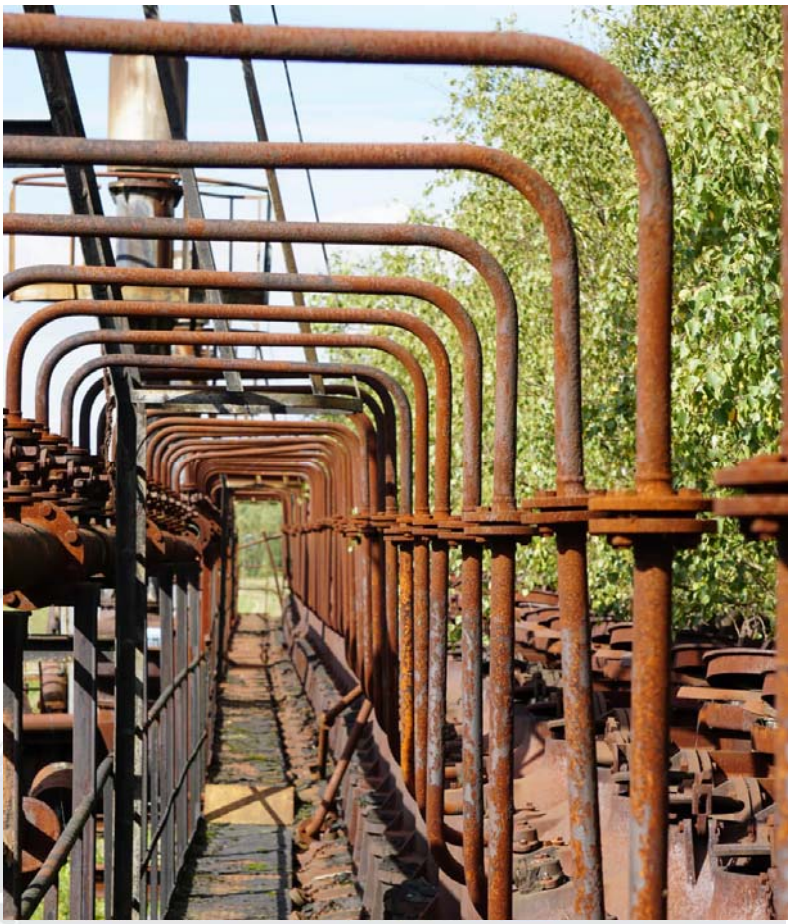
proGIreg



Hansa Coking Plant © ICLEI

Protocols of Measurements

Deliverable 4.3, Amendment 02

Work package: 4

Dissemination level: PU

Lead partner: CNR

Author: Chiara Baldacchini

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Document revision history

Version	Date	Modification reason	Modified by
1	10/12/2019	Inclusion of Ningbo city in the project; changes in the implementation plans as a consequence of the co-design process; improvement of the indicators' methodology and definition due to the involvement of proGIreg in the European Taskforce 2	Chiara Baldacchini
	20/12/19	Minor language corrections	Margot Olbertz
2	25/06/2020	Modification of the Executive Summary as requested by the Reviewers after the first Periodic Report	Chiara Baldacchini

Partner organisations

No.	Name	Short name	Country
1	Rheinisch-Westfaelische Technische Hochschule Aachen	RWTH	Germany
2	Stadt Dortmund	DORTMUND	Germany
3	Comune di Torino	COTO	Italy
4	Grad Zagreb	ZAGREB	Croatia
17	Starlab Barcelona SL	SL	Spain
20	Fundacion Privada Instituto de Salud Global Barcelona	ISGLOBAL	Spain
21	Università degli Studi di Torino	UNITO	Italy
22	Consiglio Nazionale delle Ricerche	CNR	Italy
24	Università degli Studi di Bari Aldo Moro	UNIBA	Italy
33	The Forestry Bureau of Ningbo City (FBNC), City	FBNC	China (People's Republic of)
34	Institute of Urban Environment, Chinese Academy of Sciences	IUE-CAS	China (People's Republic of)

Abbreviations

Dx.x:	deliverable
EC:	European Commission
EWG:	Expert Working Group
FRC:	Front Runner City
GA:	Grant Agreement
GI:	Green Infrastructure
GIS:	geographic information system
LCA:	Life-Cycle Analysis
LL:	Living Lab
NBS:	nature-based solutions
NDVI:	Normalized Difference Vegetation Index
NGO:	non-governmental organisation
PM:	person months
proGIreg:	productive Green Infrastructure for post-industrial urban regeneration
SME:	small and medium enterprise
WP:	work package

Executive Summary

The project entitled “productive Green Infrastructure for post-industrial urban regeneration (proGIreg)” aims at implementing eight distinct types of nature-based solutions (NBS) in specific post-industrial sites of four different cities (called front runner cities - FRC). One of the main goals of the project is to assess the benefits produced by the implemented NBS with respect to four different domains: 1) socio-cultural inclusiveness; 2) increased health and wellbeing; 3) ecological and environmental restoration; and 4) economy and labour market, corresponding to the four tasks of proGIreg Work Package 4 (WP4 – “NBS benefit assessment and monitoring”). The benefit assessment will be mainly performed at the NBS level. Assessment at the Living Lab (LL) district scale will be performed only when reasonable, considering the type of expected benefit and the NBS size. Experimental data will be obtained to assess benefits at the LL district and at the NBS scale, in a pre-post implementation design with at least 24 months between the two survey periods. Spatial data at the LL district and city level will be collected from existing databases or produced by research partners in WP4, on a yearly base, and used to assess benefits at the district scale or to upscale the results to the city level. The experimental approaches that will be adopted are shortly described here. They are presented in detail in deliverable 4.1 (D4.1 – “Monitoring and Assessment Plan”), together with the case studies to be developed within proGIreg. The detailed protocols of measurements per each selected NBS implementation are described in the present deliverable. The NBS implementations to be monitored have been selected in order to ensure as much as possible a 24-months time span between pre- and post-implementation analysis and a cross-city comparison among NBS of the same type implemented in different FRC. This report presents the specific indicators expected to be produced by the benefit assessment analysis. This is a key deliverable for WP4: the indicators provided have been developed in compliance with the guidelines of the EKLIPSE – Expert Working Group (EWG) of the European Commission (EC) and will be used to compare the proGIreg results with those of sister projects within EC Taskforce 2 “NBS Impact Evaluation Framework 2.0”. This manual will be reviewed and updated when necessary.

1. Introduction

1.1. Introduction to the project

Productive Green Infrastructure for post-industrial urban regeneration (proGIreg) is developing and testing nature-based solutions (NBS) co-creatively with public authorities, civil society, researchers and businesses. Eight nature-based solutions, which will support the regeneration of urban areas affected by deindustrialisation, will be deployed in Dortmund (Germany), Turin (Italy), Zagreb (Croatia) and Ningbo (China). The cities of Cascais (Portugal), Cluj-Napoca (Romania), Piraeus (Greece) and Zenica (Bosnia and Herzegovina) will receive support in developing their strategies for embedding nature-based solutions at local level through co-design processes.

1.2. Introduction to the deliverable

The NBS that will be implemented in the four Front Running Cities (FRC) of proGIreg are productive Green Infrastructures (GI) and they will be realized in post-industrial sites with the aim of achieving a number of benefits, classified according to four domains, corresponding to the first four Tasks of the WP4 (Fig.1): Task 4.1 – Socio-cultural inclusiveness; Task 4.2 – Increased human health and wellbeing; Task 4.3 – Ecological and environmental restoration; and Task 4.4 – Economic and labour market benefits. For each one of the proposed assessment domains, specific indicators describing the associated benefits will be quantified.

