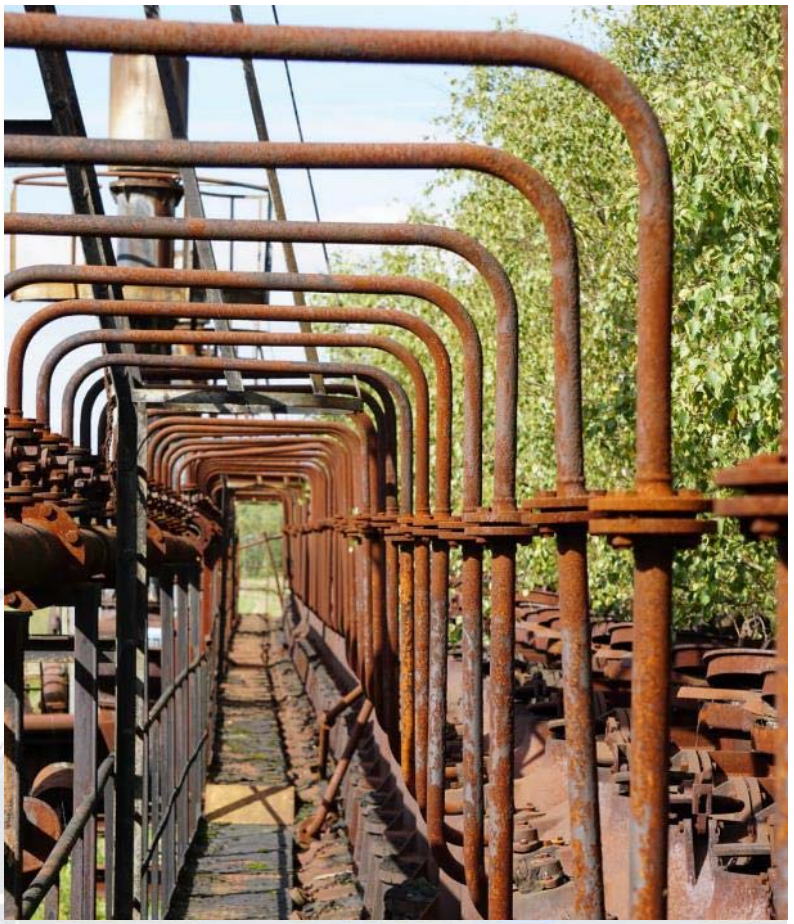
proGIreg



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Report on benefits produced by implemented NBS

Deliverable 4.5

Work package: 4

Dissemination level: PU

Lead partner: CNR

Author: Chiara Baldacchini

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Contents

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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

BASE:	spatial data from existing databases
Dx.x:	deliverable
EC:	European Commission
EDX:	energy-dispersive X-rays spectroscopy
EWG:	Expert Working Group
FC:	Follower City
FRC:	Front-Runner City
FTE:	Full Time Equivalent
GA:	Grant Agreement
GDP:	Gross Domestic Product
GI:	Green Infrastructure
GIS:	geographic information system
GQ:	general questionnaire
HIA:	Health Impact Assessment
HSRS:	high spatial resolution samplers
KPI:	key performance indicator
LCA:	Life Cycle Assessment
LL:	Living Lab
NBS:	nature-based solutions
NDVI:	Normalized Difference Vegetation Index
NGO:	non-governmental organization
PM:	particulate matter
proGIreg:	productive Green Infrastructure for post-industrial urban regeneration
SEM:	scanning electron microscopy
SME:	small and medium enterprise

SOPARC: system for observing play and recreation in communities

TSS: total suspended solid

WP: work package

Executive Summary

The project entitled “productive Green Infrastructure for post-industrial urban regeneration (proGIreg)” aims at implementing eight different 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.

To obtain an overview as comprehensive as possible of the benefits produced by the implemented NBS, four domains have been explored, to assess: 1) socio-cultural inclusiveness; 2) increased health and wellbeing; 3) ecological and environmental restoration; and 4) economy and labour market benefits.

According to the experimental approach described in the Monitoring and Assessment Plan (Deliverable 4.1 – D4.1), NBS benefits are mainly assessed at the local scale (called “NBS level”). To do this, as described in the Protocols of Measurements (D4.3), at least one implementation per NBS type per FRC has been selected for data acquisition. 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. Upon data acquisition, key performance indicators (KPIs) are calculated, in compliance with the guidelines described in the Handbook elaborated by the NBS Impact Evaluation Taskforce of the European Commission. The updated protocols of measurements and related KPIs, per each selected NBS implementation, are described in the present document.

When reasonable (considering the type of expected benefit and the NBS size), KPIs at the Living Lab (LL) district scale have been also assessed and compared with analogous ones at the city scale. For the calculation of large spatial scale indicators, data from already existing administrative or geographic information system (GIS)-derived databases are also used, as well as experimental data from a general population survey. Indicators calculated from already existing databases are obtained all along the project, on a yearly base, while the general population survey is administered twice, with a time delay of 36 months.

The present document is an intermediate report about the monitoring and assessment plan resilience, and its consequent adaptation to the NBS implementation changes and encountered barriers, and about the preliminary results on the effectiveness of the implemented NBS. Since the present document is delivered after 40 months from the starting of the project, and only 12 months after the release of the Implementation Plans of the FRC (D3.2), in most cases, only the pre-implementation indicators’ values are reported and discussed, with a few exceptions. All the results of the benefit assessment will be provided at the end of the project in D4.8 (“Updated report on benefits produced by implemented NBS”).

This document represents a key deliverable for Work Package 4 (WP4 - “NBS benefit assessment and monitoring”).

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 types of nature-based solutions, which support the regeneration of urban areas affected by deindustrialisation, are 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 NBS at local level through co-design processes.

1.2. Introduction to the deliverable

The NBS implemented during proGIreg aim at achieving several benefits, in different field of interest. Work Package (WP) 4 of proGIreg is devoted to the assessment of the benefits produced by these implemented NBS. WP4 is a collaborative action involving local authorities, the civic sector, small-medium enterprises (SMEs), and research institutes, with the aim of providing a significant and comprehensive evaluation of NBS, which ultimately can be translated into informed policies and targeted interventions aimed at promoting healthy, equitable, sustainable, and economically thriving urban environments.

NBS produced benefits' evaluation should proceed as a multi-steps process:

- Identification of the assessment domains;
- Identification of the spatial and temporal scales of interest;
- Identification of significant key performance indicators (KPIs) and related methods;
- Data collection;
- Indicators' assessment.

The first three steps of this process have been already largely described in the project Monitoring and Assessment Plan (Deliverable 4.1; D4.1)[1]. They have been developed and discussed in line with the guidelines described in 2017 by the EKLIPSE – Expert Working Group (EWG) on NBS evaluation[2]. However, in 2021, based on the experience gained by the H2020 NBS projects, including proGIreg, the NBS Impact Evaluation Taskforce of the European Commission (EC) released the Handbook entitled "Evaluating the impact of

[1] Baldacchini, C. (2019): Monitoring and Assessment Plan, Deliverable No. 4.1, proGIreg. Horizon 2020 Grant Agreement No 776528, European Commission, 124.
[2] Raymond, Berry, Breil, Nita, Kabisch, de Bel, Enzi, Frantzeskaki, Geneletti, Cardinaletti, Lovinger, Basnou, Monteiro, Robrecht, Sgrigna, Munari and Calfapietra (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.

Nature-Based Solutions"[3], which presents the most updated knowledge in the field. Thus, the proGIreg benefit assessment strategy has been (and will be) adapted to match with these newly released guidelines and will be discussed referring to them in the present document.

In particular, 12 key societal challenge areas are identified in the Handbook (Figure 1), instead of the 10 previously identified by the EKLIPSE EWG:

1. 1. Climate Resilience
2. 2. Water Management
3. 3. Natural and Climate Hazards
4. 4. Green Space Management
5. 5. Biodiversity Enhancement
6. 6. Air Quality
7. 7. Place Regeneration
8. 8. Knowledge and Social Capacity Building for Sustainable Urban Transformation
9. 9. Participatory Planning and Governance
10. 10. Social Justice and Social Cohesion
11. 11. Health and Wellbeing
12. 12. New Economic Opportunities and Green Jobs

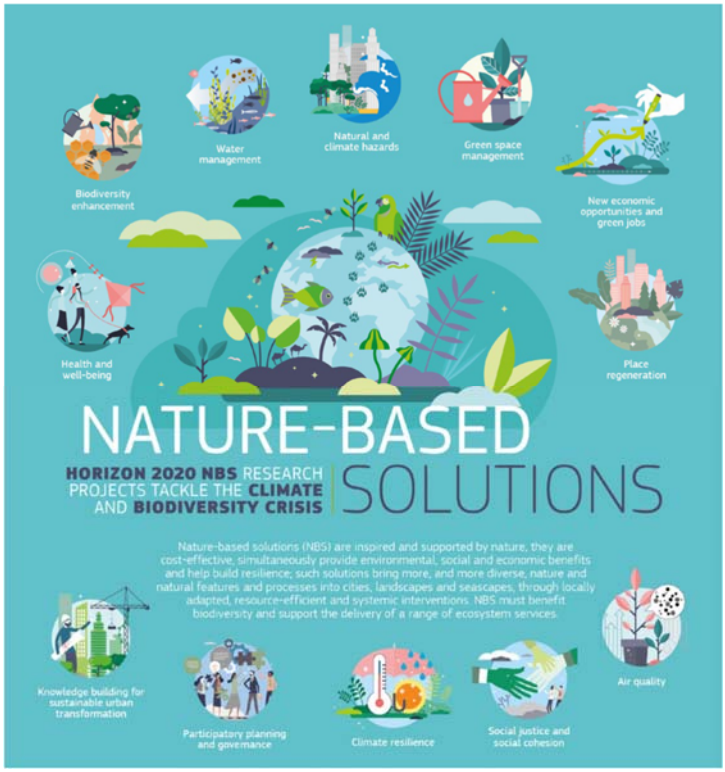

Figure 1. Key societal challenge areas identified in the Handbook realized by the EC NBS Impact Evaluation Taskforce (re-printed from Ref. 3 - image © European Union, 2021).

[3] Evaluating the impact of nature-based solutions: A handbook for practitioners, A. Dumitru and L. Wendling Eds, European Union (2021).

For each of the identified societal challenge areas, a list of useful KPIs (i.e., measurable parameters that demonstrate how effectively an NBS is producing benefits) is reported in the Handbook, with detailed methodology[3]. To provide a holistic description of produced benefits and ensure comparability, per each area, a few indicators are listed in the Handbook as "Recommended": these are the indicators that, when possible, each NBS H2020 project should assess. A further long list of "Additional" indicators is also provided, to match specific project needs.

Within this framework, the four assessment domains identified as priorities for the NBS implemented in proGIreg by D4.1 (Figure 2) match the above-mentioned societal challenge areas as follow:

- "Socio-cultural inclusiveness" mainly relates to areas 8,10 and 11;
- "Human health and wellbeing" matches area 4 and 11;
- "Ecological and environmental restoration" includes areas 1, 2, 4, 5, and 6;
- "Economic and labour market benefits" matches area 12.

