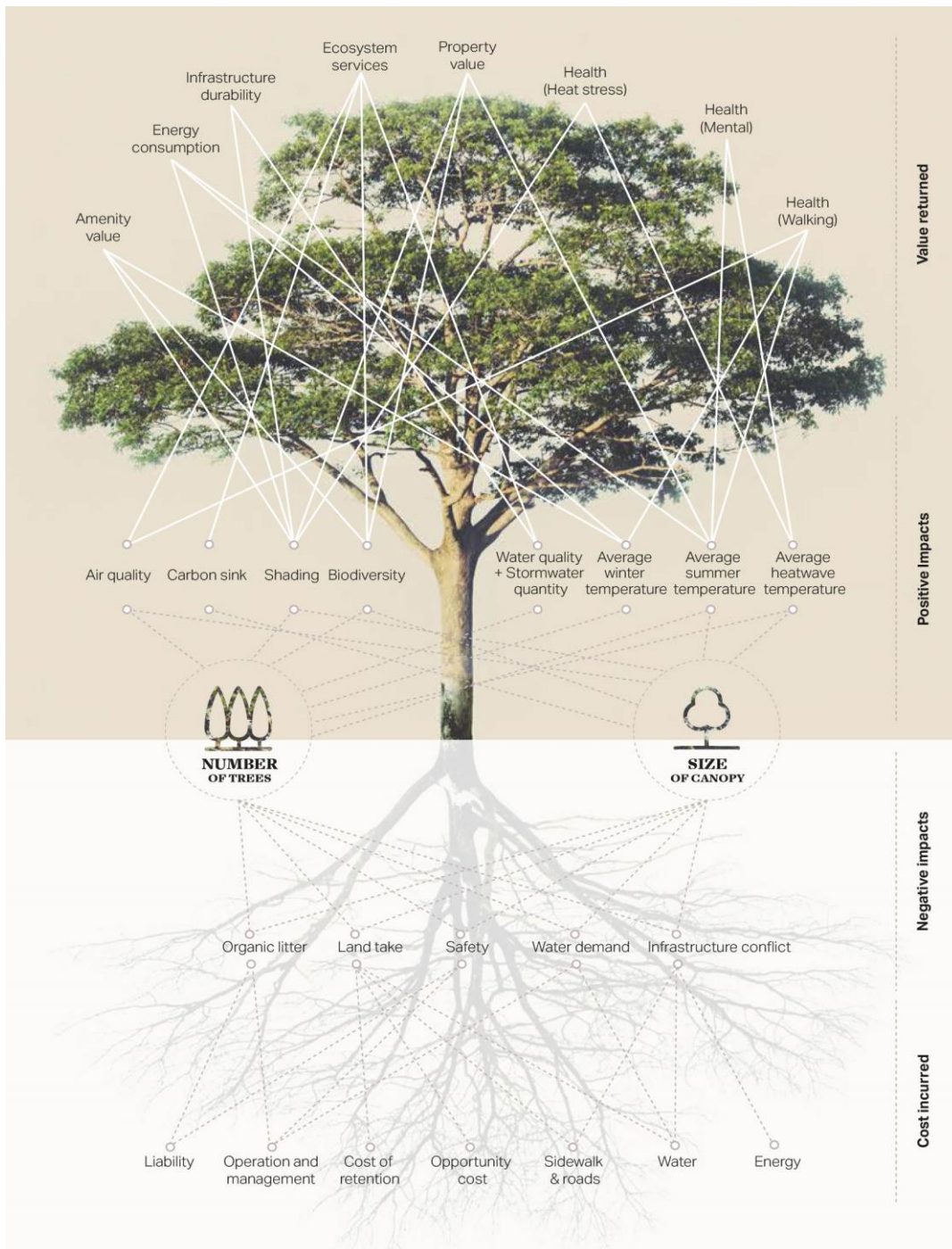https://waterbucket.ca/gi/files/2017/04/Green-Infrastructure-vital-step-brilliant-Australian-cities.pdf

Figure 12. Benefits and cost of trees. Source: Swinbourne and Rosenwax (2017): Green Infrastructure, a vital step to brilliant Australian cities.

Spatial factors/scale

In addition to the temporal factors, three spatial components are influencing the assessment of the economic impact of the NBS interventions.