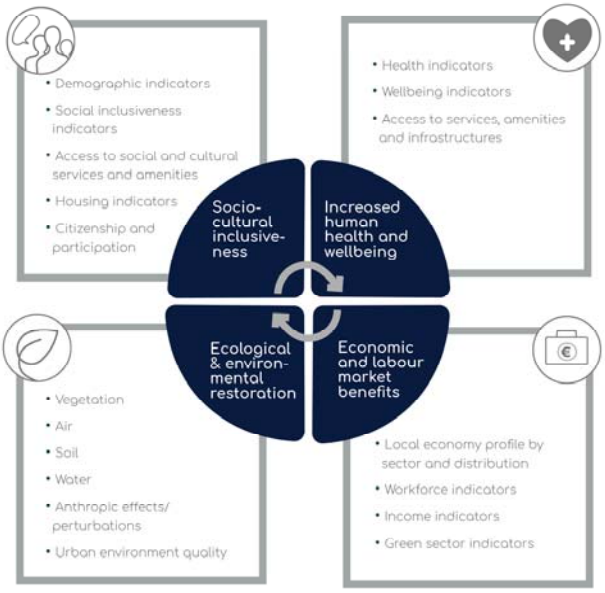

Figure 1 – The four assessment domains of WP4 (Source: ICLEI)

Eight different types of NBS will be implemented and monitored to assess their benefits. Not all the NBS types will be implemented in all FRC. However, when possible, cross-city assessment will also be performed. The different NBS types, which will be described in detail in D3.2 ("Four implementation plans: Dortmund, Turin, Zagreb, Ningbo"), are:

- NBS1: Renaturing landfill sites for leisure use and energy production
- NBS2: New regenerated soil thanks to biotic compounds for urban forestry and urban farming
- NBS3: Community-based urban farming and gardening on post-industrial sites
- NBS4: Aquaponics as soil-less agriculture for polluted sites
- NBS5: Capillary GI on walls and roofs
- NBS6: Making post-industrial sites and renatured river corridors accessible for local residents
- NBS7: Establishing protocols and procedures for environmental compensation at local level
- NBS8: Pollinator biodiversity improvement activities and citizen science project

The monitoring of the benefits provided by the implemented NBS will be conducted at three different scales (city, LL district and NBS level) generating two types of data (Spatial and Experimental). How these data will be obtained, including a description of the theoretical background of each proposed experimental approach, are discussed in detail in D4.1[1]. An overview of the different approaches is presented in Chapter 2.

In Chapter 3, the NBS selected for the monitoring and assessement activity is presented together with a detailed overview of monitoring timing and activities for each implementation. Indeed, not all the proGIreg implementations will be monitored: case by case, the monitoring scales and times have been carefully defined to highlight measurable impacts which would strictly depend on NBS size and implementation time.

In general, the implementations to be monitored should respect the following criteria:

- Implementation should start after spring 2019, to provide pre-implementation monitoring;
- Implementation should be completed no later than the summer of 2020 in order to provide post-implementation monitoring at least 24 months after implementation, as required by the proGIreg GA; and
- Implementation size should guarantee a measurable effect with respect to the other GI in the surrounding environment and to the cost of the experimental activity (in terms of both person month - PM - and money).

Nevertheless, the selection of NBS to be monitored has been flexible with respect to these constraints to remain in line with the proGIreg requirement of monitoring all NBS types and of providing cross-city assessments, where possible.

The final result of the monitoring and assessment activity will be the quantification of specific indicators, for each assessment domain, obtained by analysing the collected data. The indicators to be provided have been chosen according to the challenges and methodologies stated in the guidelines of the EKLIPSE - EWG report on NBS evaluation[2]. The indicators

[1] Baldacchini et al., 2019. Monitoring and Assessment Plan, Deliverable No. 4.1, proGIreg. Horizon 2020 Grant Agreement No 776528, European Commission.
[2] Raymond et al., 2017. An Impact Evaluation Framework to Support Planning and Evaluation of Nature-based Solutions Projects. Report prepared by the EKLIPSE Expert Working Group on Nature-based Solutions to Promote Climate Resilience in Urban Areas. Centre for Ecology & Hydrology, Wallingford, United Kingdom.

that will be used to describe the assessment of the proGIreg NBS are presented in Chapter 4. They constitute one of the main outputs of proGIreg, and their descriptory efficiency will be compared with those provided by the sister projects within EC Taskforce 2 “NBS Impact Evaluation Framework 2.0”.

2. Data Collection

The monitoring of benefits will be performed using two different types of data over three different spatial levels. Spatial data from existing databases will be collected both at the city and living lab (LL) district level. New experimental data will be collected at the LL district and NBS level. Data acquisition design will depend on the type of data; it will be repeated on a yearly basis or will be conducted in a pre-post configuration, or be obtained by a single, post-implementation assessment.

Data obtained at the LL district and NBS level will be used to carry out the benefit assessment, further described by the indicators provided in Chapter 4, while data at city level will be employed to upscale the expected benefits according to an expert-based approach that is explained in-depth in D4.6 (“Guidelines for upscaling”).

The definition of the three spatial levels has been extensively discussed in D2.2[3], and the same administrative borders previously defined will be adopted for data acquisition. Also, tools and sources for data collection are extensively presented in D4.1[1] and resumed in the following chapters.

All the data described herein will be collected and stored on the proGIreg platform, according to the description provided by D4.2[4]. Subsequently, the data will be analysed to obtain a quantification of the indicators listed in Chapter 4.

2.1. Spatial data

The spatial data produced at the city and LL district level belong to two different categories:

1. Administrative data from existing databases (BASE). This concerns basic information describing the four assessment domains in the city under investigation. A first screening for available data and data collection has been performed by proGIreg WP2 and provided in D2.2[3]. Every two years, the FRC will be requested to provide the same yearly data; i.e., in 2020, the FRC will collect data from 2019 and 2020, while in 2022 they will collect data from 2021 and 2022. The FRC will also have the opportunity to add data that were unavailable at previous requests, such as data that are measured

[3] Leopa, Elisei,et al., 2019. Spatial Analysis in Front-Runner and Follower Cities, Deliverable No. 2.2, proGIreg. Horizon 2020 Grant Agreement No. 776528, European Commission.
[4] Mattioni et al., 2019. Data Management Plan, Deliverable No. 4.2, proGIreg. Horizon 2020 Grant Agreement No. 776528, European Commission.

on a multi-annual basis (e.g., census data). The total estimated effort for this survey is **2 PM** per FRC.

2. Spatial data elaborated from geographic information system (GIS) sources. In particular, the Normalized Difference Vegetation Index (NDVI) and Walkability Index will be obtained annually until 2022.

The results of the spatial data analysis at LL district level will be provided in D4.5 ("Report on benefits produced by implemented NBS") and D4.8 ("Updated report on benefits produced by implemented NBS") of proGIreg.

2.2. Experimental data

2.2.1. District level

Social, health, and economic indicators at LL district level will be collected by means of an anonymised general population survey (general questionnaire – GQ), performed in a pre-post design, according to the detailed description in D4.1[1]. The survey will involve 300 persons in the LL district and 300 in a different, comparable city district ("control district") where no NBS implementations are planned for the next 3 years. ***Due to timing constraints, the survey will be conducted in the European FRC but not in Ningbo.***

The tentative timeline, based on the implementation timing of the different NBS in the European FRC, is as follows:

- April-July 2019: identification of the control district, translation and upload of the questionnaire on the "EUSurvey" platform[5], selection and training of interviewers, selection of the target and sending out the first-contact letter
- August-October 2019: first administration
- August-September October: second administration

The proposed three-year timeline would allow to assess as many NBS as possible close to the 24-month delay from implementation, as required by the project (many implementations will occur during 2020, or even later).

A more detailed timeline of the first two periods is reported in Fig. 2 below.