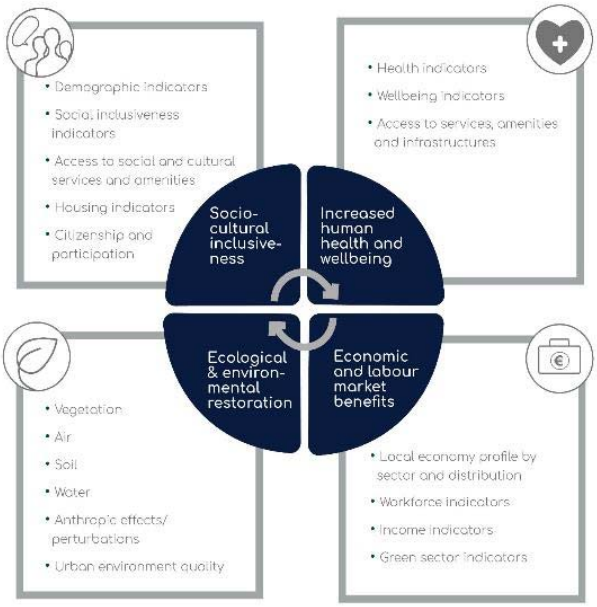

Figure 2. proGIreg assessment domains (image © ICLEI)

A short description of each proGIreg assessment domain is reported in Section 2. Per each domain, there is a corresponding Task in WP4, handled by a proGIreg scientific partner having a clear expertise in the related field. Namely:

- Task 4.1: Assessing socio-cultural inclusiveness, in charge of UNIBA;
- Task 4.2: Increased human health and wellbeing, in charge of ISGLOBAL;
- Task 4.3: Ecological and environmental restoration, in charge of CNR, with UNITO and IUE-CAS support for biodiversity and water quality assessment;
- Task 4.4: Economic and labour market benefits, in charge of SL.

The Task responsible partners are in charge of planning the monitoring activities, training the data collectors, and analysing data. Local partners (coordinated by the FRC) are responsible for data collection. The coordination of the WP4 activities oversees by CNR. A graphical representation of the partners involved in WP4 is shown in Figure 3.

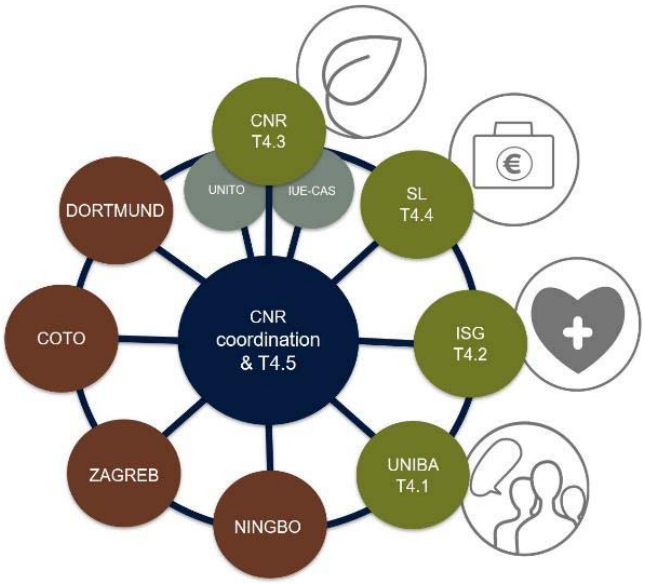

Figure 3. WP4 partners. Task responsibilities are highlighted, together with the corresponding assessment domains, represented by icons (image © ICLEI).

Per each assessment domain, the leading scientific partners have identified the spatial and temporal scales of interest, and the protocols of measurements. The monitoring of the NBS is performed by using two different types of data over three different scales (Figure 4). Spatial data from existing databases are collected both at the city and at the living lab (LL) district level. New experimental data are collected at the LL district and at the NBS level. The definition of the three scale levels has been extensively discussed in proGIreg D2.2 “Spatial Analysis in Front Runner and Follower Cities”[4] and the same administrative borders already defined will be adopted here. Data at NBS and district level are used to calculate KPIs. The city level data will be used only to upscale the LL district and NBS level results and to compare results among cities, since no direct effect of the proGIreg implementations is expected at the city level due to the small size and number of the implemented NBS. An expert-based approach will be followed for the upscaling, depending on the parameter under investigation. Methods for upscaling will be presented in D4.6 (“Guideline for upscaling”).

[4] Leopa, S.; Elisei, P.; Budău, E. et al. (2020): Spatial Analysis in Front-Runner and Follower Cities, Deliverable No. 2.2, Horizon 2020 Grant Agreement No. 776528, European Commission

Figure 4. Spatial scales of interest in the proGIreg monitoring activity: city, LL district and NBS (image © RWTH Institute of Landscape Architecture).

According to the Monitoring and Assessment Plan (D4.1)[1], NBS benefits are mainly assessed at the local scale (called "NBS level"). To do this, research partners have developed 10 NBS-level monitoring tools, which have been largely described in D4.1[1]. Each of the NBS-level monitoring tools developed allows to obtain one or more KPIs. The most relevant indicators to be assessed were identified and described in D4.3 "Protocol of Measurements"[5], but they have been updated, trying to match as much as possible the Handbook "Recommended" Indicators[3]. The NBS-level monitoring tools and the corresponding updated list of KPIs are reported in Section 3, with the related descriptions.

Then, the NBS implementations to be monitored as case studies have been selected. To do this, as described in D4.3[5], at least one case study per NBS type per FRC has been selected for data acquisition, also ensuring as much as possible a 24-months time span between pre- and post-implementation data collections and cross-city comparison. A preliminary list of the NBS implementations to be monitored for benefit assessment in proGIreg was reported in D4.3[5], together with the protocol of measurements to be performed, which includes description of the monitoring tools to be applied and of data collection timing. However, both the list of selected NBS and the protocols of measurements have been changed during the last two years, due to several factors, such as:

- Delayed realization of the NBS due to administrative barriers;
- Delayed and/or modified realization of the NBS due to natural hazards (earthquakes in Zagreb, global CoVid-19 pandemic);
- Delayed realization of the NBS due to required co-design process;
- Impossibility of performing the monitoring activity due to the COVID-19 pandemic situation;
- Unavailability of trained local staff for data collection;
- Too small or missing sample size.

The updated list of the NBS case studies with their updated protocols of measurements is reported in Section 4.

Upon the identification of KPIs and NBS case studies, the FRC started collecting data, in accordance and under the guidance of the research partners involved. Such data have been (and will be) then used by research partners to calculate the selected indicators. Data collections can be classified according to their protocol as:

[5] Baldacchini, C. (2019): Protocols of Measurements, Deliverable No.4.3, proGIreg. Horizon 2020 Grant Agreement No 776528, European Commission, 38.

- Pre/post-implementation collection: data are collected at the NBS site before the implementation and (possibly) 24 months after;
- Continuous collection: data are collected all along the project, since before the NBS implementation (providing, thus, pre/post-implementation data), with a frequency that depends on data itself;
- Only post-implementation collection: (a) indicators that depend on the existence of the NBS itself (such as, for instance, the number of jobs created or the number of users of a previously not accessible site) are assessed only after the NBS implementation; (b) for those NBS that were already realized when the monitoring activity started, or that changed site while the monitoring activity was already running, some indicators that would have required a pre/post-implementation methodology are measured only post-implementation, with a descriptive aim.

The pre-implementation monitoring has been completed for all the NBS case studies for which it was required and possible, and baseline indicators have been obtained. The continuous monitoring activities started and are running; they provided baseline data for most of the NBS case studies, and pre/post-implementation assessment in a few cases. The post-implementation data collections (for both the pre/post- and the only post-implementation designs) have been performed only in a very few cases, to respect as much as possible the 24-months delay from the NBS implementation required by the Grant Agreement (GA). Data collected up to date, and the corresponding indicators, when obtained, are presented, per each NBS case study, in Section 5, but the complete benefit assessment will be presented and discussed in D4.8 “Updated report on benefits produced by implemented NBS”), at the end of the project.

Then, Section 6 is dedicated to KPIs assessed at the LL district scale. They are a limited number, because no effect is expected at such scale for most parameters, due to the relatively small size of NBS implemented in proGIreg. Data from already existing administrative databases (BASE) or geographic information system (GIS)-derived ones are used to calculate large spatial scale indicators on a yearly base, all along the project. Additionally, social, health and economic benefits at the LL district scale are assessed by experimental data collected, in a pre/post-implementation design with 36-months delay, through a general population survey, called the *“General Questionnaire”* (GQ), and related baseline indicators are presented.

Finally, the last section of the present document, Section 7, summarizes the work done, reflecting on the necessary adaptions of the assessment plan which have been done and drawing the first conclusions based on the few results available so far.

2. Assessment domains

2.1. Task 4.1: Assessing socio-cultural inclusiveness

This task is aimed at assessing indicators of socio psychological benefits derived from the implemented NBS in each FRC. Data for the calculation of several indicators, such as connectedness to nature, mindfulness, social interaction and cohesion, and perceived restorativeness of NBS, are collected using the "*General Questionnaire*" (pre- and post-) on a district level, and with the "*NBS-visitor questionnaire*" on each selected NBS site. Partners of cities are involved in the data collection process while supervising, training, data scoring and analysis on socio psychological indicators are in charge of UNIBA partners.

Moreover, Task 4.1 aims to calculate the Walkability Index, an objective measure of how much a particular area is more or less likely to be walkable by people. It provides additional information on the urban structure of a city and districts. It has also been found to correlate with physical activity of local populations, and with social indicators, such as perceived social interaction.

2.2. Task 4.2: Increased human health and wellbeing

This task aims to evaluate the impact of NBS on human health and wellbeing. Previous evidence has shown an association between exposure to greenspace and improved physical and psychological outcomes, including cardiovascular health stress levels and cognitive functioning. However, the knowledge on the public health benefits that new nature solutions in urban settings (such as providing access to a riverbank, or a new park) may provide still deserve a strong interest. The evaluation of the newly implemented NBS allows us to estimate the potential health and wellbeing benefits. The collected data include indicators on general health, mental health, well-being, lifestyle habits, physical activity, and time spent in and perceived quality of the NBS. To be able to detect a change in health and wellbeing indicators that could be attributed to the new NBS, data are collected before and after the NBS implementation. Additionally, the number and demography of visitors and their physical activity levels in the surroundings of the implementation sites is assessed before and after NBS implementation. Finally, the perceived quality of and satisfaction with the different NBS is also assessed.

In addition, to estimate health benefits of NBS conducted in the context of proGIreg, we use Health Impact Assessment (HIA) tools, to quantify the number of cases for different adverse health conditions that could be prevented by NBS. The HIA tools can be used to upscale the findings by predicting health benefits of future NBS and different "scenarios", for which we can use the input from various stakeholders.

2.3. Task 4.3: Ecological and environmental restoration

Green Infrastructures (GI), provide to citizens several environmental services thanks to the interactions that establish with the surrounding environment. These benefits are provided both at global and local scale. At global scale there are direct and indirect interactions with the carbon biogeochemical cycle. GI can directly remove carbon dioxide (CO_2) from the atmospheric pool and, thanks to temperature regulation, the energy demand can be reduced. At local scale, the major benefits are related to air quality and microclimate regulation. GI impacts air pollution formation and deposition: vegetation through stomata removes oxides and other secondary pollutants as ozone. Moreover, particulate matter (PM), which is particularly harmful for human health, is deposited on green surfaces, and thus removed from the atmosphere, at high rates. If properly planned and managed, GI are also important for maintaining and increasing biodiversity. Finally, some NBS applications such as soil regeneration and aquaponics can contribute to solving issues related to soil consumption and use of natural resources in the urban environment, especially with the forecasted increase of population and urbanization. In this context, the objective of Task 4.3 is the evaluation of ecological and environmental restoration benefits linked to the proGIreg NBS implementations. Direct information on the benefits is experimentally obtained on local level (i.e. in the proximity of the NBS). When possible, these benefits will be scaled up to the city level.

2.4. Task 4.4: Economic and labour market benefits

Extensive research has shown that increasing GI in cities is accompanied by multiple direct and indirect economic and labour benefits (OECD 2013)[6]. Effects such as increased real estate values, new commercial initiatives, new (and frequently green) job opportunities and new business opportunities, among others, are all possibilities when implementing NBS in a city.

Task 4.4 aims to quantify the economic and labour market benefits and co-benefits of the proGIreg project in the FRC where NBS are implemented.

Several measurement tools are defined for the impact assessment plan. For Task 4.4 the main tool to capture the direct and indirect economic and labour costs and benefits of the NBS implemented is the *"Economic and Labour Market Questionnaire"*, which is tailored to each combination of NBS+city+stakeholders and administered at least 1 year after the NBS implementation.