NBS (object-related): Investment, Funding, value of green space

CAL (region-related): new jobs in the area, PPPs, total investment, open innovation related to the region, crowdfunding, rental price in the region, Knowledge about NBS

City (city-related): Since the comparison with other regions in the city, in which no NBS interventions take place, is intended, it is important to consider the whole city with its comparable areas.

Target group

Of course, the people affected by NBS in the CAL regions are also a significant factor. In connection with economic development and opportunities, these are usually affected indirectly.

Based on the CALs objectives there are different target groups including: residents, children/pupils and parents, migrants and refugees, elderly, potential workers for new created jobs (professionals and volunteers and start-ups).

3.3. Cross analysis between CALs and in the European Monitoring Framework

The assessment of the effectiveness of any solution includes its validation under various environments or conditions. Urban environments are complex systems where many elements are interlinked. NBS have been proposed as potential urban regeneration solutions to tackle several challenges. To prove the accuracy of such claims the assessment of the expected outcomes need to be monitored and evaluated, preferably in multiple settings. Thus, the potential benefits of NBS need to be corroborated and assess the extent to which NBS are capable of reaching specific goals.

This section aims at finding common ground on the evaluation and monitoring among the CLEVER FR Cities and at framing the KPI indicator selection within the European Monitoring Framework.

Table 15. Cross analysis of posible shared KPIs among CLEVER FR Cities

Topics where KPIs may be shared	Hamburg	London	Milano
Participation (e.g. number of users/ visitors/ participants)	X	X	X
Appreciation of NBS		X	X
Knowledge related to NBS	X	X	X
Quantification of green area	X	X	X
Noise measurement	X		X
Air quality measurement	X		X
Housing price monitoring	X		X
Perception of security	X	X	X

After the revision of all KPIs considering all CALs, shared links have been identified. Table 15 shows the topics where it is more likely to find common basis to establish identical or very similar KPIs. For example, in the three cities it is recurrent to find KPIs related to the number of people visiting the NBS or participating in events. However, small nuances may be present among KPIs. Another example of common selected KPI is the "House and apartment price per m^2" as a way to evaluate the boosting of local value chain. However, probably due to the higher difficulty to evaluate the impacts of urban green spaces on health and well-being, few KPI directly related to health have been found.

A first review of EU funded Horizon 2020 projects, e.g. the EKLIPSE or NATURE4CITIES, research works and ThinkNature Taskforce, indicated that the structure indicators of the CLEVER Cities is aligned with the general KPI framework. Indicators with a long history like "air quality - pollutant concentration" are well defined where there is less of a discussion not only in the definition but also in the metrics. However, for the evaluation of health, well-being or social impacts the debate is still opened. CLEVER Cities in the course of the project will work for bringing some light to this complex issue.

4. Local monitoring plan approach

5.1 Monitoring Plans in cities

This section is devoted to present the general criteria for the Local monitoring Plan in the Front Runner cities. On that sense the elements that are presented are the key ones that must be defined to obtain an operative and feasible monitoring process:

-        Stakeholders for monitoring: relevant roles for monitoring are presented and can be divided in 4 general categories: research activities, strategy or decision-making process, development of the monitoring and assistance-support.

-        Tools for monitoring: details about the tools that will be used for the KPIs gathering are presented in a very general approach. These tools will be linked to the specific metrics to asses KPIs that must be defined with more detail in each CAL in order to assure the impact assessment to trach the outcomes achievement.

-        Schedule for monitoring: the pre-greening and post-greening scenario has specific time line requirements regarding the project but also for the NBS impact assessment. Also, a coordination with the procurement and public works of the interventions in CALs must be developed.

4.1.1. London

STAKEHOLDERS FOR MONITORING

There are a number of stakeholders that will be involved in the monitoring and evaluation of CLEVER London. These stakeholders will be involved in a variety of ways and depths.
The first point to consider when deciding what types of tools we will use for monitoring is understanding what type of questions we want to answer. Through the process of developing the ToC and starting to identify priority outcomes, it became very apparent that much of the data we will be gathering will be qualitative. This data which is expected to have a fairy small sample will nevertheless be very rich.