[5] https://ec.europa.eu/eusurvey/home/welcome

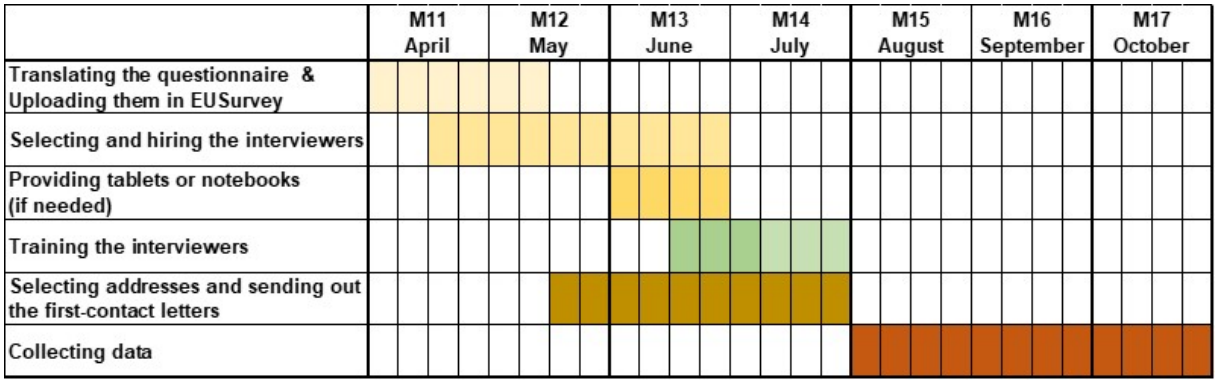

Figure 2 - Tentative timeline of the first months of the GQ survey preparation and administration (Source: CNR)

The estimated time efforts and responsible partners of the tasks in Fig. 2 are:

1. Translation of the questionnaire in the local language: formally the task of the FRC, which estimated that a long time might be needed to recruit translators; other project partners could be involved to speed up the process;

2. Uploading the questionnaire on the platform for administration ("EUSurvey"[5]): the partners from T4.1 and T4.2 are in charge of this task; estimated time is 3 working days;

3. Selecting and hiring of interviewers: the FRC are in charge. The allotted time could be estimated to be ~1 PM; this depends on the city;

4. Training of the interviewers: partners from T4.1 will be in charge and train face-to-face or via telematically; this will require 6 working days on the part of the FRC;

5. Selecting addresses and sending out the first-contact letters: this task will be taken on by the FRC and will require about ~1 PM;

6. (if needed) Sending out reminder letters and selecting an additional sample of addresses: handled by the FRC in ~0.5 PM;

7. Sending out re-contacting letters after three years: task of the FRC (~0.5 PM);

8. Obtaining questionnaire data: assuming it takes 1.5 hours to obtain 1 questionnaire (including making the appointment, transportation time, informed consent procedures, etc.), it would require about 900 hours to obtain the pre-evaluation and 900 hours to obtain the post-evaluation (~12 PM, task of the FRC);

9. Data download, storage and analysis: handled by partners in T4.1, T4.2, and T4.4; a time range of 20 to 30 PM can be collectively estimated.

The results of the GQ will be provided at the end of the project (D4.8 – "Updated report on benefits produced by implemented NBS").

2.2.2. NBS level

The experimental activity at NBS level will involve all four assessment domains. Nine different experimental tools have been developed to assess benefits at the NBS level. They have been extensively described in D4.1[1] and are resumed in the following table.Table 1 – NBS monitoring tools. Estimated time effort for data collection by the FRC is provided for most of the tools. Etimated time for acquisition of the needed instruments by the FRC (when required) or for data analysis by the other partners in WP4 cannot be sufficiently estimated at this stage.

Code - Short name	Data type	Description of data collection
A - NBS-visitor questionnaire	Social and health indicators of a specific NBS	Anonymous survey to be performed 24 months after NBS implementation (**1 PM** per implementation, according to UNIBA and ISGLOBAL instructions)
B - SOPARC	Number of users and type of physical activity for a specific NBS	Survey performed by using the "System for Observing Play and Recreation in Communities"[6], post intervention, and when possible in a pre-post design (**1 PM** per implementation, under the guidance of ISGLOBAL)
C - Economic and labour impact questionnaire	Economic impact indicators of a specific NBS	Survey about economic parameters to be submitted to the organisation in charge of NBS implementation as well as to the organisation in charge of long-term management (**1 PM** per FRC, under the supervision of SL)
D – Carbon impact	Carbon storage	Environmental, GIS or economic data will be elaborated by CNR through mathematical models, to obtain information on the carbon storage in specific NBS
	Saved carbon dioxide emissions	Data on building energy demand will be converted in CO_2 equivalent
	Saved carbon dioxide emissions	Data on energy production by photovoltaic systems will be converted in CO_2 equivalent

[6] McKenzie, Cohen, Sehgal, Williamson, Golinelli, (2006). System for Observing Play and Recreation in Communities (SOPARC): Reliability and Feasibility Measures. J. Phys. Act. Health 3 Suppl 1, S208-S222.

E - Air quality	Ozone (O_3) and nitrogen dioxide (NO_2) concentrations	Discontinuous concentration measurements by passive diffusion tubes in the proximity of the NBS and in a control site, repeated before the implementation and two times after. For each monitoring site, 36 passive diffusion tubes are needed (3 tubes x 2 gases x 3 years = 18 passive tube samples for both sample and control sites). Samples should be placed onsite, removed after three weeks, and sent for analysis. FRC will be incharge of installing, removing and sending the sensors (**6 working days** in three years) and buying sensors for the two post implementation campaigns. CNR will be in charge of purchasing and installing the sensors for the pre implementation campaign
F - Air temperature	Air temperature	Continuous measurement of air temperature inside an NBS and in a control site over three years. For each monitoring site, 6 temperature sensors are needed (3 for the site and 3 for the control site). The sensors should be checked monthly for data download and battery (**9 working days** per NBS in three years). Installation sites will be set by CNR
G – Particulate biomonitoring	Particulate matter uptake by the specific NBS	Leaf-deposited particulate matter estimation, using standard techniques, to be repeated twice. The FRC will be asked to sample 2 leaves for 3 replicate branches per sampling campaign (**2 working day**s in total) and to send them to CNR for analysis
H – Environmental footprint	Amount of soil saved Life-Cycle Analysis (LCA) indicators for environmental impacts (e.g., Global warming potential, land use, ecosystem damage potential, resource depletion)	Data for both the approaches will be collected and provided by the stakeholder responsible for NBS management and implementation. CNR and the SME involved will perform the estimation of the amount of soil saved and the LCA analysis

I - Biodiversity	Pollinator and plankton number and species in the proximity of a specific NBS	Biodiversity monitoring surveys of selected pollinator species, in FRC Turin, will be the responsibility of UNITO; to be performed according to specific protocols adapted to the NBS and observers, and repeated 2-3 times during the lifetime of the project Plankton biodiversity will be monitored in Ningbo once a week, along the project duration, by collecting water at 3 sampling points set at the inlet, outlet and centre of the restoring lake
J – Water Quality	Transparency, water temperature, pH, dissolved oxygen, total suspended solids, chemical oxygen demand, total phosphorus, total nitrogen, chlorophyll, ammonia nitrogen	The collection of water quality samples is carried out by IUE-CAS, and the staff analyses three water samples every week. The sampling points were set at the water inlet, outlet and the centre of the lake

Some of the monitoring tools are NBS specific, such as “H – Environmental footprint”, which applies only to NBS2 and NBS4. Others are generic and can assess benefits over a wide range of NBS types. For instance, “C – Economic and labour impact questionnaire” would provide economic assessement of all the productive GI implemented within proGIreg.

In the following chapter, the monitoring protocols per NBS type will be presented. The time and monetary efforts required from the FRC in connection with this analysis will be tentatively summarized in Chapter 3.9. Time estimation and monetary effort per monitoring activity for the other partners (namely, CNR, UNIBA, ISGLOBAL, SL, UNITO and IUE-CAS) is difficult at this stage.

3. NBS level monitoring protocols in the FRC

The NBS implementations chosen for monitoring and assessing benefits within the proGIreg project are presented in this chapter, together with the NBS-specific assessment protocols developed, based on implementation timing, size, and cost-effect *ratio*. Not all implemented NBS have been selected for monitoring, as detailed in D4.1[1]. However, the requirements of monitoring at least one implementation per NBS type and to provide cross-city analysis (when possible) have been taken into account. The NBS implementations to be monitored will be presented per NBS type for each FRC. A more detailed description of these implementations, together with all others, are found in D3.2 (“Four Implementation Plans: Dortmund, Turin, Zagreb, Ningbo”).