[6] www.oecd.org/regional/regionaldevelopment/49330120.pdf

3. Monitoring tools and key performance indicators at the NBS-level

During the proGIreg project, eight different types of NBS are implemented and monitored to assess their benefits (Figure 5). Not all the NBS types are implemented in all FRC, given to local settings and available expertise. However, when possible, cross-city assessment is performed. The name and description of the different NBS types have been slightly updated during the project period. They are described in detail in D3.2 ("Four Implementation Plans: Dortmund, Turin, Zagreb, Ningbo")[7], and are now labelled as:

- NBS1: Leisure activities and clean energy on former landfills;
- NBS2: New regenerated soil;
- NBS3: Community-based urban farms and gardens;
- NBS4: Aquaponics;
- NBS5: Green walls and roofs;
- NBS6: Accessible green corridors;
- NBS7: Local environmental compensation processes;
- NBS8: Pollinator biodiversity.

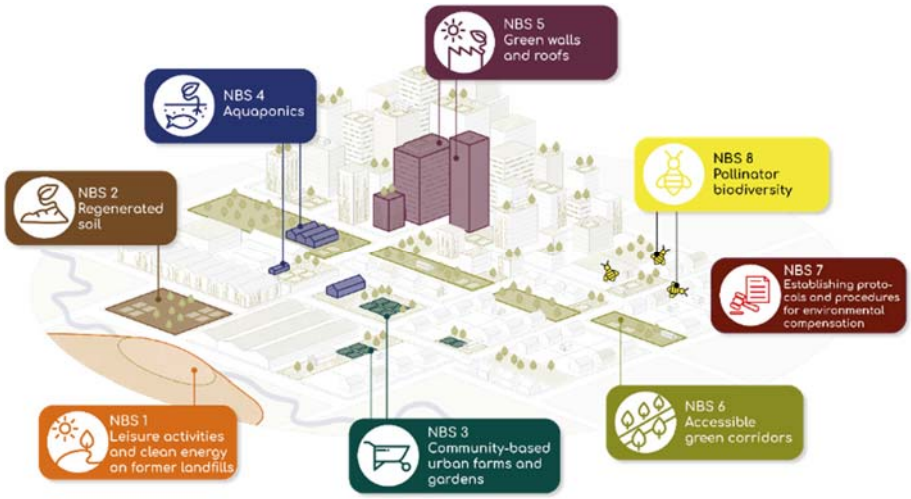

Figure 5. Eight NBS being implemented in the proGIreg FRC (image © RWTH Institute of Landscape Architecture).

The experimental activity at NBS level involve all four assessment domains. Ten 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 1.

[7] Saraco, R. (2020): FRC Implementation PLans, Deliverable No. 3.2, proGIreg. Horizon 2020 Grant Agreement No 776528, European Commission

Table 1. NBS monitoring tools applied in proGIreg to assess benefits at the NBS level.

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
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"[8], post intervention, and when possible, in a pre/post-implementation design
C - Economic and labour market 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
D – Carbon impact	Carbon storage Saved carbon dioxide emissions	Elaboration through mathematical models of environmental, GIS or economic data, to obtain information on the carbon storage in specific NBS Data on building energy demand will be converted in CO_2 equivalent Data on energy production by photovoltaic systems will be converted in CO_2 equivalent
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 twice after; for each monitoring site, 36 passive diffusion tubes are needed (3 tubes x 2 gases x 3 years for both sample and control sites)
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)
G – Particulate biomonitoring	Particulate matter (PM) uptake by the specific NBS	Leaf-deposited PM estimation, using scanning electron microscopy coupled with energy-dispersed x-ray spectroscopy (SEM/EDX), to be repeated twice during the project
H – Environmental footprint	Amount of soil saved Environmental and economic data needed for the Life-Cycle Assessment (LCA) of the selected NBS	Elaboration through cause-effect relationship and mathematical models of environmental, GIS or economic data, in order to obtain information on the environmental footprint of the NBS

[8] 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.

I - Biodiversity	Pollinator and plankton number and species in the proximity of a specific NBS	In Turin, biodiversity monitoring surveys of selected pollinator species performed according to specific protocols adapted to the NBS and observers, and repeated once a week during the pollinators' season, and repeated for 3 years during the project In Ningbo, plankton sampling once a week, along the project duration, by collecting water at 3 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	Three water samples are collected every week at the water inlet, outlet and the centre of the restoring lake in Ningbo

Each one of the above-mentioned assessment tools has been developed to produce raw data to be further processed and translated into KPIs. The list of the indicators that are expected to be obtained per each monitoring tool, together with a short description, is reported in Table 2.

Table 2. Key performance indicators to be assessed at the NBS-level, with a short description and indication of the related assessment domain in proGIreg and of the NBS-level monitoring tool used to produce the corresponding raw data. Per each indicator, it is also specified the societal challenge areas and if it is indicated as "Recommended" (R) or "Additional" (A) in the EC Handbook[3], when available.

NBS-level monitoring tool	Indicator Name	Description	Assessment domain in proGIreg	Societal Challenge Area	R/A
A – NBS questionnaire	15.4. Pro-environmental behaviour	A behaviour which is generally judged a behaviour with a significant impact of the environment and a tribute to the healthy environment	Socio-cultural inclusiveness (Task 4.1)	8. Knowledge and Social Capacity Building for Sustainable Urban Transformation	R
	20.2 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)	Socio-cultural inclusiveness (Task 4.1)	10. Social Justice and Social Cohesion	A
	20.4.2. Perceived social support	Perception of various ways in which individuals aid others	Socio-cultural inclusiveness (Task 4.1)	10. Social Justice and Social Cohesion	A

	20.5. Perceived social cohesion	Social cohesion indicates the set of behaviours and bonds of affinity and solidarity between individuals or groups	Socio-cultural inclusiveness (Task 4.1)	10. Social Justice and Social Cohesion	A
	22.13. Perceived restorativeness of NBS	Perception of restoration coming from an NBS	Socio-cultural inclusiveness (Task 4.1)	11. Health and Wellbeing	A
	8.31.3 Number of and reasons for visits to an NBS area	Visits means discretionary time, ranging from a few minutes out of the home to an all-day trip. Visits may include time spent close to home or further afield, potentially while on holiday	Human health and wellbeing (Task 4.2)	4. Green Space Management	A
	8.31.4 Frequency of use of green and blue spaces	Self-reported time spent in green and blue spaces in hours per week, separately during summer and winter	Human health and wellbeing (Task 4.2)	4. Green Space Management	A
	8.33 Satisfaction with green and blue spaces	Self-reported satisfaction with the green and blue spaces in the neighbourhood	Human health and wellbeing (Task 4.2)	4. Green Space Management	A
	22.1 Self-reported physical activity	Self-reported physical activity in metabolic equivalent of task (MET) minutes per week	Human health and wellbeing (Task 4.2)	11. Health and Wellbeing	A
	Self-reported restoration	Restoration Outcome Scale (ROS-S; Subiza-Pérez et al., 2017). This instrument, using a 0 to 5 scale, includes items related to the main components of a restorative experience: relaxation and calmness, attention restoration, clearing one´s thoughts and reflection.	Human health and wellbeing (Task 4.2)		
B –SOPARC	8.31.2 Number of visitors in new recreational areas	The amount of people visiting, for leisure purpose over a year, the area where the new infrastructure (both NBS, Hybrid solutions and Grey	Human health and wellbeing (Task 4.2)	4. Green Space Management	A

		infrastructures) is implemented.			
	22.2 Observed physical activity levels within NBS	Observed weekly physical activity in the NBS (% over three levels of physical activity [sedentary, walking, or vigorous])	Human health and wellbeing (Task 4.2)	11. Health and Wellbeing	A
C – Economic and labour market questionnaire	23.3 Direct economic activity: Number of new jobs created	Number of FTEs created after implementation (i.e. for the long term maintenance of the NBS)	Economy and labour market benefits (Task 4.4)	12. New Economic Opportunities and Green Jobs	R
	24.5 NBS cost/benefit analysis: Initial costs	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.	Economy and labour market benefits (Task 4.4)	12. New Economic Opportunities and Green Jobs	A
	24.6 NBS cost/benefit analysis: Maintenance costs	Maintenance expenses are the costs incurred to keep an item in good condition or good working order. This total maintenance cost must include total annual labour costs, land leasing costs, machinery, energy costs, licensing, etc.	Economy and labour market benefits (Task 4.4)	12. New Economic Opportunities and Green Jobs	A
	24.12 Income generated via application of green administrative policies within Living Lab district	New income streams produced by implementation of green policies, with breakdown of typology/origin	Economy and labour market benefits (Task 4.4)	12. New Economic Opportunities and Green Jobs	A
	24.15 Increase in tourism	The increase (or decrease) in number of visitors per day that is seen as fully or partially connected to the NBS at a local or international level	Economy and labour market benefits (Task 4.4)	12. New Economic Opportunities and Green Jobs	A
	24.19 Number of new jobs related to	Number of FTEs (full time equivalents)	Economy and labour market benefits	12. New Economic	A

	NBS construction and maintenance	used to construct/implement the NBS	(Task 4.4)	Opportunities and Green Jobs	
	24.34 Value of food produced in NBS	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)	Economy and labour market benefits (Task 4.4)	12. New Economic Opportunities and Green Jobs	A
	24.35 Renewable energy produced in NBS	Energy produced by NBS with photovoltaic systems. Also breakdown of: energy used and energy sold to the grid	Economy and labour market benefits (Task 4.4)	12. New Economic Opportunities and Green Jobs	A
D – Carbon impact	1.2 Avoided greenhouse gas emissions from reduced building energy consumption	CO2 emissions related to building energy consumption (direct via, e.g., residential combustion and indirect via, e.g., electric heating and cooling) with and without NBS implementation (kWh/y and t C/y saved)	Ecological and environmental restoration (Task 4.3)	1. Climate Resilience	R
	2.1.1 Total carbon stored in vegetation	Total amount of carbon (tonnes) stored in vegetation, described per unit area and unit time	Ecological and environmental restoration (Task 4.3)	1. Climate Resilience	A
E – Air Quality	12.1 Removal of atmospheric pollutants by vegetation	With this KPI the main aim is to calculate the pollutions removed by vegetation (in stem, leaves and roots) (kg ha-1 year-1) using formulas and equations in order to assess the impact of the NBS	Ecological and environmental restoration (Task 4.3)	6. Air Quality	A
	12.7 Concentration of particulate matter (PM10 and PM2.5), NO_2, and O_3 in ambient air	Concentration of PM2.5, PM10, NO_2 and ground-level O_3 ($\mu g/m^3$) in ambient air	Ecological and environmental restoration (Task 4.3)	6. Air Quality	A