Table 16. Stakeholders definition for London

Organisation	Role	Level of Involvement
Peabody	Strategic evaluation lead	High
Peabody, GLA & Groundwork	Oversight of evaluation plan	Medium
ARUP, TSIP, Uni Greenwich	Technical and academic advice	Medium
University of Greenwich	Research Assistant	High
GLA Opinion Team	Opinion research advice and strategy	Medium
Groundwork	Community UIP Lead	High
GLA	Strategic UIP Lead	Medium
Urban Mind Research Group	Digital Crowdsource Support	Medium

TOOLS FOR MONITORING

At present the methods for our approach to evaluation is still being determined. The CLEVER London team are working towards agreeing our priority KPIs – once this has been completed a research assistant from University of Greenwich will provide the necessary academic verification and support on developing a methods paper. However, in the workshops held in Bilbao, it became apparent that most of the data, based on the identified KPIs, will be qualitative and observational rather than quantitative. We are committed to the involvement of local stakeholders and the use of citizen science as a way to engage and upskill interested local partners. We are exploring with the Economic Development team at Peabody, how we could recruit 5-10 research assistants who would provide the much needed on the ground support. They would be rewarded by both pay and training.

Below is an outline of the types of tools we expect to use across each of the CALs:

Table 17. Types of tools London expects to use in ach CAL

Tool	CAL 1	CAL 2	CAL 3
Focus Group	✓	✓	✓
Interviews	✓	✓	✓
Observational Work	✓	✓	✓
Ethnographic Study	✓		
Questionnaires	✓	✓	✓
Community walks	✓	✓	✓
Annotative Image Mapping	✓	✓	
Drone footage	✓	✓	✓
Film footage	✓	✓	✓
Acoustic sensors		✓	
Water quality testing		✓	
Activity monitors e.g. Health app or pedometers	✓	✓	
Digital route mapping	✓		
Urban Mind app	✓	✓	✓
Crowd sourced photography	✓	✓	✓
Time lapse photography	✓	✓	✓
Biobliz with children	✓	✓	✓

SHEDULE FOR MONITORING

Below is the draft schedule for pre-greening. This will be further developed in the coming months. As the methods paper is firmed up, more detail of pre-greening and ongoing monitoring will be available. Key to our approach is to ensure that monitoring gets built into the activities we will be running – this is to ensure that monitoring is both effective and not ponderous.

Table 18. Pre-greening schedule 2019

June	Water quality testing
	Opinion research at community events
	Pilot observational work
July	Opinion research at community events
	Observational work in all CALs
	Water quality testing
Aug	Opinion research at community events
	Focus groups
	Water quality testing
Sep	Drone and film footage
	Observational work in all CALs
	Annotative image mapping
	Drone recording
	Focus group
	In depth interview
	Thamesmead opinion survey
	Water quality testing
Oct	Opinion research schools
	Physical activity monitoring – schools children (TBC)
	Community led guided walks
	Pilot Urban Mind app
	Digital route mapping
	Ethnographic study
	Crowd sourced photography
	Water quality testing
	Annotative image mapping

Nov	Acoustic monitoring
	Pilot Urban Mind app
	Digital route mapping
	Water quality testing
	Opinion research schools
	Annotative image mapping
Dec	Opinion research schools
	Opinion research at community events

4.1.2. Hamburg

STAKEHOLDERS FOR MONITORING

For monitoring and evaluation of the interventions that will be implemented in the scope in the scope of the CLEVER Cities project, different institutions of the Free and Hanseatic City of Hamburg will be involved. Their contribution to monitoring will vary in type and scope. The following

Table *19* gives an overview of the involved institutions along with their level of involvement. There are two possible levels of involvement: "High" and "Medium". While "High" means this organization will have the main responsibility or will be involved in the monitoring activities on strategic and supervising level. "Medium" level of involvement indicates a rather contributing role to monitoring activities

Table 19. Organisations involved in the monitoring activities (Hamburg Team 2019)

Organisation	Role	Level of Involvement
Steg	Strategic evaluation lead	High
TUHH	Oversight of evaluation plan	High
TUHH, HCU, FHH-BUE	Technical and academic advice	Medium
HCU	Students research work	Medium
Steg	Opinion research advice and strategy	Medium
Steg	Community involvement lead	High
FHH-Bezirksamt Harburg	Strategic UIP Lead	Medium
FHH-LGV	Digital Support; Data Management	High

Organisation	Role	Level of Involvement
FHH-LGV (Possible Cooperation with TU-Berlin for app development)	Digital Crowdsource Support	Medium
Community	Monitoring on site	Medium

TOOLS FOR MONITORING

The tools that will be used for the monitoring activities depend mainly on the issue that is evaluated. This requires developing a precise idea of which results, or processes should be evaluated within the framework of the project (see Chapter 3). After developing the Theory of Change workshops and the desired long-term goals of our interventions, it became very apparent that much of the data we will be gathering will be qualitative. Usually these data are based on a rather small sample but nevertheless able to provide very rich information, depicting very individual and local sensitivities. In the case of CLEVER Hamburg mirrors perfectly with monitoring activities the interventions in Neugraben-Fischbek at small scale with a rather local impact.