For each implementation, the adopted NBS monitoring tools will be listed along with the proposed experimental timing and FRC expected effort. Lastly, for each assessement the deliverable in which the results will be presented is specified (either D4.5 – "Report on benefits produced by implemented NBS" or D4.8 - "Updated report on benefits produced by implemented NBS").

3.1. NBS1: Renaturing landfill sites for leisure use and energy production

NBS1 will be implemented only in Dortmund where solar energy production (40,000 m^2; 3.6 MWp) and sports activities on 2 ha will be integrated on the site of the renatured Deusenberg landfill. The solar panels have already been installed while the sports activities are under definition, since the site will be involved in further interventions related with the International Garden Exhibition in 2027. Protocols of measurements are presented in Table 2 for the three parts of the implementation.Table 2 – NBS1: New forest, solar panels and sport activity on the renatured Deusenberg landfill in Dortmund.

NBS monitoring tool	Analysis type	Timing for data collection	Deliverable	FRC efforts
NEW FOREST - Implementation timing: already implemented				
D – Carbon impact	Post	Summer 2020	4.5	**4 working days**, for field data acquisition
G – Particulate Biomonitoring	Post	Summer 2019	4.5	**1 working day**, for field data acquisition
SOLAR PANELS - Implementation timing: already implemented				
C - Economic impact questionnaire	Post	January 2021	4.5	**1 working day**
D – Carbon impact	Post	January 2021	4.5	**1 working day**
SPORT ACTIVITIES - Implementation timing: to be defined				
A - NBS-visitor questionnaire	Post	Depending on implementation time	4.8	Expected target: 100 people, expected time: **1 PM**

B - SOPARC	Pre-Post	Depending on implementation time	4.8	**1 PM**
C - Economic impact questionnaire	Post	Depending on implementation time	4.8	**1 working day**

3.2. NBS2: New regenerated soil thanks to biotic compounds for urban forestry and urban farming

NBS2 was planned to be implemented in Turin and in Ningbo. In Turin, along the Sangone river, within the already existing Sangone public park, a 2,000 m^2 area will be destined to the production of new soil that will eventually be sold. Also, a new forest will be planted in the Sangone park, close to the soil production site in order to test the new soil. In Ningbo, the sediment of the Moon Lake should be transformed into regenerated soil, to be further used in a nearby green spaces of about 20 ha. However, while soil analyses in Turin confirmed that NBS2 implementation can be conducted, the high levels of heavy metals concentration in Ningbo Moon Lake sediments prevent from their use as regenerated soil. As a consequence, **NBS2 in Ningbo will neither be realized nor monitored.** Protocol of measurements for Turin NBS2 is presented in Table 3.

Table 3 - NBS2: new soil production and new forest in Turin.

NBS monitoring tool	Analysis type	Timing for data collection	Deliverable	FRC efforts
TURIN NEW SOIL - Implementation timing: 10/2019 – 04/2020				
C - Economic impact questionnaire	Post	Autumn 2022	4.8	**1 working day**
H – Environmental Footprint	Post	Autumn 2021	4.8	**1 working day**
TURIN NEW FOREST - Implementation timing: 10/2019 – 04/2020				
A - NBS-visitor questionnaire	Post	Spring 2022	4.8	Expected target: 100 people, expected time: **1 PM**
B - SOPARC	Pre-Post	Autumn 2019, Spring 2020,	4.8	**1 PM**

		Spring and Autumn 2022		
C - Economic impact questionnaire	Post	Autumn 2022	4.8	**1 working day**
D - Carbon impact	Post	January 2022	4.8	**4 working days**, for field data acquisition
E - Air quality	Pre- Post- Post	Summer 2019 Summer 2021 Summer 2022	4.8	36 passive sensors, **6 working days**
F - Air temperature	Continu-ous	From Summer 2019	4.8	6 sensors, **9 working days**
G - Particulate biomoni-toring	Pre-Post	Summer 2020 Summer 2022	4.8	**2 working days**

3.3. NBS3: Community-based urban farming and gardening on post-industrial sites

NBS3 interventions will reuse abandoned places to create new spaces for social activities in the shape of urban farms and gardens. Moreover, they will provide economic benefits through the growth of vegetable products. It is the only NBS type that will be implemented in all FRC, thus providing a suitable example for cross-city analysis. In Dortmund, a Food Forest and Gardening NBS will be implemented on a 2,153 m^2 area in Huckarde. In Turin, many NBS3 implementations will be developed, among them are the Gardens in Cascina Piemonte as the largest implementation site (2.5 ha). Two NBS3 implementations will be developed in Zagreb Sesvete City Garden consisting of upgrading an existing garden and a new therapy garden: the comparative assessment of the two implementations will provide valuable results. In Ningbo, an area of 21,641 m^2 along the shore of Moon Lake will be planted with aquatic plants, including 1,918 m^2 of emergent plants and floating plants, and 19,723 m^2 of submerged plants. The five selected NBS3 implementations will be monitored using the same tools (except for biodiversity monitoring), but at different times due to different implementation schedules. The protocols for monitoring activities are presented in Table 4 below.

Table 4 – NBS3: new gardens and food forest in the proGIreg FRC.

NBS monitoring tool	Analysis type	Timing for data collection	Deliv-erable	FRC efforts
DORTMUND FOOD FOREST AND GARDENING – Implementation timing: 09/2019 – 09/2020				
A - NBS-visitor ques-tionnaire	Post	Summer 2022	4.8	Expected target: 100 people, expected time: **1 PM**
B - SOPARC	Post	September 2022	4.8	**1 PM**
C - Economic impact questionnaire	Post	Autumn 2022	4.8	**1 working day**
E - Air quality	Pre-Post-Post	Summer 2019 Summer 2021 Summer 2022	4.8	36 passive sensors, **6 working days**
F - Air temperature	Continu-ous	From Summer 2019	4.8	6 sensors, **9 working days**
G – Particulate biomoni-toring	Pre-Post	Summer 2020 Summer 2022	4.8	**2 working days**
TURIN GARDENS IN CASCINA PIEMONTE - Implementation timing: 02/2019 -07/2020				
A - NBS-visitor ques-tionnaire	Post	Summer 2022	4.8	expected target: 100 people, expected time: **1 PM**
B - SOPARC	Post	Summer 2019 Summer 2022	4.8	**1 PM**
C - Economic impact questionnaire	Post	Autumn 2022	4.8	**1 working day**

E - Air quality	Pre- Post- Post	Summer 2019 Summer 2021 Summer 2022	4.8	36 passive sensors, **6 working days**
F - Air temperature	Continu-ous	From Summer 2019	4.8	6 sensors, **9 working days**
G – Particulate biomoni-toring	Pre-Post	Summer 2020 Summer 2022	4.8	**2 working days**
I - Biodiversity	Pre- Post- Post- Post	Summer 2018 Summer 2019 Summer 2020 Summer 2021	4.8	
ZAGREB SESVETE CITY GARDEN - UPGRADE and NEW THERAPY GARDEN Implementation timing: 09/2019 - 06/2021				
A - NBS-visitor ques-tionnaire	Post	Summer 2022	4.8	Expected target: 200 people, expected time: **2 PM**
B - SOPARC	Pre-Post	Spring 2020Spring 2022	4.8	**2 PM**
C - Economic impact questionnaire	Post	Autumn 2022	4.8	**1 working day**
E - Air quality	Pre- Post- Post	Summer 2019 Summer 2021 Summer 2022	4.8	54 passive sensors, **6 working days**
F - Air temperature	Continu-ous	From Spring 2020	4.8	9 sensors, **9 working days**
G – Particulate biomoni-toring	Pre-Post	Summer 2020 Summer 2022	4.8	**2 working days**