F – Air temperature	1.3 Monthly mean value of daily maximum temperature (TXx)	Monthly mean value of daily maximum temperature	Ecological and environmental restoration (Task 4.3)	1. Climate Resilience	R
	1.4 Monthly mean value of daily minimum temperature (TNn)	Monthly mean value of daily minimum temperature	Ecological and environmental restoration (Task 4.3)	1. Climate Resilience	R
G – PM biomonitoring	12.2 Total particulate matter (PM) removed by NBS vegetation	The PM abatement is defined as the PM deposed on tree and shrub leaves	Ecological and environmental restoration (Task 4.3)	6. Air Quality	A
H – Environmental footprint	4.19 Rainwater or greywater use for irrigation purposes	Amount of green or grey water collected and reused in place by the NBS (m^3)	Ecological and environmental restoration (Task 4.3)	2. Water Management	A
	4.21 Water dependency for food production	Amount of water used to produce food in aquaponics systems (m^3)	Ecological and environmental restoration (Task 4.3)	2. Water Management	A
	10.15 Equivalent used soil	Total amount of peat saved by using the soil regeneration procedures proposed within the NBS	Ecological and environmental restoration (Task 4.3)	5. Biodiversity Enhancement	A
	12.6 Trends in emissions of NO_X and SO_X	Measure air concentrations of NOx and SOx in $\mu g/m^3$ at identified sampling points close to planned nature-based interventions and highway improvement schemes both pre and post-intervention. Compare these data for differences, and also compare these data to historical city wide data to identify trends	Ecological and environmental restoration (Task 4.3)	6. Air Quality	A
I – Biodiversity	9.4 Species diversity within a defined area	The Shannon Diversity is a very common index used in ecology to quantify diversity in a community. The index provides more information about the fauna and flora composition than simply area	Ecological and environmental restoration (Task 4.3)	5. Biodiversity Enhancement	R

		richness. It takes into consideration both the number of different species observed and their relative abundances			
	9.5 Number of species within a defined area	The Shannon Evenness Index provides information about area comparison and species richness. It gives information about homogeneity of individual distribution between species in the community	Ecological and environmental restoration (Task 4.3)	5. Biodiversity Enhancement	R
J – Water quality	3.2 Water quality – general urban	Calculating/predicting the change in water quality caused by diverting rainfall or surface water flow through an NBS (e.g., green roof, tree pit, bioretention pond, rain garden, wet woodland, naturalised waterway, etc). Implementing an NBS can result in a positive or negative impact on water quality. This is dependent upon: the quality of water entering the system, the type of NBS, the age of NBS, and the water quality parameters being investigated. Both positive and negative impacts of NBS on water quality are of relevance for this indicator. Remote sensing and earth observation approaches are only generally used to provide background/mapping data that can be fed into water quality modelling	Ecological and environmental restoration (Task 4.3)	2. Water Management	R
	3.3 Water quality: TSS content	Total suspended solids (TSS) or turbidity (%, mg/L and total; units dependent upon measurement technique). A measure of the suspended solids in wastewater, effluent, or water bodies, determined by tests for "total suspended non-filterable solids"	Ecological and environmental restoration (Task 4.3)	2. Water Management	R

	3.4 Nitrogen and phosphorus concentration or load	Nitrogen and phosphorus in surface water and/or groundwater (%, expressed as total annual N or P load and/or reduction of maximum annual concentration)	Ecological and environmental restoration (Task 4.3)	2. Water Management	R
	4.33 Eutrophication	The water eutrophication level will be evaluated by a Set Pair Analysis of 5 indices	Ecological and environmental restoration (Task 4.3)	2. Water Management	A

4. NBS case studies and protocols of measurements

The NBS case studies selected, and the corresponding protocols of measurements, are presented in the following Table 3, grouped per FRC.

Table 3. Selected NBS case studies and related protocol of measurements, per FRC.

NBS type and title (Implementation timing)	Tool	Protocol of measurements	Comments	Status
DORTMUND				
NBS1.1: Integrating solar energy production on Deusenberg landfill (already realized at the project start) .	C – Economic and labour market questionnaire	Post-implementation assessment	Data collection planned in January 2021; delayed to October 2021 by the difficulties encountered during questionnaire preparation	**PENDING**
	D - Carbon Impact	Post-implementation assessment	Data collection planned in June 2020; delayed to January 2021	**COMPLETED**
NBS1.2: Exercise Park in an Existing Park in Huckarde (01/2021-12/2022)	A - NBS-visitor questionnaire	Post-implementation assessment	Planned in June 2022; delayed to May 2023 due to delay in implementation	**PENDING**
	B – SOPARC	Pre/post-implementation assessment	Pre-implementation survey planned in June 2020, delayed to September 2020 due to COVID-19 pandemic; post implementation survey planned in September 2022 and delayed to May 2023 due to delay in implementation	**BASELINE**
	C – Economic and labour market questionnaire	Post-implementation assessment	Originally planned, to be better defined after the co-design process	**CANCELED because there are no economic activities in the area**
NBS3.1: Food forests and permaculture orchard in Huckarde (11/2019-11/2021)	A - NBS-visitor questionnaire	Post-implementation assessment	Planned June 2022; delayed to September 2022 to be aligned with tool B and C	**PENDING**

	B – SOPARC	Post-implementation assessment	Planned September 2022	**PENDING**
	C – Economic and labour market questionnaire	Post-implementation assessment	Planned September 2022	**PENDING**
	E – Air Quality	Pre/post-implementation assessment, with 2 post replicates.	Planned June2019, 2021, 2022	**BASELINE & 1 POST ASSESSMENT**
	F – Air Temperature	Continuous acquisition	From Summer 2019	**RUNNING**
	G – PM Biomonitoring	Two replicates	Planned August 2020 and 2022	**1 REPLICATE**
NBS4: Community managed aquaponics system (10/2020-12/2021)	C – Economic and labour market questionnaire	Post-implementation assessment	Planned September 2022	**PENDING**
	H – Environmental Footprint	Post-implementation assessment	Planned January 2022; delayed to January 2023 due to delay in implementation	**PENDING**
NBS6: Connection of Huckarde borough with the renatured Emscher river and Deusenberg sites (07/2020-12/2022)	B – SOPARC	Pre/post-implementation assessment	Pre-implementation survey in June 2020; post implementation survey planned in September 2022 and delayed to May 2023 due to delay in implementation	**BASELINE**
	C – Economic and labour market questionnaire	Post-implementation assessment	Originally planned, to be better defined after the co-design process.	**CANCELED because there are no economic activities in the area**
NINGBO				
NBS2: Transforming Lake sediment into soil fertilizer (01/2019-12/2020)	C – Economic and labour market questionnaire	Post-implementation assessment	Planned September 2021	**CANCELED because too high soil contamination level**

	H – Environmental Footprint	Post-implementation assessment	Planned September 2021	**CANCELED because too high soil contamination level**
NBS3: Planting aquatic plants along the shore of the lake (06-2019-12/2020)	A - NBS-visitor questionnaire	Post-implementation assessment	June 2021	**COMPLETED**
	B – SOPARC	Post-implementation assessment	June 2021	**COMPLETED**
	G – PM Biomonitoring	Post-implementation assessment	Leaf collection planned in June 2020, executed in August 2020 due to COVID-19 pandemic	**COMPLETED**
	I – Biodiversity	Continuous acquisition	From Summer 2019	**RUNNING (stoppedJanuary-June2020 due to COVID-19 pandemic)**
	J – Water quality	Continuous acquisition	From Summer 2019	**RUNNING (stoppedJanuary-June2020 due to COVID-19 pandemic)**
NBS7: Procedures for environmental compensation (07/2020-12/2021)	C – Economic and labour market questionnaire	Post-implementation assessment	Planned September 2021; delayed to October 2021 since still not ready	**PENDING**
		TURIN		
NBS2: New soil production in Sangone Park (12/2019-02/2020)	A - NBS-visitor questionnaire	Post-implementation assessment	Planned June 2022	**PENDING**
	B – SOPARC	Pre/post-implementation assessment	Planned October 2019, Spring 2020, Spring and Autumn 2022; due to COVID-19 pandemic, the second assessment has been deleted and remaining two post-implementation surveys have been moved to October 2021 and October 2022.	**BASELINE**

	C – Economic and labour market questionnaire	Post-implementation assessment	Planned September 2022	**PENDING**
	D - Carbon Impact	Post-implementation assessment	Data collection planned in January 2022	**PENDING**
	E – Air Quality	Pre/post-implementation assessment, with 2 post replicates.	Planned June 2019, 2021, 2022	**BASELINE & 1 POST ASSESSMENT**
	F – Air Temperature	Continuous acquisition	Planned from Summer 2019; delayed to February 2020 to be aligned with NBS implementation	**RUNNING**
	G – PM Biomonitoring	Pre/post-implementation assessment,	Planned July 2020 and 2022	**BASELINE**
	H – Environmental Footprint	Post-implementation assessment	Planned September 2021	**PENDING**
NBS3.2: Gardens in Cascina Piemonte (Orti Generali) (06/2018-05/2019)	A - NBS-visitor questionnaire	Post-implementation assessment	Planned June 2022	**PENDING**
	B – SOPARC	Pre/post-implementation assessment	Planned October 2019 and 2022; post-implementation survey has been changed to October 2021 to respect the 24-months delay of the other surveys.	**BASELINE**
	C – Economic and labour market questionnaire	Post-implementation assessment	Planned September 2022	**PENDING**
	E – Air Quality	Pre/post-implementation assessment, with 2 post replicates.	Planned June 2019, 2021, 2022	**BASELINE & 1 POST ASSESSMENT**
	F – Air Temperature	Continuous acquisition	Planned from Summer 2019; delayed to February 2020 to be aligned with NBS implementation	**RUNNING**

	G – PM Bio-monitoring	Pre/post-implementation assessment	Planned July 2020 and 2022	**BASELINE**
	I – Biodiversity	Pre/post-implementation assessment (3 post assessment)	Planned April-September 2018-2019-2020-2021; April 2020 data are missing due to COVID-19 pandemic	**BASELINE & 2 POST ASSESSMENT**
NBS5.2: Green wall indoor at school (08/2020-01/2021)	A – NBS questionnaire	Pre/post-implementation assessment	Planned December 2020 - Spring 2022	**BASELINE**
	E – Air Quality	Pre/post-implementation assessment	NOT PLANNED – data collected by ARPA Piemonte December 2020 – January 2021	**COMPLETED**
	G – PM Bio-monitoring	Two post-implementation assessments	Planned August 2021 and 2022; delayed to September 2021-2022 because the school was closed in August	**PENDING**
NBS5.3: Green wall outdoor on a homeless dormitory (08/2020-12/2020)	A – NBS questionnaire	Post-implementation assessment	To be defined	**UNDER EVALUATION**
	C – Economic and labour market questionnaire	Post-implementation assessment	Planned September 2022	**UNDER EVALUATION**
	F – Air Temperature	Continuous acquisition	Data collected by ARPA Piemonte since July 2020	**RUNNING**
	G – PM Bio-monitoring	Two post-implementation assessments	Planned August 2021 and 2022; delayed to September 2021-2022 to be aligned with the school wall sampling	**PENDING**
NBS5.4: New green roof at WOW (03/2020-05/2020)	C – Economic and labour market questionnaire	Post-implementation assessment	Planned September 2022	**CANCELED – because the building is abandoned**
	D - Carbon Impact	Post-implementation assessment	Data collection planned in January 2022	**CANCELED – because the building is abandoned**

	E – Air Quality	Pre/post-implementation assessment, with 2 post replicates.	Planned June 2019, 2021, 2022	**BASELINE & 1 POST ASSESSMENT**
	F – Air Temperature	Continuous acquisition	Planned from Summer 2019; delayed to February 2020 to be aligned with NBS implementation	**RUNNING**
	G – PM Biomonitoring	Two post-implementation assessments	Planned August 2021 and 2022	**CANCELED – only grass**
	I – Biodiversity	Pre/post-implementation assessment	Planned April-September 2021-2022	**CANCELED – only grass and not accessible to researchers**
NBS6.1: Green corridor (08/2020-06/2021)	B – SOPARC	Pre/post-implementation assessment	Planned October 2020 and 2022	**BASELINE**
	C – Economic and labour market questionnaire	Post-implementation assessment	Planned September 2022	**PENDING**
	I – Biodiversity	Pre/post-implementation assessment	NOT PLANNED Late May-September 2020 and April-September 2021 (only butterflies)	**BASELINE**
NBS7.1: Strategic public-private partnership for greening the City (07/2019-12/2021)	C – Economic and labour market questionnaire	Post-implementation assessment	Planned September 2022	**PENDING**
NBS8: Butterfly gardens for disadvantaged people (01/2019-12/2021)	C – Economic and labour market questionnaire	Post-implementation assessment	Planned September 2022	**PENDING** to be performed in collaboration with UNITO, also including social indicators
	I – Biodiversity	Post-implementation assessment	Spring 2020 and 2021	**CANCELED – no sufficiently trained users**