The monitoring activities will be supervised and planned by the project partners but will also involve local citizens to a large extent with the possibility to include student projects. In general, the Urban Data Platform Hamburg forms the digital basis for the monitoring activities: FHH-LGV operates, provides and steers and implements the ongoing development of the Urban Data Platform and provides advise on its usage as well as on the integration, interconnection and retrieval of data.

Besides common qualitative tools, such as questionnaires and interviews, also digital devices and tools will be deployed, including apps for mobile devices. Specifically, to investigate the perceived security in the project area, the LMT is currently evaluating possibilities for a cooperation with a chair of the Technical University of Berlin, where researchers developed an app for mobile devices which is based on a citizen-centric crowdsourcing approach: it enables users to report their personal perception of safety anytime and at any site as well as to explore and experience the collected data in their surroundings, depending on the current location. For CLEVER Cities, the app could be adapted, such that it does not only ask for a basic assessment of the safety at the given location, but also offers the possibility to elaborate on which measures may improve that perception. The resulting targeted data collection about the perceived safety in specified areas could reveal a comprehensive and complete picture of the perceived safety in the respective urban environment, which may support the prioritization of places in the project area for upcoming interventions and also help to identify discrepancies between actual crime rates and

incidents and the subjective feeling of insecurity. Thus, deploying the app and including the resulting data in the local monitoring activities may serve as a basis for both clarification and prevention of actual crimes through environmental design, resulting in a true co-creation with residents. The Table 20 below gives an overview of the deployed tools across each of the CALs.

Table 20. Tools overview (Hamburg Team 2019)

Tool	CAL 1	CAL 2	CAL 3
Focus group interviews	✓	✓	✓
Participatory sensing	✓	✓	
Questionnaires	✓	✓	✓
Annotative Image Mapping (Finding Places, DIPAS online participation tool and touch table for on-site participation)	✓	✓	
"Kiezläufer" Neighbourhood mentors	✓		
Smartphone App for measuring perceived safety	✓	✓	
Acoustic sensors (citizens science)		✓	
Digital route mapping	✓		
Incident reporting ("Melde-Michel" Portal)	✓	✓	✓
Crowd sourced photography (combined with other social media tools)	✓	✓	✓
Social GIS data of local administration	✓		

SCHEDULE FOR MONITORING

The Table 21 below shows the draft schedule for the pre-greening. This will be further implemented in the coming months once the activities in the CALs will be developed in detail. The monitoring of our CALs follows the approach of co-monitoring ensuring empowerment and participation from the local level.

Nevertheless, the procedure described here represents the current state of planning. But due to the uncertain development in the CALs and the resulting changes, the CLEVER Hamburg team will adjust the procedure according to the latest developments and needs. Also, the dynamics of the involvement processes might lead to some minor plan adjustments.

Table 21. Pre-greening schedule 2019 (Hamburg Team 2019)

Month	Activities
June	Pilot observational work (students) Opinion research at community events
July	Observational work in all CALs
Aug	Opinion research at community events Ad Hoc status quo determination Dissemination and presentation of digital tools for safety perception
Sep	Observational work in all CALs In depth interviews Questionnaires local situation
Oct	Opinion research in schools Community led guided walks Digital route mapping Crowd sourced photography Opinion research at community events
Nov	Acoustic monitoring Opinion research in schools
Dec	Opinion research in schools Opinion research at community events

5.1.3 Milano

STAKEHOLDERS FOR MONITORING

All members of Local Cluster team will be involved in the monitoring and evaluation of CLEVER Milano, with also some additional representatives of UIP or CAL stakeholders, such as OMD cited in the following table, selection of Stakeholders for monitoring support is an ongoing process, during co-design of CAL actions. These stakeholders will be involved in a variety of ways and depths, even varying from one CAL to another, since actors and site location are different for each CAL in Milano. Particularly CAL1 monitoring will be supported by owners of buildings were experimental Green Roof and Walls will be located, once these buildings will be selected through public tender that is set to be published in September 2019.