NINGBO LAKE SHORE – Implementation timing: 01/2019 – 12/2021				
A - NBS-visitor questionnaire	Post	Summer 2021	4.8	Expected target: 100 people, expected time: **1 PM**
B - SOPARC	Post	Summer 2021	4.8	**1 PM**
G – PM biomonitoring	Post	Summer 2021	4.8	**1 working day**
I - Biodiversity	Continuous	Summer 2019	4.8	Once a week per two years: about **4 PM**
J – Water quality	Continuous	Summer 2019	4.8	Once a week per two years: about **4 PM**

3.4. NBS4: Aquaponics as soil-less agriculture for polluted sites

Aquaponics combine aquaculture and hydroculture into a resource-friendly circulatory system that resembles the natural nitrogen cycle. The nutrient-rich waste stream generated by aquaculture is used to fertilize plants in the hydroculture section. The plants withdraw nutrients from the processed water, which can be reused in aquaculture. The soil-less cultivation system allows to use areas with impoverished or contaminated soil, which makes it suitable for food production on post-industrial sites. Dortmund will lead the implementation of community-managed aquaponics systems in the three European FRC. However, Turin's implementation will be very small; thus a comparative assessment between Dortmund and Zagreb for NBS4 will be conducted, as depicted in Table 5.

Table 5 – NBS4: aquaponic community testing systems in Dortmund and Zagreb.

NBS monitoring tool	Analysis type	Timing for data collection	Deliverable	FRC efforts
DORTMUND aquaponics system - Implementation timing: to be defined **ZAGREB aquaponics system - Implementation timing: 12/2019 - 06/2020**				
C - Economic impact questionnaire	Post	January 2022	4.8	**1 working day**

H - Environmental foot-print	Post	January 2022	4.8	**1 working day**

3.5. NBS5: Capillary GI on walls and roofs

Modern green roofs and walls are building elements designed to support living vegetation in order to improve a building's performance. The benefits of these NBS include improved sound insulation, reduced heating and cooling requirements, reduced and slowed stormwater runoff, capture of gaseous and particulate pollutants, alleviation of urban heat island effects and increased biodiversity. NBS5 will be implemented in Turin and Zagreb in similar contexts and as result of a co-design process. In Turin, the objects of the monitoring activities will be a new green roof on top of a public building, a green wall on a homeless asylum (outdoor) and a green wall in a school (indoor). In Zagreb, a green roof and a green wall will be implemented in the Sesvete LL, together with a solar panel system.The same protocols will be adopted for the two roofs and the two outdoor walls, as shown in Table 6. For the indoor wall in Turin, a study of the impact of the green wall on childrens' health will be considered. The protocol for the photovoltaic system is also described, and it will be compared to an analogous system implemented in NBS1 in Dortmund.

Table 6 – NBS5: green roofs and green walls in Turin and Zagreb.

NBS monitoring tool	Analysis type	Timing for data collection	Deliv-erable	FRC efforts
TURIN NEW GREEN ROOF ON A PUBLIC BUILDING - Implementation timing: 12/2020 – 02/2021				
C - Economic impact questionnaire	Post	Autumn 2022	4.8	**1 working day**
D – Carbon impact	Post	January 2022	4.8	**1 working day**

E - Air quality	Pre- Post- Post	Summer 2019 Summer 2021 Summer 2022	4.8	36 passive sensors, **6 working days**
F - Air temperature	Continu-ous	From Summer 2019	4.8	6 sensors, **9 working days**
G – Particulate biomoni-toring	Pre-Post	Summer 2020 Summer 2022	4.8	**2 working days**
I - Biodiversity	Pre-Post	To be co-de-fined	4.8	
TURIN OUTDOOR GREEN WALL - Implementation timing: to be co-defined				
A - NBS-visitor ques-tionnaire	Post	To be co-de-fined	4.8	Target still undefined
C - Economic impact questionnaire	Post	To be co-de-fined	4.8	**1 working day**
G - Particulate biomoni-toring	Pre-Post	To be co-de-fined	4.8	**2 working days**
TURIN GREEN WALL INDOOR - Implementation timing: to be co-defined				
A - NBS-visitor ques-tionnaire	**Post**	To be co-de-fined	4.8	Target still undefined. **Expected PM: 4**
ZAGREB GREEN ROOF - Implementation timing: 02/2020 - 06/2021				
C - Economic impact questionnaire	Post	Autumn 2022	4.8	**1 working day**

D – Carbon impact	Post	January 2022	4.8	**1 working day**
E - Air quality	Pre- Post- Post	Summer 2019 Summer 2021 Summer 2022	4.8	36 passive sensors, **6 working days**
F - Air temperature	Continu-ous	From Spring 2020	4.8	6 sensors, **9 working days**
G - Particulate biomoni-toring	Pre-Post	Summer 2020 Summer 2022	4.8	**2 working days**
ZAGREB PHOTOVOLTAIC CELLS - Implementation timing: 02/2020-06/2021				
C - Economic impact questionnaire	Post	Autumn 2022	4.8	**1 working day**
D – Carbon impact	Post	January 2022	4.8	**1 working day**
ZAGREB GREEN WALL- Implementation timing: to be co-defined				
A - NBS-visitor ques-tionnaire	Post	To be co-de-fined	4.8	Expected target: 100 people, expected time: **1 PM**
C - Economic impact questionnaire	Post	To be co-de-fined	4.8	**1 working day**
G – Particulate biomoni-toring	Pre-Post	To be co-de-fined	4.8	**2 working days**

3.6. NBS6: Making post-industrial sites and renatured river corridors accessible for local residents

Improving accessibility to river corridors and renatured post-industrial sites (brownfields, landfills) from disadvantaged urban areas makes the city more liveable and inclusive and helps to improve the physical and mental health of citizens. NBS6 is one of the core implementations in proGIreg. It is under realization in Dortmund and Zagreb and the corresponding monitoring protocol is reported in Table 7. The feasibility of the Economic impact questionnaire will be evaluated after the completion of the implementations, depending on the presence and number of economic activities along the paths.

Unfortunately, a number of technical problems arose in Turin and, to date, it is not clear if, when and where it will be realized. However, if NBS6 implementation is realised in Turin, and if time is sufficient, it will be monitored following the same experimental protocol reported below.

Table 7 – NBS6: a new cycling path in Dortmund and Zagreb.

NBS monitoring tool	Analysis type	Timing for data collection	Deliverable	FRC effort
DORTMUND CONNECTING PATH - Implementation timing: to be defined				
B - SOPARC	Pre-Post	Spring 2020 Spring 2022	4.8	**1 PM**
C - Economic impact questionnaire	Post	September 2022	4.8	**1 working day**
ZAGREB NEW CYCLING PATH - Implementation timing: 01/2020 - 12/2020				
B - SOPARC	Pre-Post	Spring 2020 Spring 2022	4.8	**1 PM**
C - Economic impact questionnaire	Post	September 2022	4.8	**1 working day**

3.7. NBS7: Establishing protocols and procedures for environmental compensation at local level

Turin and Zagreb FRC will establish an "environmental tariff" for temporary events (based on duration, public attendance, location, energy consumption, waste production, etc.) to achieve better fundraising for NBS. Implementation timing of NBS7 in Turin is still under definition, while in Zagreb it is planned to start in 2021.

In Ningbo, Tianhe Aquatic Ecosystems Engineering Co.Ltd will implement NBS2 and NBS3, and IUE-CAS will monitor the water environment and provide water quality reports. If the water quality will be up to standard, the government will compensate the implementation costs of NBS2 and NBS3.

If timing allows, NBS7 economic impact will be assessed by submitting the Economic and labour impact questionnaire to the municipality, in the case of Turin and Zagreb, and to the SME involved in the NBS implementation in Ningbo. Data could be collected in autumn 2022 (2021 in the case of Ningbo), with the results reported in D4.8.