ZAGREB				
NBS3.1: Modernization of existing urban garden (01/2021-06/2021)	A – NBS questionnaire	Post-implementation assessment	Planned June 2022; delayed to Spring 2023 to improve the delay after implementation and to align with the post-implementation SOPARC survey	**PENDING**
	B – SOPARC	Pre/post-implementation assessment	Pre-implementation planned June 2020; delayed to September 2020 due to COVID-19 pandemic; delayed to March 2021 due to implementation delay after earthquake; post-implementation shifted to March 2023	**BASELINE**
	C – Economic and labour market questionnaire	Post-implementation assessment	Planned September 2022	**PENDING**
	E – Air Quality	Pre/post-implementation assessment, with 2 post replicates.	Planned June2019, 2021, 2022; post-implementation shifted to 2022 and 2023 due to delay in the implementation	**BASELINE**
	F – Air Temperature	Continuous acquisition	Planned from Spring 2020	**CANCELED - the area was already green**
	G – PM Biomonitoring	Two post-implementation assessments	Planned June 2020 and 2022; delayed to August 2020 and 2022	**BASELINE**
NBS3.2: New therapy garden in Sesvete (01/2021-06/2021)	A – NBS questionnaire	Post-implementation assessment	Planned June 2022; delayed to Spring 2023 to improve the delay after implementation and to align with the post-implementation SOPARC survey	**UNDER EVALUATION due to vulnerability of the users**
	B – SOPARC	Planned pre/post-implementation assessment; modified in only post-implementation	Pre-implementation planned June 2020; delayed to September 2020 due to COVID-19 pandemic; delayed to March 2021 due to implementation delay after earthquake and then CANCELED because the site was inaccessible before	**PENDING**

			implementation; post-implementation shifted to March 2023	
	C – Economic and labour market questionnaire	Post-implementation assessment	Planned September 2022	**PENDING**
	E – Air Quality	Pre/post-implementation assessment, with 2 post replicates.	Planned June2019, 2021, 2022; post-implementation shifted to 2022 and 2023 due to delay in the implementation	**BASELINE**
	F – Air Temperature	Continuous acquisition	Planned from Spring 2020; delayed to October 2020 due to COVID-19 pandemic and then to August 2021 for wrong setup.	**RUNNING**
	G – PM Biomonitoring	Two post-implementation assessments	Planned June 2020 and 2022; delayed to August 2020 and 2022	**BASELINE**
NBS5: Seedling factory with aquaponics installations and green roof (01/2021-07/2021) (Replaces the previously planned green roof, green wall and integrated solar energy after the earthquake)	A – NBS questionnaire	Post-implementation assessment	Planned Spring 2023	**PENDING**
	C – Economic and labour market questionnaire	Post-implementation assessment	Planned September 2022	**PENDING**
	D – Carbon impact	Post-implementation assessment	Planned January 2022; delayed to January 2023, to increase the post implementation period	**PENDING**
	E - Air Quality	Pre/post-implementation assessment	Planned June 2020, 2021, 2022	**CANCELED because no time to acquire the pre-implementation data**
	F – Air Temperature	Continuous acquisition	Planned from August 2021	**RUNNING**
	G – PM Biomonitoring	Two post-implementation assessments (only green wall, because there are	Planned August 2021 and 2022; delayed to September 2021-2022 because of staff vacations	**RUNNING**

		only draught resistant plants on the roof)		
NBS6: New cycling track (03/2021-12/2021)	B – SOPARC	Pre/post-implementation assessment	Planned Spring 2020 and 2022; delayed to March 2021-2023 due to COVID-19 pandemic	**BASELINE**
	C – Economic and labour market questionnaire	Post-implementation assessment	Planned September 2022	**PENDING**
NBS7: New protocols (09/2020-06/2022)	C – Economic and labour market questionnaire	Post-implementation assessment	Planned September 2022	**PENDING**

5. Benefits' assessment at the NBS level: achieved results per NBS case study

5.1. Dortmund NBS1.1: Integrating solar energy production on Deusenberg landfill

The former Deusenberg landfill site has been recultivated since 1992, with a four-meter-thick isolation layer being applied to an area of around 54 hectares and up to 55 meters in height for future vegetation. About 150,000 trees have been planted for this purpose. The Deusenberg was named after the Deusen district and opened to the public in 2004. Since then, it has become a popular destination for various recreational activities such as (dog) walking, jogging, cycling, mountain biking, bird watching, etc. Access to the top of Deusenberg is mainly from the northeast side via several trails and stairs. The other exposures are "gated" or a fenced by maintenance and work facility. Because of its uniqueness, recreational and spatial significance, the citizens of Huckarde have expressed their desire to local politicians to improve the connection of their settlements to the Deusenberg recreational area. Thus, the Deusenberg is not only be made accessible by proGIreg (NBS6, barrier-free path in the southeast side), but also become part of the exhibition area of the International Garden Exhibition in 2027.

The NBS1.1 in Dortmund has been implemented on the Deusenderg since 2017 by a private energy company, ENTEGRO Photovoltaik-Systeme GmbH. The solar park on Deusenberg site belongs to the city of Dortmund but is managed and maintained by a private affiliated company called EDG, Entsorgung Dortmund GmbH (Waste management company). The solar park has a capacity of 3952 kWp (3.952 MWp) and produces around 3,600,000 kWh per year. 12735 solar modules produce the electricity, 61 inverters produce the AC voltage.

Figure 6. The solar park on Deusenberg site (image © www.entegro.eu).

Tool C - Economic and Labour Market Questionnaire

The Economic and Labour Market Questionnaire created by SL, in collaboration with partners from SWUAS, will be administered in October 2021. The questionnaire has been tailored taking into account the specific combination of NBS+city+stakeholders. In the case of NBS1.1, the following indicators are assessed in the questionnaire:

- 23.3 Direct economic activity: Number of new jobs created
- 24.5 NBS cost/benefit analysis: Initial costs
- 24.6 NBS cost/benefit analysis: Maintenance costs
- 24.19 Number of new jobs related to NBS construction and maintenance
- 24.35 Renewable energy produced in NBS

The text of the questionnaire can be found in the Annex 1 of the present document.

Tool D - Carbon Impact

In 2021, CNR estimated the CO_2 emission saved thanks to the solar energy production in NBS1.1. The park produces about 3600000 kWh of electricity and thus avoids 780,000 m³ of natural gas or about 780,000 litres of heating oil[9]. According to the standard emission factor for Germany[10], this production saved up to 2246 t CO_2.

To provide a wider characterization of the environmental impact of the whole renaturalization of the Deusenberg landfill, in 2020 a deep investigation was also carried out, to collect biometric and tree health status information of the trees planted around the NBS1.1. This field sampling collection, together with the meteorological and atmospheric pollutants concentration data, allowed the use of *i-Tree Eco* model[11] to obtain the estimation of air pollutants and carbon removal by the species present in the renatured landfill. The carbon impact was evaluated through the modelling of carbon storage and carbon gross sequestration, thus resulting in 352.6 ± 88.9 tons ha^{-1} and a carbon gross sequestration of 12.8 ± 2.4 tons ha^{-1} $year^{-1}$, offsetting for the 0.22% of the carbon emitted by the urban area of Dortmund (Figure 7). Additionally, the results obtained showed an annual removal 46.4 ± 10.7 kg ha^{-1} of tropospheric O_3, 26.5 ± 6.0 kg ha^{-1} of NO_2, 2.4 ± 0.6 kg ha^{-1} of SO_2 and finally 3.4 ± 0.8 kg ha^{-1} of PM2.5.

[9] https://www.entegro.eu/solarpark-deusenberg-ist-im-bau/
[10] https://www.covenantofmayors.eu/IMG/pdf/technical_annex_en.pdf
[11]https://www.itreetools.org/, Hirabayashi, Satoshi, Charles N. Kroll, and David J. Nowak. "i-Tree eco dry deposition model descriptions." Citeseer (2012).

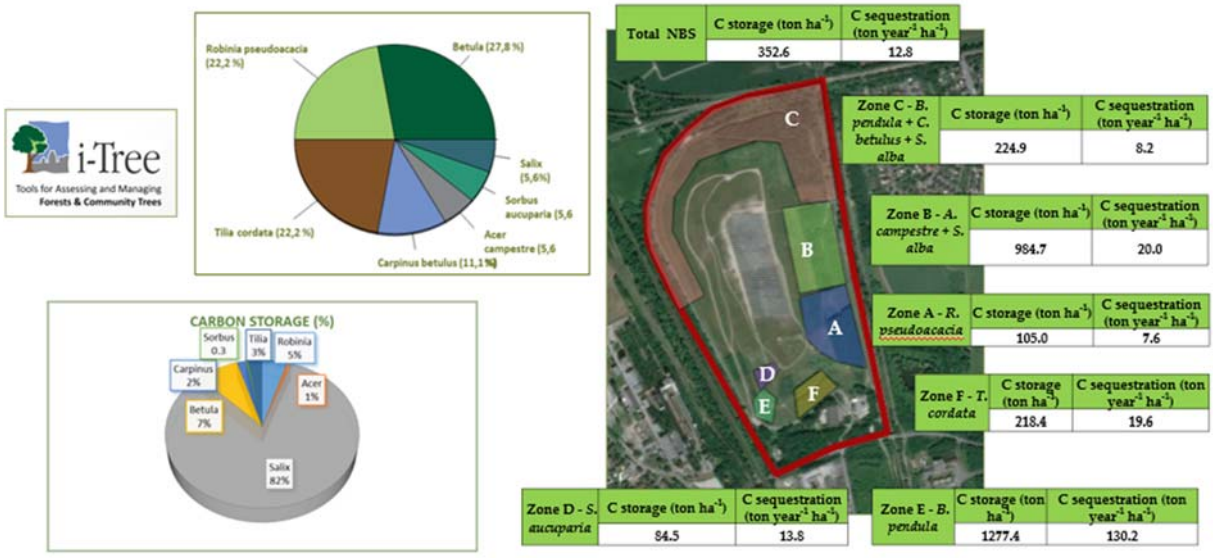

Figure 7. Dortmund NBS 1 - New forest planted on the renatured Deusenberg landfill and its species-specific composition. *i-Tree Eco* modelled carbon storage and sequestration (tons ha^{-1} and tons ha^{-1} $year^{-1}$). Results related to the total NBS and different zones within the NBS are presented.

Tool G - PM Biomonitoring

Leaf sampling was carried out in September 2019, from four different tree species, within this NBS: *Acer campestre* L., *Betula pendula* Roth, *Carpinus betulus* L. and *Salix alba* L.. Two plants for each species were individuated and three branches (exposed to North, South, and West) were collected from the external part of the crown, at 3 meters from the ground. To ensure homogeneity, only the youngest leaves at the top of each branch were selected for SEM/EDX microanalysis. Density, elemental composition and weight of leaf deposited PM, were assessed as a function of particle size fraction and tree species (Figure 8, 9 and 10). PM10 removal resulted in a maximum of 3.8 ± 0.4 µg cm^{-2} of leaf unit area, detected for *S. alba* L. (Figure 10). These experimental results, upscaled at the NBS level, corresponded to a removal of 6.8 ± 1.3 and 14.9 ± 2.9 kg ha^{-1} $year^{-1}$, respectively for PM2.5 and PM10. Furthermore, experimental PM2.5 results were compared with those modelled by the *i-Tree Eco* model. To this aim, only the species analysed by SEM/EDX were taken into consideration. Species-specific mass concentrations of PM2.5 obtained through the SEM/EDX procedure were multiplied for the LA (in cm^2) modelled by i-Tree Eco model and the total surveyed number of trees of *A. campestre* L., *B. pendula* Roth, *C. Betulus* L. and S. alba L. in this NBS. Interestingly, the same species-specific trend has been obtained both experimentally and theoretically, even if modelled data of PM removal were slightly underestimated, likely due to the lack of a species-specific characterization of PM deposition velocities in the model.