Table 22. Stakeholder definition for Milano

Who	Organisation	Role
CDM, Coppi	CDM AMAT	Strategic evaluation lead
Dajelli, Morello, Bono, Vona, Coppi CDM	ITALFERR Polimi AMB ELI AMAT CDM, OMD Osservatorio Metereologico Duomo	Tecnical and academic advice
Vona, CDM, FPM,	ELI - CDM FPM	Survey Strategy and Assistant
Vona Dajelli	ELI ITALFERR	Biodiversity monitoring
WWF CDM	WWF CDM	Information channels monitoring
Fiori, Coppi, Dajelli	AMAT ITALFERR POLIMI (ABC)	Sensor monitoring
CDM, Bono, Forbici Prampolini, Vona	CDM AMB Assofloro WWF ELI	UIP Lead and engagement monitoring
CDM, D.Resilenza +URB, Coppi, Lorenzi	CDM AMAT FPM	Data transfer and platform, GIS Mapping

TOOLS FOR MONITORING

In Milan, since almost all the interventions are aimed to answer to social challenges through NBS use, in application of H2020 SCC-2 2017 Topic as detailed in CLEVER proposal, during TOC workshop emerged that a significant part of monitoring data will be qualitative and social surveys

analysis. By the same time, since experimental NBS in the built environment, particularly Green Roofs and Walls in CAL1, and Green Walls in CAL3 - Tibaldi train stop, are reviewing performances in heat island and flash floods mitigation, also quantitative analysis and physics measurement are envisioned, particularly spot measurements, considering small scale of these interventions.

Also in Milano, definition of methods for our approach to evaluation is still an ongoing process. The CLEVER Milano team is gathering scientific advice from FPM / POLIMI (both from DASTU/Urban Studies Dept., both from ABC/Architecture, Building-engineering and built-environment Dept.) and technical expertise from AMAT, ITALFERR, AMB and ELI to reach a methodology that will at the same time scientifically sound, and easily applicable also by stakeholders and public that will take part to co-monitoring in practice. Particularly social surveys will be supported by expertise both from local cluster experts (ELI, FPM/POLIMI) and also from Social Empowerment experts working on Lorenteggio/Giambellino Rehab with CDM

List of possible tools and activities is still under construction, and scrutiny:

Table 23. Types of tools Milano expects to use in each CAL

Tool	CAL 1	CAL 2	CAL 3
Focus Group	X	X	X
Interviews/Questionaires	X	X	X
Observational Work		X	X
Community walks	X	X	X
Annotative Image Mapping	X	X	
Drone footage or Aerial and Satellite Mapping	X		X
Film footage	X	X	X
Accoustic sensors		X	X
Activity monitors e.g. Health app or pedomitors		X	
Digital route mapping		X	X
Urban Mind app https://www.urbanmind.info/#hometop		X	
Digital co-monitoring		X	X

Tool	CAL 1	CAL 2	CAL 3
Crowd sourced photography		X	
Time lapse photography		X	X

SHEDULE FOR MONITORING

Below is our draft schedule for pre-greening monitoring. This will be further developed in the coming months, so more details of pre-greening and ongoing monitoring will be provided on revision of local monitoring plan. Particularly, as defined in D.2.2, each CAL in Milano has separate timing and location, so monitoring schedule has to be adaptive to each co-creation roadmap, and pre-greening monitoring will be developed during next 18 months according to each CAL program of activities and available access to construction sites.

Table 24. Pre-greening schedule 2019/2020 for Milano

	GENERAL	CAL1	CAL2	CAL3
Summer 2019	• Baseline finalization and check	• Existing green roof mapping and case study analysis	• Significant SH interviews	• Thermal data Heath island measurements if possible
Fall 2019	• Social Network and communication monitoring	• Accounting of training and promotional events participants	• Pre-intervention perception surveys and interviews	• Acoustics monitoring • Pre-intervention perception surveys and interviews
Winter 2019-20		• (selection of GRW proposed sites)	• Pre-intervention perception surveys and interviews	• Run Off measurement or modelling
Spring 2020		• Run Off measurement or modelling		

		• Thermal data Heath island measurements		
Summer 2020		• Thermal data Heath island measurements	• Thermal data Heath island measurements (after soil remediation)	• (start) Thermal data Heath island measurements on train stop building, before NBS application
Fall 2020				
Winter 2021				

5. Next steps

Monitoring and evaluation is an on-going part of any urban implementation strategy. CLEVER FR Cities have made good advancement towards defining a preliminary list of KPIs for the assessment of NBS impact. However, the fine-tuning of the monitoring data model for each city is envisioned. There are various points to address before the final monitoring plan is set:

- A final process of reflection to determine if the chosen KPIs are the most suitable /enough to evaluate the identified outcomes

- A discussion about the metrics for each KPIs will help to define the KPI and determine what will be measured, the frequency of measurement and the comparability of KPIs

- A discussion about the methods to capturing data for each KPI

- The abovementioned point will promote a dialogue on how to assess a cross analysis and comparability study within the CLEVER Cities.