3.8. NBS8: Pollinator biodiversity improvement activities and citizen science project

NBS8 creates pollinator-friendly green spaces including the possibility of producing honey. Enhancing the presence of pollinators will increase biodiversity in green spaces, which will be monitored by citizen science projects related to biodiversity assessement. NBS8 in Turin is already implemented and monitored by UNITO. NBS8 will also be implemented in Dortmund, but it has been not possible to find available trained people to perform the monitoring.

Table 8 – NBS8: pollinator biodiversity monitoring with citizen science approach in Turin.

NBS monitoring tool	Analysis type	Timing for data collection	Deliverable	FRC efforts
C - Economic impact questionnaire	Post	Autumn 2020	4.5	**1 working day**
I - Biodiversity	Continuous	Summer 2019 Summer 2020	4.5	

3.9. FRC efforts in contributing to NBS monitoring

A first approximate estimation of the total expected efforts to be sustained by the three European FRC to participate in the monitoring activity of NBS benefits is summarised in the following table, in terms of personnel costs and direct costs. Given the different local settings of the three FRC, it has been possible to provide only direct costs related to the purchase of air quality (second and third campaigns: 15 € per each gas sensor, analysis included) and temperature sensors (80 € each; maximum number of sensors required has been taken into account, but will likely be reduced). Assessment at the three spatial levels (city, LL district and NBS) is included. Those activities that do not involve the FRC at all (e.g. GIS data production or the Environmental footprint and Biodiversity monitoring tool) have not been included in the Table.

Nevertheless, as the table only regards netto-efforts on a best case estimation, it only represents part of the overall financial and time effort required of the respective FRC in order to manage WP4. For many activities intensive preparation and subsequent work is needed. In part, external help will be necessary generating costs. The respective additional work and costs will vary in each FRC according to local settings, but will nonetheless increase the numbers in Table 9.

Table 9 – Expected FRC efforts in NBS level monitoring (PM: person/month; WD: working day; €: EUR for sensors, including analysis in the case of tool E).

	BASE	GQ	NBS monitoring tool						
			A (PM)	B (PM)	C (PM)	D (PM)	E (€ & PM)	F (€ & PM)	G (PM)
Dortmund	2	15	2	3	1	0.2	360 & 0.3	480 & 0.4	0.1
Turin	2	15	3	3	1	0.2	1080 & 0.8	1440 & 1.0	0.4
Zagreb	2	15	3	3	1	--	1080 & 0.8	1200 & 1.0	0.4
Ningbo	2	--	1	1	0.2	0.2	--	--	0.2

4. Indicators for benefit assessment

The Monitoring and Assessment Plan (D4.1[1]) and Protocols of Measurements (present document) proposed by proGIreg WP4 aim to assess the benefits produced by the implemented NBS.

The EKLIPSE EWG on NBS evaluation[2] indicates that each methodological approach to be used in NBS evaluation should be based on the ten challenges defined by the expert report on NBS supported by DG Research and Innovation[7] and by a recent review on NBS frameworks[8]. Such challenges are:

1) Climate mitigation and adaptation;
2) Water management;
3) Coastal resilience;
4) Green space management (including enhancing/conserving urban biodiversity);
5) Air/ambient quality;
6) Urban regeneration;
7) Participatory planning and governance;
8) Social justice and social cohesion;
9) Public health and wellbeing;
10) Potential for new economic opportunities and green jobs.

[7] European Commission, 2016. Policy topics: Nature-based Solutions. https://ec.europa.eu/research/environment/index.cfm?pg=nbs.
[8] Kabisch, Frantzeskaki, Pauleit, Naumann, Davis, Artmann, Haase, Knapp, Korn, Stadler, Zaunberger, Bonn (2016). Nature-based solutions to climate change mitigation and adaptation in urban areas: Perspectives on indicators, knowledge gaps, barriers, and opportunities for action. Ecol. Soc. 21, art39.

Within this framework, four assessment domains have been defined, to be explored within proGIreg by the scientific partners in WP4, with the collaboration of the FRC, corresponding to the first four tasks of the WP, namely:

- Socio-cultural inclusiveness (Task 4.1, lead by UNIBA, including challenges 7 and 8);
- Human health and wellbeing (Task 4.2, lead by ISGLOBAL, including challenge 9);
- Ecological and environmental restoration (Task 4.3, lead by CNR, including challenges 1, 4, 5, 6);
- Economic and labour market (Task 4.4, lead by SL, including challenge 10).

To describe benefit assessement, the EWG also recommended using specific indicators, which could easily and effectively describe the benefits and simultaneously provide efficient tools for comparing different NBS.

The data collected as previously described and by following the Monitoring and Assessment Plan (D4.1[1]), after having been stored in the proGIreg platform (see D4.2[4]), will then be analysed by the WP4 partners according to their Task responsability. For each of the above-mentioned domains, data analysis will quantify the benefits in terms of specific indicators, calculated on the basis of the experimental data obtained. These indicators will be the final output of the proGIreg project and will be also used to compare the effectiveness of both the implemented NBS types and the developed monitoring protocols with those tested within the sister projects belonging, together with proGIreg, to EC Taskforce 2 “NBS Impact Evaluation Framework 2.0”.

Identification of key indicators of NBS performance and impact was organized in proGIreg in three steps, aimed at focusing the number and types of indicators to be developed, estimated and followed as much as needed. At each step, the number of partners involved in the work improves, while the number of selected indicators decreased, as described in Figure 3.

First, the research groups leading Task 4.1, 4.2, 4.3 and 4.4 in proGIreg responsible for the four different assessment domains previously described, provided independent lists of possible indicators, based on the review of existing indicators and reference frameworks and scientific literature on the effects of nature-based solutions. These preliminary lists were merged in the so-called “General list”, which was mostly composed by City level and District level indicators.

Then, the four research groups participated in several online and also a final face-to-face meeting. During these meetings, each research group proposed a number of possible monitoring tool and the resulting indicators. They were critically discussed and compared, by specifically analyzing:

- possible overlapping of proposed indicators;
- consistency of the proposed indicator and the real effect expected by the total of the proGIreg NBS in each FRC (mainly considering NBS size and number of people involved);
- possibility of obtaining the same indicator either at LL district and at NBS level.

As a consequence of this analysis, it has been decided:

- to reduce the monitoring activity only at LL district and at NBS level (by collecting administrative data and few GIS data at City level to be further used only for the benefit upscale);
- to monitor social, human health and economic benefits at LL district level by using a single survey (the GQ) to obtain consistent indicators over these three assessment domains;
- to do not monitor environmental benefits at LL district scale (due to reduced size of the NBS to be implemented)

Most of the NBS level tools presented in Chapter 2 were developed at this stage, and the number of suitable indicators were strongly reduced, resulting in the so-called “Reduced List”.

Finally, research groups in WP4 individually discussed with the FRC and the SME involved in the implementation of the productive NBS, in order to:

- verify the applicability of the proposed methodology;
- identify the NBS to be monitored (based on the updated timing, the real accessibility of the site, the availability of facilities and other issues);
- highlight the critical aspects of the selected NBS with respect to the four assessment domains;
- identify possible critical issues that could lead to the exclusion of suggested indicators and/or to the definition of NBS-tailored ones.

Accordingly, the final list of the monitoring NBS has been obtained (as reported in Chapter 3), new tools to monitor the NBS-specific indicators have been developed or identified (such as tool H – Environmental footprint - for NBS2 and NBS4 or tool J – Water Quality – for NBS3 in Ningbo), and final list of indicators (the so-called “Core List”) has been produced.