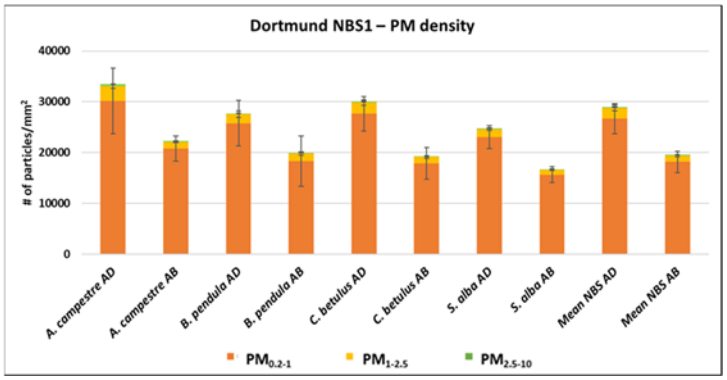

Figure 8. Mean species-specific particle densities (number of particles *mm^{-2}), with standard deviations, on the adaxial (AD) and abaxial (AB) sides, for the three PM size fractions ($PM1_{0.2-1}$, $PM_{1-2.5}$, $PM_{2.5-10}$). Results averaged over the four species are also reported as mean NBS values.

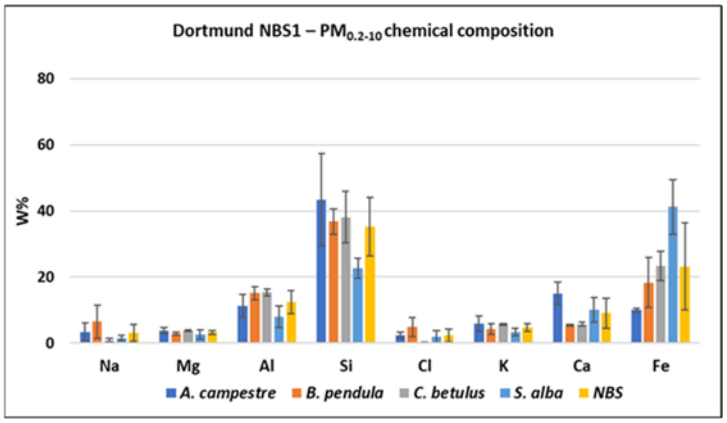

Figure 9. Relative chemical composition and standard deviations, as estimated by the W% obtained from the SEM/ EDX analysis, for $PM_{0.2-10}$ for all the species sampled. Results averaged over the four species are also reported as mean NBS values.

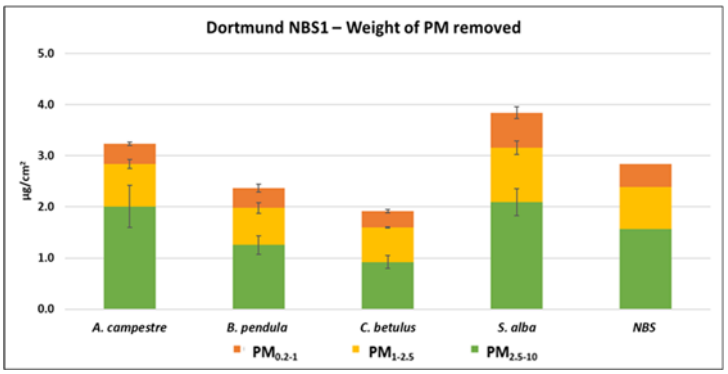

Figure 10. Weight of PM removed (µg cm^{-2}), as obtained from SEM/EDX, through the combination of PM density and chemical composition results. Results averaged over the four species are also reported as mean NBS values. Standard deviations are given for each size fraction and each species.

Results relative to the PM monitoring and the carbon impact evaluation (monitoring tool G and D) carried out around the Dortmund renatured landfill have been presented in a peer-reviewed scientific paper, which is under evaluation (August 2021).

5.2. Dortmund NBS1.2: Exercise Park in an existing Park in Huckarde

This NBS will be implemented in the eastern part of an existing park in the Huckarde district and aims at providing sports devices that encourage physical exercises that can be integrated into the daily routine. Since it is in a public park (Gustav Heinemann Park), this NBS will be public and will invite the users of the park, the pupils of the adjacent school and the citizens of Huckarde. The Park is owned, managed, and maintained by the City of Dortmund.

Figure 11. The Gustav Heinemann Park (image © Mais Jafari).

Tool B - SOPARC

The Park is used more on weekdays than on weekends. Children and adults are the main user groups and use the park for walking activities (Figure 12). It was also observed that the park was little used for sedentary activities, such as sitting, socializing, or reading (Figure 13). Senior citizens were rarely present in the park.

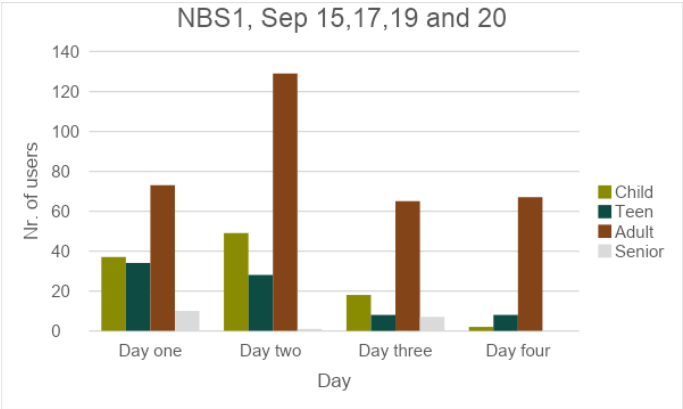

Figure 12. User groups for NBS1.2 in Dortmund LL in the four observation days of the SOPARC pre-implementation assessment (15, 17, 19 and 20 September 2020).

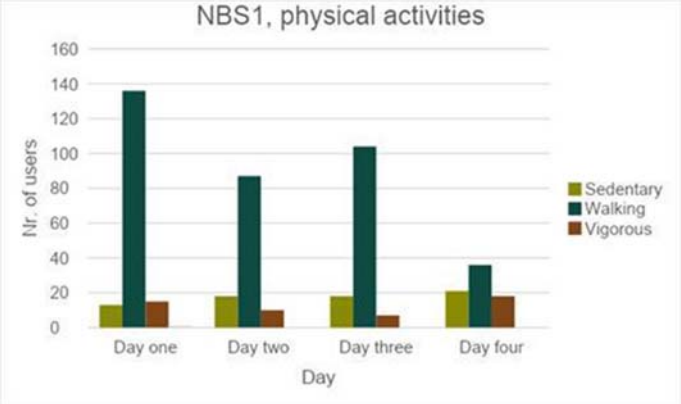

Figure 13. Physical activity levels of NBS1.2 in Dortmund LL in the four observation days of the SOPARC pre-implementation assessment (15, 17, 19 and 20 September 2020).

5.3. Dortmund NBS3.1: Food forests and permaculture orchard in Huckarde

A 3000 m² food forest - a self-sustaining forest ecosystem for food production - has been created together with the scouts and members of the parish of St. Urbanus. The food forest of St. Urbanus has been implemented in workshops with the parish and the boy and girl scouts of the Deutsche Pfadfinderschaft Sankt Georg (DPSG). The Co-implementation is also intended to empower people to maintain the garden in the long term. The food forest is also used as a place of education for the local population to learn about sustainable cultivation methods for their own garden areas.

Figure 14. The food forest of St. Urbanus (image © Mais Jafari).

Tool E - Air Quality

Passive samplers for O_3 and NO_2 were exposed in the NBS3.1 area and control points from 14/06/2019 to 3/7/2019 to have the baseline data of these selected air pollutants (Figure 15). At the beginning of summer 2021 the measurement campaign has been repeated and the samples are under analysis in the lab.

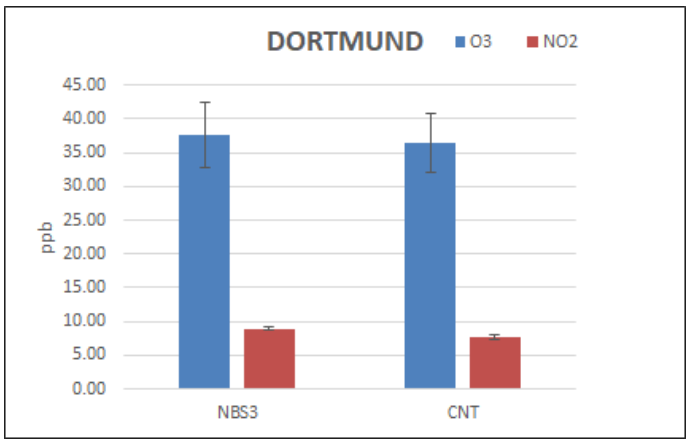

Figure 15. Concentrations (ppb) of O_3 (blue columns) and NO_2 (red columns) in NBS3.1 and Control for baseline measurement. Vertical bars represent the standard error of the mean (n=3).

Tool F - Air Temperature

At the end of 2019, air temperature sensors were installed in NBS3.1 and control points within the LL of the city of Dortmund. Only at the beginning of 2020, a complete set for the two treatments (at least a sensor working for each treatment) was obtained. Figure 16 is showing the temporal variation of hourly mean of air temperature in both NBS3 and control points. As expected, preliminary results showed higher temperature in summer months and minimum temperature in winter periods. At this stage it was not possible to perform any statistical analysis due to the lack of coexistence of a sufficient number of replicas at the same time. In any case, it was possible to analyse some data trends on a daily basis. Figure 17 shows the temporal variation of daily maximum, minimum and temperature range of control points and NBS3.1. It is evidenced how, after a first period of absence of clear trend, the temperature range of control point is almost higher than that at NBS3.1. This seems to be due to different reasons during the different seasons, but that could be both linked to the greening of the NBS. Indeed, during summer months, the maximum temperature recorded in control points is noticeably higher than that measured at NBS3.1, while during winter months the minimum temperature of NBS3.1 is higher than control points. These preliminary results need to be confirmed with further data and analysis.

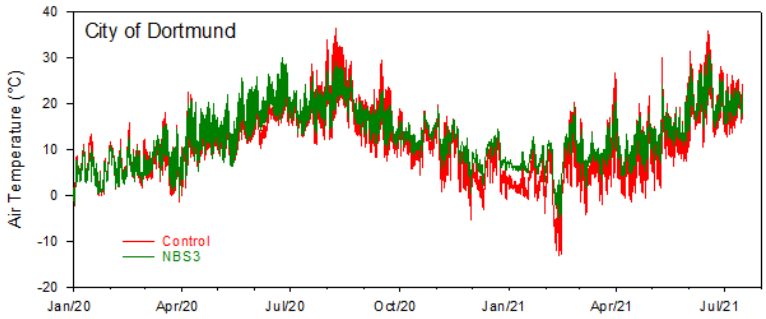

Figure 16. Hourly mean of air temperature recorded in control points (red line) and NBS3.1 (green line).