After these points have been analysed and discussed the cities will be in a position to agree upon common KPIs and can challenge themselves to include innovative or new indicators when relevant.

Moreover, CLEVER Cities also need to advance in the definition of the Local Monitoring Plan and the data platform.

Annex A. Identified KPIs associated to topics

CHALLENGE	TOPICs	KPIs	BRIEF DESCRIPTION
Regeneration Challenge 1: Human health and well-being	Healthy eating/healthy food	Gardening space per area	Proportion of area attributed to gardening spaces, in %
	Physical activity	Physical activity in CALs	Proportion (%) of people using CAL areas for walking, cycling, outdoor activities (e.g. gardening) Proportion (%) of people visiting green space: 1. three or more times a week 2. less than once a month Proportion (%) of people who feel it is unsafe to walk at night
		Number of individuals walking and cycling in and around areas of interventions	Counts people who are using the new developed facilities

CHALLENGE	TOPICs	KPIs	BRIEF DESCRIPTION
	Physical health	Self-reported general health status and medication use	Proportion (%) of people feeling 1. 'good' and 'very good' in the past 12 months 2. 'bad' and 'very bad' in the past 12 months Percentage of people reporting medication use (hypertension, diabetes, pollen allergies, sedatives…)
	Public transport and physical connectivity (Active mobility)	Public transport and physical connectivity	Proportion of the intervention area in walkable distance to public transport stops, in % Road traffic accidents by mode of travel in the intervention area per year Proportion of the area attributed to pedestrian routes and trails with quality streetscapes, building façades and ground floor frontages
	Access to green space (NBS, including blue)	Availability of parks and/or ecosystem services with respect to specific individual or household socioeconomic profiles	Looks on the number of greenspaces in the neighbourhood and how many people profit from it

CHALLENGE	TOPICs	KPIs	BRIEF DESCRIPTION
	Urban heat island	Thermal comfort score	
		Weather-related mortality	Mortality rate - heat-related causes (summer, age 65-75)
		Surface temperature; air temperature	Records the temperature at a specific spot before and after the intervention and calculates the changes
		Urban Heat Island Index (UHI)	RAMSES FP7 project followed this approach: UHI intensity based on 8-day averaged daily mean land surface temperature (LST, i.e. skin surface temperature) data during summer months (June-August). Data from MODIS (MOD11A2, MYD11A2) datasets. Other studies considered the information from the meteorological stations located inside (urban) and outside (rural) the city and compared the air temperature data to find the UHI index.
	Thermal comfort (perception)	Estimation based on coefficients of plants used reduction capacity	
		Wind chill temperature	Determines the perceived temperature from temperature (T) and wind speed (V)

CHALLENGE	TOPICs	KPIs	BRIEF DESCRIPTION
		Index of thermal stress (ITS)	Ratio between the rate of sweat necessary to maintain the thermal equilibrium to the cooling efficiency of the body based on the microclimate and clothing characteristics
		Predicted mean vote (PMV)	It is an empirical index applicable for field measurements of thermal comfort or indoor analysis based on the Fanger comfort model
		Physiologically equivalent temperature (PET)	It is "the air temperature at which, in a typical indoor setting (without wind and solar radiation), the heat budget of the human body is balanced with the same core and skin temperature as under the complex outdoor conditions to be assessed
		Standard Effective Temperature (SET)	It is an out-door adaptation of an indoor index based on the effective temperature by considering the mean radiant temperature
		Universal Thermal Climate Index (UTCI)	It is an indicator based on the multi-node dynamic thermo-physiological UTCI-Fiala model that defines thermal effects on the whole human body