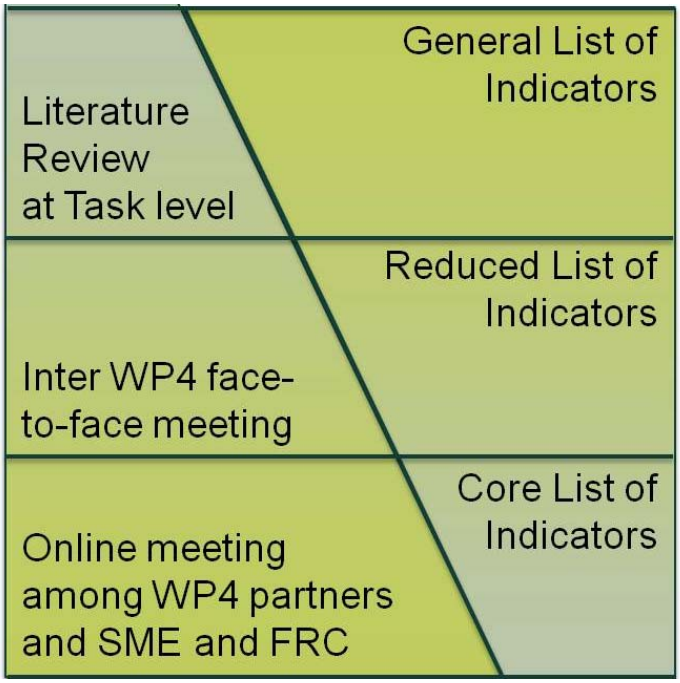

Figure 3 - Indicator definition process (Source: CNR)

The indicators that will be obtained based on the proGIreg proposed methodology are listed by domain in the following tables. For each indicator, a short explanation is provided along with the unit and type of data or data source from which it was derived. Also, the corresponding challenge within the description of the EKLIPSE EWG report on nature-based solutions evaluation[2] is proposed. More information (e.g. method of scoring of all data) will be provided in D4.5 ("Report on benefits produced by implemented NBS") or D4.8 ("Updated report on benefits produced by implemented NBS").

Table 10 - Indicators for the socio-cultural inclusiveness, with specified the EKLIPSE EWG challenge (EC) to which they belong.

Indicator	Explanation	Units	Data	EC
Total population	Total number of persons living in the specific area. Indicator should be collected for both city and LL district level	Number	BASE	6
Population density	Number of persons per square km of land area. Indicator should be collected for both city and LL district level	n/(m*m)	BASE	6
Population growth rate	Average annual rate of change of population size (%). Indicator should be collected for both city and LL district level	%	BASE	6
Migration rate	Net number of migrants per 1,000 population. Indicator should be collected for both city and LL district level	%	BASE	6
Material deprivation rate	Material deprivation rates gauge the proportion of people whose living conditions are severely affected by a lack of resources	%	BASE	4+8
Diversity statistics	% foreign born residents (if available, for both scales) or population by ethnicity	%	BASE	6
Educational attainment	Average level of education completed by the 18 years of age and older population	Number	BASE	8
Recreational or cultural facilities	Relevant for LL/regeneration level: Number and identification of recreational and/or cultural facilities	Number	BASE	4+6

Accessibility of public urban green spaces	% population having access to green space within a 15-minute walking distance or within 30 minutes' travel time by public transportation[9]	%	BASE	4+6
Density of the built environment	Floor Area Ratio (Total floor area divided by total built surface area), or if unavailable, Building Coverage Ratio	%	BASE	6
Connectedness to nature	Sense of connectedness and oneness to nature[10]	Number	GQ	4
Perceived social support	Perception of various ways in which individuals aid others[11]	Number	GQ A	8
Perceived social cohesion	Social cohesion indicates the set of behaviors and bonds of affinity and solidarity between individuals or groups[12]	Number	GQ A	8
Perceived social interaction	Sequence of social actions between individuals or groups who modify their actions and reactions due to actions by their interaction partner(s)[13]	Number	GQ A	8
Mindfulness	Ability of being conscious or aware of something within the environment[14]	Number	GQ	9
Perceived restorative quality of implemented NBS	Perception of restoration coming from an NBS[15]	Number	GQ A	4

[9] Urban green spaces and health. Copenhagen: WHO Regional Office for Europe, 2016.
[10] Mayer, 2004. The connectedness to nature scale: A measure of individuals' feeling in community with nature. Journal of environmental psychology, 24, 503-515.
[11] Pearson, 1986. The definition and measurement of social support. Journal of Counseling & Development.
[12] Stanley, 2003. What do we know about social cohesion: The research perspective of the federal government's social cohesion research network. Canadian Journal of Sociology/Cahiers canadiens de sociologie, 5-17.
[13] Baumeister, Leary, 1995. The need to belong: desire for interpersonal attachments as a fundamental human motivation. Psychological bulletin, 117(3), 497.
[14] Feldman, Hayes, Kumar, Greeson, Laurenceau, 2007. Mindfulness and emotion regulation: The development and initial validation of the Cognitive and Affective Mindfulness Scale-Revised (CAMS-R). Journal of psychopathology and Behavioral Assessment, 29, 177.
[15] Hartig, Korpela, Evans, Gärling, 1997. A measure of restorative quality in environments. Scandinavian housing and planning research, 14(4), 175-194.

Adverse impact NBS	Number of participants reporting an adverse event while in the NBS[16]	Number	A	6
Greenness	Spatial map indicating the presence of green areas for each pixel (10 m pixel)[17]	Normalized index	GIS	4
Walkability	GIS derived raster image, function of connectivity, accessibility and perceived pleasantness with values ranging from 0 to 1 where 1 indicates the most walkable area (e.g., a park with pedestrian lanes well connected to city hot spots like residential and working areas) and 0 indicates the least walkable area (e.g., a major urban road).[18]	Normalized index (30-1000 m pixel)	GIS	4+8

Table 11 - Indicators for human health and wellbeing, with specified the EKLIPSE EWG challenge (EC) to which they belong.

Indicator	Explanation	Units	Data	EC
Use of green and blue spaces	Time spent in natural environments[19]	Hours/ week	GQ	4
Visual exposure to green space	The amount of green space in the view from windows at home and the frequency of looking at the view	Number	GQ	9
Satisfaction with green and blue spaces	Satisfaction (scale 1 to 5) with the green/blue spaces in the neighborhood[19]	Number	GQ	9
Perceived general health	Self-perceived general health[20]	Number	GQ	9

[16] Grellier et al., 2017. BlueHealth: a study programme protocol for mapping and quantifying the potential benefits to public health and wellbeing from Europe's blue spaces. BMJ Open; 7, 6.
[17] Hystad, Davies, Frank, Van Loon, Gehring, Tamburic, Brauer, 2014. Residential greenness and birth outcomes: evaluating the influence of spatially correlated built-environment factors. Environmental health perspectives, 122, 1095-1102.
[18] Fan, Xu, Yue, Chen, 2017. Accessibility of public urban green space in an urban periphery: The case of Shanghai. Landscape and Urban Planning, 165, 177-192.
[19] Nieuwenhuijsen et al., 2014. Positive health effects of the natural outdoor environment in typical populations in different regions in Europe (PHENOTYPE): a study programme protocol. BMJ Open; 4, 4
[20] Brazier et al., 1992. Validating the SF-36 health survey questionnaire: a new outcome measure for primary care. BMJ, 305,160.

Somatisation	Somatisation (scale 0 to 3) and category (low, moderately high, very high) [21]	Number	GQ	9
Self-reported mental health and wellbeing	Mental health and wellbeing (scale 1 to 6)[20]	Number	GQ	9
Perceived stress	Perceived Stress Scale (scale 0 to 4) [22]	Number	GQ	9
Self-reported anxiety	Anxiety (scale 0 to 3) and category (mild, moderate, severe)[23]	Number	GQ	9
Self-reported depression	Number of participants reporting depression	Number	GQ	9
Current asthma and/or allergies	Number of participants with asthma or allergy attacks/episode	Number	GQ	9
Self-reported physical activity	Physical activity levels, calculated as the metabolic equivalent of task (MET) minutes per week[24]	MET minutes /week	GQ A	9
Overweight and obesity	Body Mass Index (BMI)-based overweight or obesity	kg/m^2	GQ	9
Visits to and time spent in NBS(s)	Hours/week spent in NBS site(s)[16]	Hours /week	GQ (post) A	9
Perceived improvement in neighbourhoods	Number of participants perceiving an improvement in the Living Lab neighbourhood	Number	GQ (post)	6
Perceived increase in visits to the NBS	Number of participants to report increased visits to the NBS site	Number	A	6

[21] Terluin et al., 2006. The Four-Dimensional Symptom Questionnaire (4DSQ): a validation study of a multidimensional self-report questionnaire to assess distress, depression, anxiety and somatization. BMC Psychiatry, 6, 34.
[22] Cohen, Kamarck, Mermelstein, 1983. A global measure of perceived stress. Journal of Health and Social Behavior, 24, 4.
[23] Spitzer et al., 2006. A brief measure for assessing generalized anxiety disorder: The GAD-7. JAMA Internal Medicine, 166, 10.
[24] Lee, Macfarlane, Lam, Stewart, 2011. Validity of the international physical activity questionnaire short form (IPAQ-SF): A systematic review. International Journal of Behavioral Nutrition and Physical activity, 8,115.