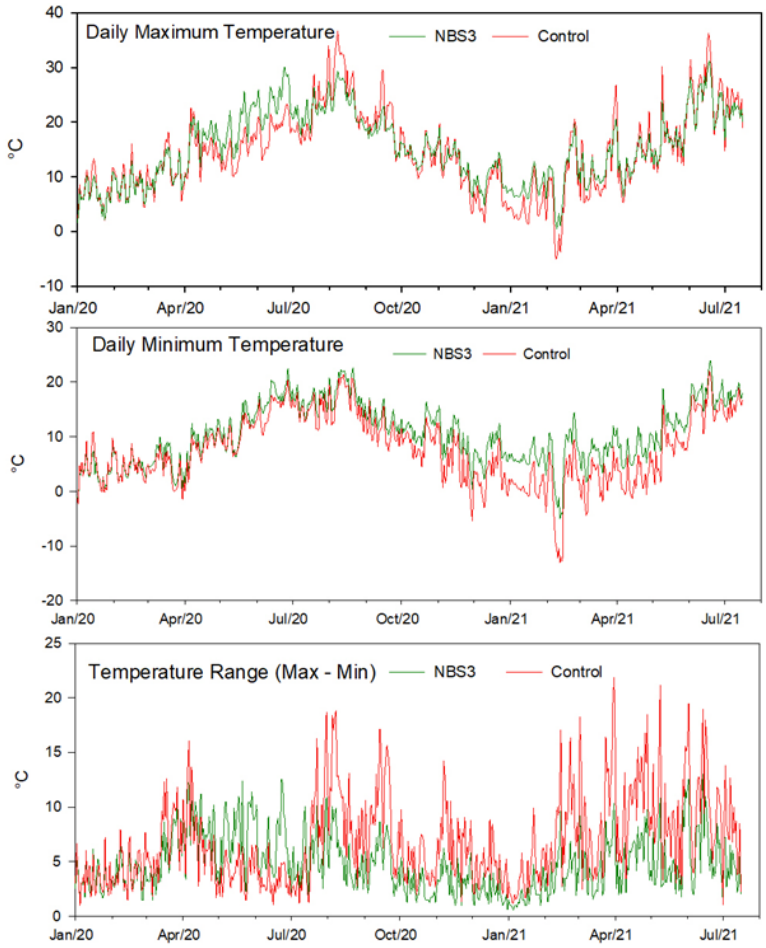

Figure 17. Daily maximum (upper panel), daily minimum (central panel) and temperature range (below panel) recorded in control points (red line) and NBS3.1 (green line).

Tool G - PM Biomonitoring

Leaf samplings were conducted within the Food forest in Huckarde, at the end of August 2020, for the pre-implementation evaluation of the atmospheric PM abatement of different shrubs/tree species located within this NBS3.1. Specifically, leaves were sampled from four species, two shrubs (*C. avellana* L. and *Cornus* spp.) and two trees (*R. pseudocacia* L. and *C. betulus* L.). Biometric data were also collected, such as trunk circumference (cm), DBH (cm) and height of sampled plants. In accordance with protocols and for each species considered, two leaves were sampled from three replicate branches, for a total of six leaves. Leaves were analysed by SEM/EDX. Data elaboration and assessment of 1) density (as number of particles per mm^2 of leaf area unit) and 2) chemical composition of leaf deposited particles as a function of particle size and sampled species were carried out (Figure 18 and 19). These two first parameters were then combined to obtain the weight of removed PM, again as a function of size and sampled species (Figure 20).

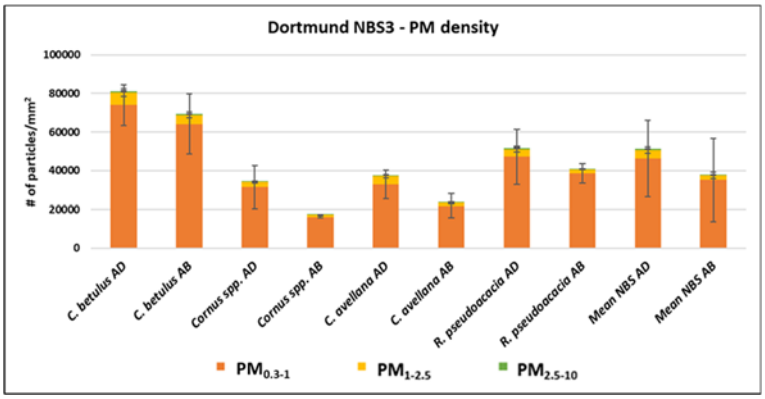

Figure 18. Mean species-specific particle densities (number of particles *mm^{-2}), with standard deviations, on the adaxial (AD) and abaxial (AB) sides, for the three PM size fractions ($PM_{0.3-1}$, $PM_{1-2.5}$, $PM_{2.5-10}$). Results averaged over the four species are also reported as mean NBS3.1 values.

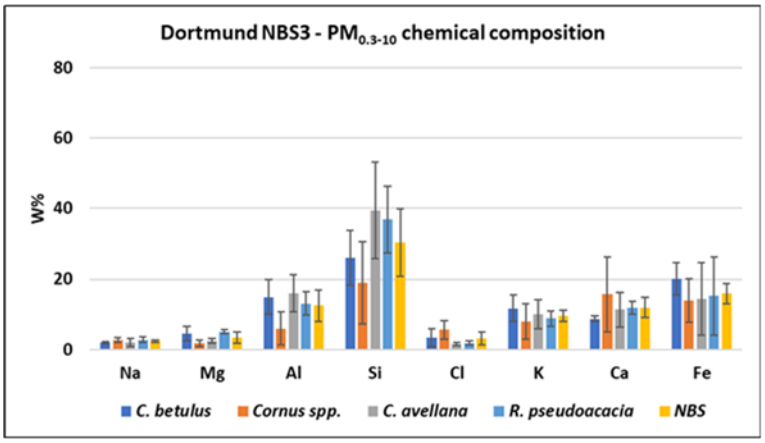

Figure 19. Relative chemical composition and standard deviations, as estimated by the W% obtained from the SEM/ EDX analysis, for $PM_{0.3-10}$ for all the species sampled. Results averaged over the four species are also reported as mean NBS3.1 values.

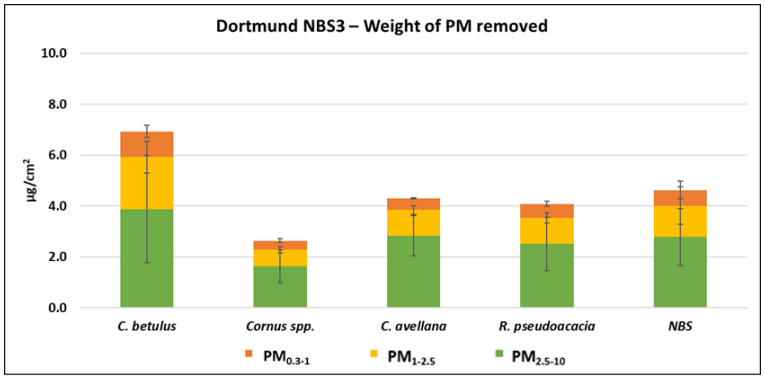

Figure 20. Weight of PM removed (µg cm^{-2}), as obtained from SEM/EDX, through the combination of PM density and chemical composition results. Results averaged over the four species are also reported as mean NBS3.1 values. Standard deviations are given for each size fraction and each species.

5.4. Dortmund NBS6: Connection of Huckarde borough with the renatured Emscher river and Deusenberg sites

A 115 m long path will be created in this NBS, which will connect the former landfill site in Deusenberg with the River Emscher cycling route. It will provide a shorter access to the recreational areas on the Deusenberg for Huckarde citizens. This NBS will be implemented by the City of Dortmund and maintained by its affiliated company EDG, Entsorgung Dortmund GmbH (Waste management company).

Figure 21. The site where the new walk path in Deusenberg will be realized (image © Mais Jafari).

Tool B - SOPARC

The future NBS6 implementation site is rarely used as the current path on the site is hidden and located in an isolated area. Scanning periods at evening hours were cancelled because the path is in a remote area, and it is not safe to stay at night. During the 4 days of observation, only few adult people (n=15) were observed in the site, and just to walk, likely due to the isolated location of the site.

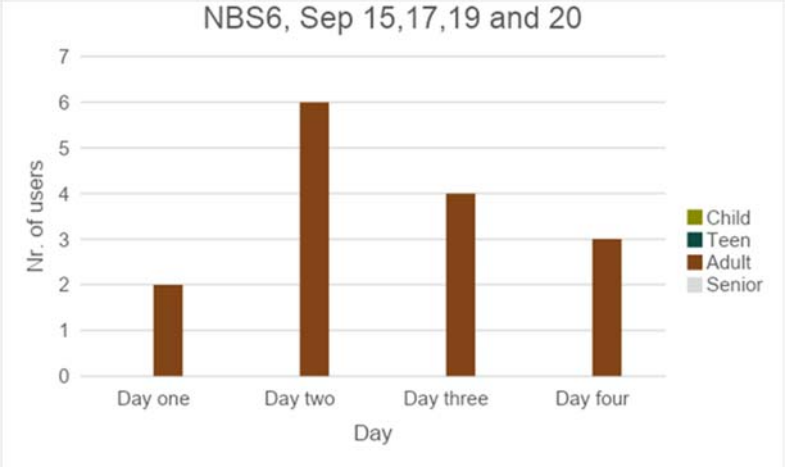

Figure 22. User groups for NBS6 in Dortmund LL in the four observation days of the pre-implementation SOPARC assessment (15, 17, 19 and 20 September 2020).

5.5. Ningbo NBS2: Transforming Lake sediment into soil fertilizer

In Ningbo, NBS2 activities are mainly divided into two steps:

1) Regenerate the ecological structure of blue areas by employing sediment dredging equipment to remove the endogenous pollution sources within a contaminated urban lake.

2) Utilising the fertiliser derived from lake sediment into the soil regeneration in a total area of 20 ha green space located in the central district of Ningbo City.

The activity to remove the sediments of Moon Lake was successfully carried out. However, during the second step of converting the sediment into fertilizer, it has been found that the heavy metal content in the sediment was too high, the conversion process was complicated, and the cost was too high, and this activity has been cancelled.

5.6. Ningbo NBS3: Planting aquatic plants along the shore of the lake

This NBS consists in using macrophytes to re-nature a 5 km corridor surrounding the Moon Lake, to limit the runoff from non-point pollution sources in urban space. Aquatic plants used mainly include iris, canna, calamus and Pontederia, and professional gardeners have planted and maintained them. These plants can not only reduce water pollution, but also increase the beauty and ornamentation of Moon Lake Park, which can attract more tourists.

Figure 23. The newly planted aquatic plants in the Moon Lake (image © proGIreg).

Tool A - NBS-visitor questionnaire

The NBS-visitor questionnaire has been administered in the NBS3 in the city of Ningbo in July 2021. The questionnaire was intended to evaluate the perceived change in social and health benefits derived from the NBS3 implementation. Ninety-seven questionnaires were completed. Data collection was in charge of the city of Ningbo. UNIBA provided detailed online training before starting the data collection.

Comparisons among the assessed indicators will be available when data collections on NBS3 in the other FRCs will be completed. The aforementioned data collections are scheduled in the next two years of the project. Demographic characteristics of the sample population and descriptives on the assessed indicators are shown in Table 4.

Table 4. Results of the NBS-visitor Questionnaire from NBS3 in Ningbo (M=mean; SD=standard deviation; *third gender non present; N=frequency; %=percentage).

SAMPLE CHARACTERISTICS (N = 97)		
Gender* [N(%)]	Female	41 (42.3%)
	Male	56 (57.7%)
Age (M ± DS)		(41 ± 212)
Education in years (M ± DS)		(11 ± 4)
Employment status [N(%)]	Employed	34 (35.5%)
	Unemployed	1 (1%)
	Student	24 (24.5%)
	Stay-at-home parent	7 (7%)
	Rehabilitation/Disabled	1 (1%)
	Retired	30 (31%)
	Other	-
Chinese nationality [N(%)]		97 (100%)
Years in the current address (M)		28
Smoking habits [N(%)]	Neve smoking	58 (59.8%)
	Current smoker	27 (27.8%)
	Former smoker	12 (12.4%)
Alcohol habits [N(%)]	Never	46 (47.4%)
	Occasionally (few ti-mes/month)	32 (33%)
	Frequently (1-5 ti-mes/week)	16 (16.5%)

		Daily	3 (3.1%)	

INDICATORS

		M ± DS of the scale scores	**Mini-mum score**	**Maxi-mum score**
Satisfaction for the NBS	Times visiting NBS (last month)	17.5 ± 17.1	0	60
	Visit more often than before [N(%]	74 (73.4 %)		
	Time spent (h/visit)	1.2 ± 0.5	0.5	4
Perceived social cohesion		(19.3 ± 4.3)	6	24
Perceived neighbourhood relationship improvement (a lot) [N(%)]		30 (30.9%)		
Physical activity levels (hours/week at the NBS)	Vigorous p50(p25;p75)	(0.27 ± 0.99) 0 (0;0)	0	7
	Moderate p50(p25;p75)	(2.4 ± 5) 0 (0;1.15)	0	21
	Walking p50(p25;p75)	(2.7 ± 4.8) 1(0;3)	0	30
Perceived restoration of the NBS		(39 ± 5.1)	18	45

Tool B - SOPARC

The Moon Lake NBS is more frequently visited by men and adults across day periods. Seniors use the site mostly in the morning and afternoon, a lower proportion of children and teens visit the NBS in the lunchtime and afternoon. The most common physical activity level is vigorous across the day periods, followed by walking. Results are shown in Figure 24.