CHALLENGE	TOPICs	KPIs	BRIEF DESCRIPTION
	Air pollution/quality	Non-spatial indicators of gross quantities: annual amount of pollutants captured/removed by vegetation	
		PM10, PM2.5, NO2, Ozone	Concentration of pollutants
	Noise (acoustic environment)	Lnight	Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002
		Lden	
	Impact of noise (psychosocial) /	Sleep disturbance	ISO/TS 15666:2003 Acoustics -- Assessment of noise annoyance by means of social and socio-acoustic surveys
		Annoyance at home	
		Annoyance outdoor	
		Perceived noise	Percentage of people fairly or very disturbed by environmental noise in the intervention area
	Soundscape	Soundscape (SSC)	ISO 12913-1:2014 Acoustics -- Soundscape -- Part 1: Definition and conceptual framework ISO/TS 12913-2:2018 Acoustics -- Soundscape -- Part 2: Data collection and reporting requirements

CHALLENGE	TOPICs	KPIs	BRIEF DESCRIPTION
	Health literacy	Health Literacy, Food Label Use, and Dietary quality eating behaviour in Young Adults	Proportion (%) of young adults understanding health information and dietary components on food labels
	Mental health (incl. stress, anxiety)	Self-reported mental health status	Percentage of people reporting mental well-being on the scale from 0 to 5
	Food growing	TBD (To be determined)	
	Knowledge of NBS	Number of volunteers	Counting the participants in an event in the CAL (e.g. tree planting action etc.)
	NBS volunteering	TBD	
	Green Skills	TBD	
	Urban design features	Heights of trees/vegetation density/ visibility index	
	Social co-benefits	Qualitative assessment of user attachment to user preferences on green/blue areas	
	Satisfaction with community	Satisfaction with community/neighbourhood/ NBS	Percentage of people fairly or very satisfied with community/ neighbourhood/NBS with places they like and places they avoid

CHALLENGE	TOPICs	KPIs	BRIEF DESCRIPTION
	Perceptions of equality	TBD	
	Value given to green space by residents	Frequency of site visits	Accounts how often a person visits the respective greenspace
	Sociability of public spaces	Number of people using the space during day/night	
		Social status of people visiting the site	Determines the social status of visitors and counts the number
	Strength of relationships and trust/ social networks	TBD	
	Biodiversity (e.g. soil macrofauna as indicator for soil quality)	Soil macrofauna as indicator for soil quality	Counting earth worms can give a proxi for soil quality (can easily be done with children and amateurs
	Soil quality improvement (Carbon content as an indicator)	Soil carbon content as an indicator	Due to sustainable soil management, carbon contend in the top soil (humus layer) will increase
Regeneration Challenge 2: Sustainable economic prosperity	Boosting regional and local value chains	Number of starts ups (Encourage business start-ups)	Start-ups are defined as young companies (age up to 7 years according to Vienna business agency). They be indicator for innovation and economic development.

CHALLENGE	TOPICs	KPIs	BRIEF DESCRIPTION
		Number of positions (Job Opportunities for professionals/Job Opportunities for volunteers)	Counts the new positions that have been established directly or indirectly by the intervention
		House and apartment prices per m2 (Housing market and neighbourhood stability)	Measures the price development for houses or apartments in the district
		Number of projects handed in (Open Innovation)	Open innovation is a profound method of activating the knowledge of the crowd and generate new innovative ideas. Open innovation is typically organised by public authorities, funding bodies, seed financing fonds and investors. Open innovation calls are broadly published.
	Encourage investment	Total investment OR Investment per m2 OR Investment per CAL inhabitant (General investment)	The interventions in CAL areas are connected to investment not only in NbS but moreover in housing and grey infrastructure. Often, it is not possible to assign the investments to the named realms. The sum of investment in a CAL is described within this project as general investment.

CHALLENGE	TOPICs	KPIs	BRIEF DESCRIPTION
		Investment in NBS	NBS represent a core component of the CALs
		Number of PPPs OR Investment raised by PPPs (Local government budget)	Public-Private-Partnerships represent a well-established means of financing of infrastructure projects. NBS - being a crucial infrastructure component - can be financed by PPPs as well.
		Budget deployed for NBS in CAL areas Budget deployed for all sorts of interventions	Public budgets are commonly used to improve the quality of neighbourhoods and provide infrastructure, both aspects connected to NBS.
		Funding for NBS (Funding)	Funding can origin from different sources, as public budgets or funding associations and programs, as H2020. Funding shall help to raise financing and guarantee certain project qualities
		Number of campaigns OR Investment raised (Crowdfunding)	Crowdfunding opens the possibility to support projects and ideas to the broad public aka crowd. The raised investment may vary strongly as does the size of crowds. The means of crowdfunding can be used to realize common interests, as NBS interventions, in neighbourhoods. Crowdfunding campaigns are