Use of the NBS	Number of visitors of the NBS per week[7]	Number	B	6
Activity type within the NBS	Number of visitors by activity types per week[7]	Number	B	9
Observed activity level within NBS	Energy expenditure in the NBS per week, calculated as the metabolic equivalent of task (MET) minutes per week[7]	MET-hour/ week	B	9

Table 12 - Indicators for ecological and environmental benefit assessment, with specified the EKLIPSE EWG challenge (EC) to which they belong.

Indicator	Explanation	Units	Data	EC
Reduction of air pollutants	Potential estimation of pollutant abatement[25]	%	BASE	5
Carbon uptake	The estimation of the carbon sequestered by the NBS[25]	t C ha $^{-1}$ year^{-1}	D	1
Reduction of energy demands	The energy not consumed for heating and cooling buildings can be accounted with an estimation of reduction of CO_2 emissions[25]	t C year^{-1}	D	1
NO_2 Removed	Changes on NO_2 concentration within the NBS with respect to control point[25]	%	E	5
O_3 Removed	Changes on O_3 concentration within the NBS with respect to control point[25,26]	%	E	5
Air temperature modification	Changes on day and night average, minimum and maximum temperatures within the NBS with respect to control point[2]	ΔC° / day	F	1
PM removed	Estimation of PM removed by the green surfaces of the NBS[27]	g m^{-2}	G	5

[25] Nowak, Crane, Stevens, Hoehn, Walton, 2008. A ground-based method of assessing urban forest structure and ecosystem services. Arboriculture & Urban Forestry, 34, 347–358.
[26] Manes et al., 2016. Regulating ecosystem services of forests in ten Italian metropolitan cities: Air quality improvement by PM10 and O_3 removal. Ecol. Indic. 67, 425–440.
[27] Baldacchini, Sgrigna, Clarke, Tallis, Calfapietra, 2019. An ultra-spatially resolved method to quali-quantitative monitor particulate matter in urban environment. Env. Sci. Pol. Res., 26, 18719–1872.

Equivalent used soil	Total natural soil saved by using the re-generation procedures	m^2	H	4
Global warming potential (GWP)	GWP will be expressed on an equivalency basis relative to CO_2	kg	H	1
Water dependency (WD)	It is the quantity of water needed per kg of food production	m^3/kg	H	2
Shannon Diversity Index	Measure of species diversity related to species richness[28]	Number	I	6
Shannon Evenness Index	Measure of species diversity related to species equality[28]	Number	I	6
Nutrient abatement in surface waters	Nutrient (N & P) abatement (%, expressed as total annual pollutant load and/or reduction of maximum annual concentration) in surface waters	%	J	2
Eutrophication Reduction	The water eutrophication level will be evaluated by a Set Pair Analysis of 5 indices accounting for total nitrogen, total phosphorus, chlorophyll concentration and dissolved oxygen[29]	%	J	2

Table 13 - Indicators for economics and labour market, with specified the EKLIPSE EWG challenge (EC) to which they belong.

Indicator	Explanation	Units	Data	EC
Green jobs	Total number of green jobs in the LL area. Green jobs are those within the environmental economy. These encompass two broad groups of activities and/or products: 'environmental protection' — all activities related to preventing, reducing and eliminating pollution and any other degradation of the environment; 'resource management' — preserving and maintaining the	Number	BASE GQ	10

[28] Stiling, 1999. Ecology: theories and applications. Prentice Hall, 638.
[29] Wu, Wang, 2012. Eutrophication evaluation based on set pair analysis of Baiyangdian Lake, North China. Procedia Environmental Sciences,13, 1030-1036.

	stock of natural resources and hence safe-guarding against depletion[30]			
Companies in the green sector	Number of companies with activity in the environmental economy in the LL area[31]	Number	BASE	10
Turnover in the green sector	Companies with activity in the environ-mental economy in the LL area; turnover and Gross Value Added (GVA)	EUR	BASE	10
Employment rate	The percentage of employed persons in relation to the comparable total population in the LL area[32]	%	BASE	8 + 10
Unemployment rate	The number of people unemployed as a percentage of the labour force, according to the Eurostat/ILO definition, in the LL area[33]	%	BASE	8 + 10
Change in prop-erty sale value for residential use	Average property value for single- and col-lective housing, sale price, in the LL area	EUR/m^2	BASE	10
Change in prop-erty rental value for residential use	Average property value for single- and col-lective housing, renting (monthly), in the LL area	EUR/m^2	BASE GQ	10 + 6
Change in prop-erty value for commercial/ in-dustrial/ office use	Average property value, sale price , in the LL area	EUR/m^2	BASE	10
Change in prop-erty rental value for commercial/	Average property value, renting (monthly), in the LL area	EUR/m^2	BASE	10

[30] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Environmental_economy_–_statistics_on_employment_and_growth
[31] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Environmental_economy_–_statistics_on_employment_and_growth
[32] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Employment_rate
[33] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Unemployment

industrial/ office use				
Monthly disposable income	Income available each month for spending and saving after discounting taxes and social security. In the case of self-employed respondents, average monthly disposable income also after discounting taxes and social security	EUR	GQ	10
Population mobility	% of respondents who declare to have moved in the past 1, 2, 5 years. The questionnaire asks the year they last moved.	%	GQ	10
Volume of new soil created	Volume of new soil created by NBS	m^3	C	10
Income from soil sold	Income produced from sale of soil by NBS	EUR	C	10
Number of direct jobs created to implement NBS	Number of FTEs (full time equivalents) used to construct/implement the NBS	Number	C	10
Labour costs of the NBS implementation	Labour cost of the construction/implementation of the NBS	EUR	C	10
Cost of NBS implementation	Cost of the NBS implementation discounting labour costs mentioned above. With breakdown into costs of permissions/licences, construction material and other equipment, land access, machinery rental, usage fees, taxes, etc.	EUR	C	10
New jobs created post implementation	Number of FTEs created after implementation (i.e. for the long term maintenance of the NBS)	Number	C	10
Labour costs of long-term maintenance of NBS	Cost of the jobs created to maintain the NBS in the long term	EUR	C	10

Maintenance costs of NBS	Total costs of maintaining the NBS, including equipment, electricity, fresh water, plants/fish, taxes, rental of machinery, fees, land access, taxes, etc.	EUR	C	10
Number of visitors	Number of visitors received per year once the NBS is functioning, as measures/estimated by the organization in charge of maintaining the space (not SOPARC), if available	Number	C	10
Extension of new green area created	Extension of new green area created	m^2	C	10
Annual energy consumption per year of buildings	Energy consumption (for heating and cooling) of buildings where NBS (green roof/wall) are to be installed in each of the 5 years previous to NBS implementation and each year after implementation (based on utility bills)	kwh	C	6
Value of food produced	Income obtained from the sale of the food produced (honey, fruits/veg, fish, etc). If no income produced- market value of food produced and distributed by other means (donation, sharing, etc)	EUR	C	10
Renewable energy produced	Energy produced by NBS with photovoltaic systems. Also breakdown of: energy used and energy sold to the grid	kWh	C	1 + 10
Income produced by the application of green administrative policies within the LL district	New income streams produced by NBS7 implementation, with breakdown of typology/origin	EUR	C	10