CHALLENGE	TOPICs	KPIs	BRIEF DESCRIPTION
			typically operated on professional platforms and disseminated in the media.
	Environmental impact assessment (economic point of view)	Insurance rates for property with and without NBS (Reduced flood risks)	Pluvial flooding causes damages to private and public property. Due to climate change extreme rain events will occur more often. Therefore, pluvial flooding receives ever more awareness from politicians etc. The insurance industry is aware of the flood risk.
		Insurance rate for health insurance (Reduced health risks)	Heat waves and especially tropical nights have significant negative impact on people's health. The insurance industry is aware of this fact.
Regeneration Challenge 3 Social cohesion and environmental justice	Enhance equal distribution and access to environmental qualities/Accessibility of green public spaces	Measured as distance or time of urban green spaces for population	
	Strengthen community ties	TBD	

CHALLENGE	TOPICs	KPIs	BRIEF DESCRIPTION
	Social participation/ social inclusion	Social participation/ social inclusion	Proportion (%) of people who take part in at least one social activity in the intervention area Proportion (%) of people who volunteer: formally, informally Proportion (%) of people who feel alienated from the community or society general
		Number of groups representatives participating	Gives an information how many representatives of a certain group participate in intervention actions
	Local identity/sense of belonging	Local identity/sense of belonging	Proportion (%) of people not willing to admit they live, work in or associated with the intervention area Proportion (%) of people with feelings of trust and reciprocity or mistrust Proportion (%) of people with perception of personal safety in shared space by age gender, ethnic or cultural group, socio-economic group
		Knowledge about the nature/history of the district	Might be a proxi for identification with the neighbourhood

CHALLENGE	TOPICs	KPIs	BRIEF DESCRIPTION
	Accessibility for different population group	Accessibility	Distance travelled to urban green space segregated by household socioeconomic characteristics (e.g. Income, degree of education, ethnic background/ nationality, age) Proportion (%) of key leisure and recreation opportunities that:1. require payment, 2. have reduced rates for vulnerable groups, 3. are free
	Quality of amenities	amenities	Availability of adequate urban furniture for e.g. seating, public toilets, access to drinking water, shading and baby changing facilities designed to encourage use of public open spaces in the intervention area by a wide range of user groups
	Management of Green space (Maintenance of Public Places)	number of maintenance events on ground to NBS	
	Networks and referral pathways	TBD	
	Involvement in local decision making (voice	TBD	

CHALLENGE	TOPICs	KPIs	BRIEF DESCRIPTION
	and participation)		
	Inclusion of diverse groups in local decision making	TBD	
	Collective action	Number of participants	Gives an information how many representatives of a certain group participate in an action
	SROI (Social Return on Investment)	TBD	
	Self-awareness: behavioural change	TBD	
Regeneration Challenge 4: Citizen security	Flood risk assessment including the assessment of the direct flood damages/ impacts (also with the flood probability/ hazard assessment)	TBD	

CHALLENGE	TOPICs	KPIs	BRIEF DESCRIPTION
	Run-off	Runoff Coefficient and peaks	total rainfall volume/total water detention time Direct measurement of runoff, USDA Curve Number. Unit = mm, Rational Method for estimating 'peak' flow rates for simple urban watersheds/sewers. Units = m3/s or litres/s, Statistical estimation of 'peak' runoff rates for return periods of 5,10,100 years Units = litres/s or m3/s, Process-based hydraulic modelling. Units = various, Rainfall. Standard guage method - logged. Unit = mm
	Navigation and routes to green spaces / Nodes	Functionality of routs; frequency of use	Use frequency gives a proxy for successful intervention
	Use of green space	Number of visitors per day/month	Use frequency gives a proxy for successful intervention
	Security / crime hotspots/crime in vicinity	Number and types of crime committed in the demonstration area per inhabitant OR use	
		perception of safety of pedestrians	Evaluation how the people feel if they use this certain street, place, bridge etc.
	Perceptions of safety and security	Residents' and area users' perceptions of safety	

CHALLENGE	TOPICs	KPIs	BRIEF DESCRIPTION
	Devices contributing to safety	Self-reporting instruments to assess indicators of literacy, numeracy and perceived levels of crime and safety.	
		Example lighting: increase in brightness	If e.g. lighting is improved in a underpass the increase of brightness can be measured
	Traffic safety	TBD	