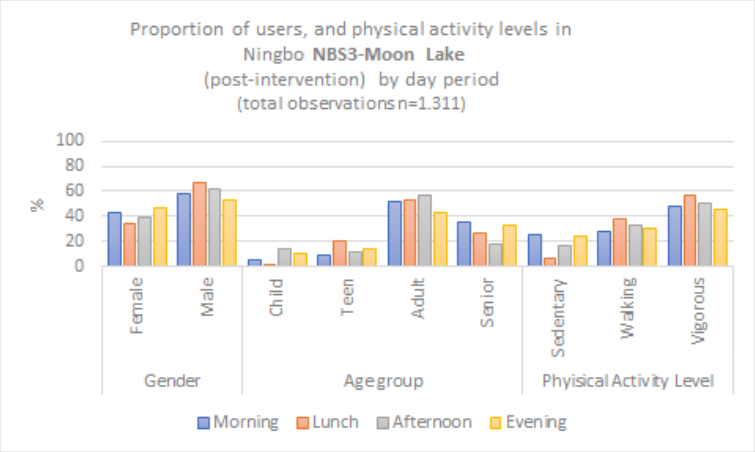

Figure 24. User groups and physical activity levels for NBS3 in Ningbo LL in the four observation days of the post-implementation SOPARC assessment (14, 15, 16 and 18 July 2021).

Tool G - PM Biomonitoring

PM biomonitoring at this NBS, was carried out through leaf sampling from species planted along the shore of the Moon Lake and subsequent SEM/EDX microanalysis of the leaves. Leaves were collected in August 2020 from two herbaceous species, namely *A. calamus* L. and *C. aquatica* L.. Two leaves from three different plants of *A. calamus* L. (for a total of six leaves) and two leaves from three different plants of *C. aquatica* L. (for a total of six leaves) were sampled in a first sampling location along the shore (Site A, Figure 25). Then for *C. aquatica* L., additional leaves were also sampled in other two locations (Site B and C Figure 25), thus collecting two leaves from three different plants in each of these sites.

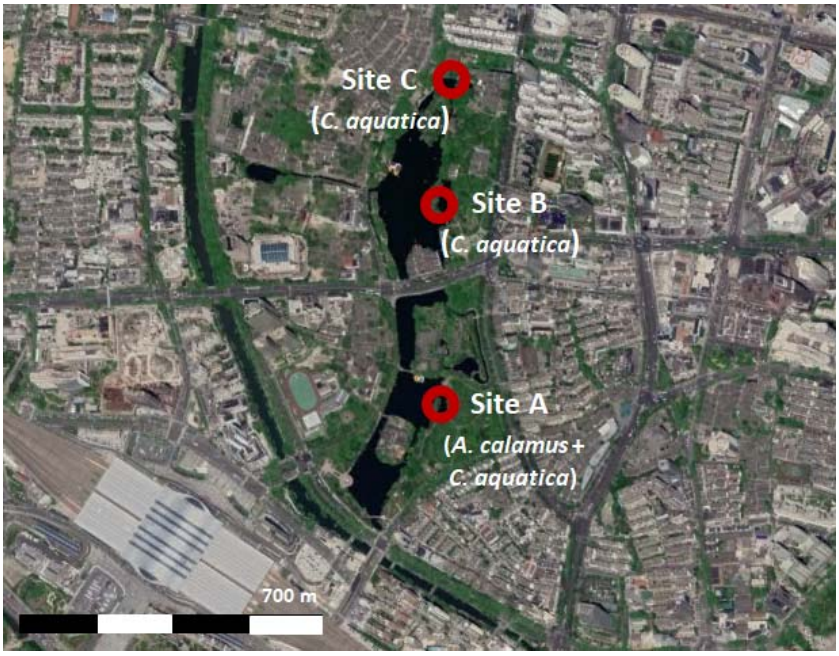

Figure 25. Leaf sampling sites in Ningbo NBS3 for PM biomonitoring task.

Therefore, and in this specific case, it was possible not only to evaluate the species-specific PM abatement of the two species, but also to retrieve information on the site-specific PM abatement (only for *C. aquatica* L.). In accordance with protocols and after the sampling, leaves were stored and sent to CNR for SEM/EDX microanalysis. As shown in Figure 26, 27, and 28, results relative to the density (number of particles per mm^2 of leaf area unit), the chemical composition and the weight (µg per cm^2 of leaf area unit) of removed and leaf deposited particles were obtained. All these results were expressed as a function of species, particle size and specifically for *C. aquatica* L. also as a function of sampling site.

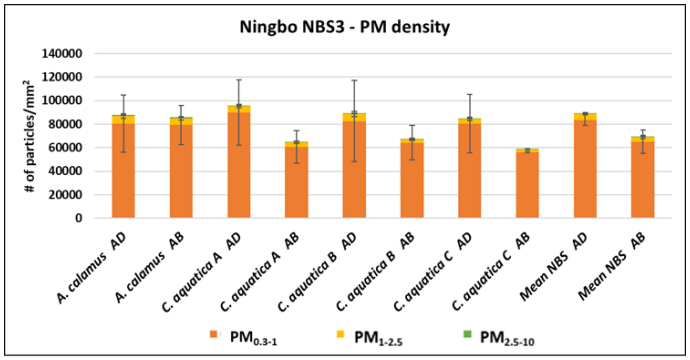

Figure 26. Mean species-specific particle densities (number of particles *mm^{-2}), with standard deviations, on the adaxial (AD) and abaxial (AB) sides, for the three PM size fractions ($PM_{0.3-1}$, $PM_{1-2.5}$, $PM_{2.5-10}$). Results averaged over the four species are also reported as mean NBS values.

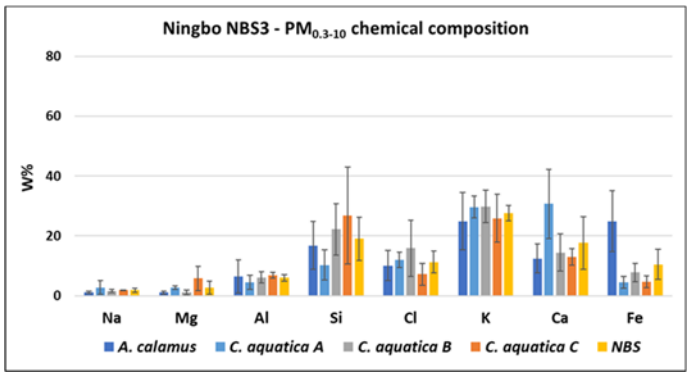

Figure 27. Relative chemical composition and standard deviations, as estimated by the W% obtained from the SEM/ EDX analysis, for $PM_{0.3-10}$ for all the species sampled. Results averaged over the four species are also reported as mean NBS values.

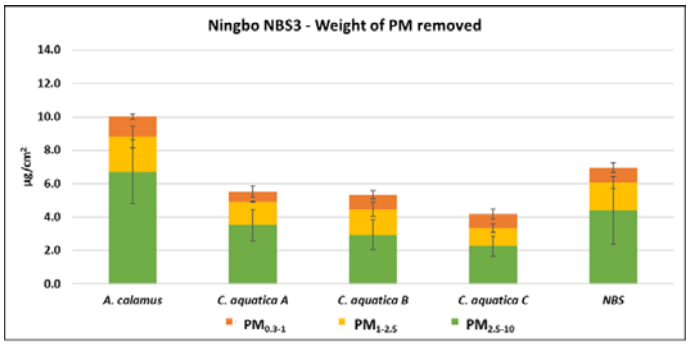

Figure 28. Weight of PM removed (µg cm^{-2}), as obtained from SEM/EDX, through the combination of PM density and chemical composition results. Results averaged over the four species are also reported as mean NBS values. Standard deviations are given for each size fraction and each species.

Tool I - Biodiversity

Biodiversity monitoring in the Moon Lake in Ningbo is in charge of IUE-CAS. It involves plankton, which plays an important role in fisheries, water pollution prevention and environmental impacts of water conservancy projects. Plankton is the primary consumer and producer of freshwater ecosystems and is extremely sensitive to changes in the water environment. Different plankton community structures indicate different water quality conditions. For example, *Conochionus* and *Trichocerca* are indicator species for poor nutrient water, and *Polyarthra* and *Bosmina* are indicator species for eutrophic water. By investigating the diversity of zooplankton and phytoplankton in the Moon Lake, the impact of NBS3 (using the macrophytes to re-nature a 5 km corridor surrounding the urban lake) can be reflected. The collection of water samples began in January 2019, once a week. Three sampling points have been set up in the Moon Lake, located at the water inlet, the water outlet and the centre of the lake (Figure 29). All samples were stored in a 4° C refrigerator, until professionals observe the species and quantities of zooplankton and phytoplankton under the microscope.

Figure 29. Moon Lake Park（Continuous red line）and 3 sampling points and the experimenters are collecting plankton samples (image © IUE-CAS).

In March 2020, zooplankton samples collected from January to April 2019 in Moon Lake were analysed by light microscopy. At the genus level, 17 genera of zooplankton have been identified. Figure 30 shows the main genus of zooplankton. Figure 31 shows the relative abundance of zooplankton. In January, the relative abundance of *Filinia* dominates at S1 and S2, while *Brachionus* dominates at S3. The relative abundance of *Brachionus* remained high in February and March, and in April the relative abundance of the genera became more balanced.

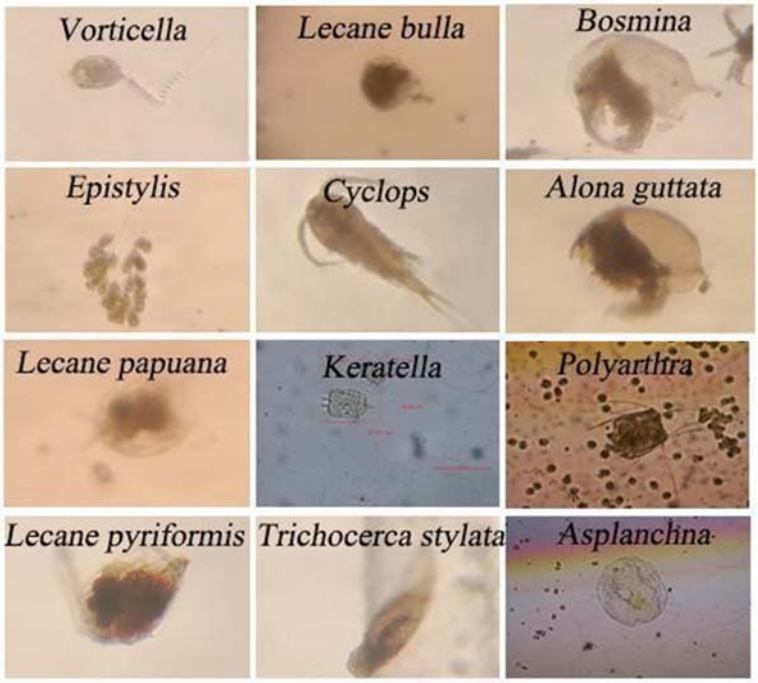

Figure 30. The main genus of zooplankton in Moon Lake.

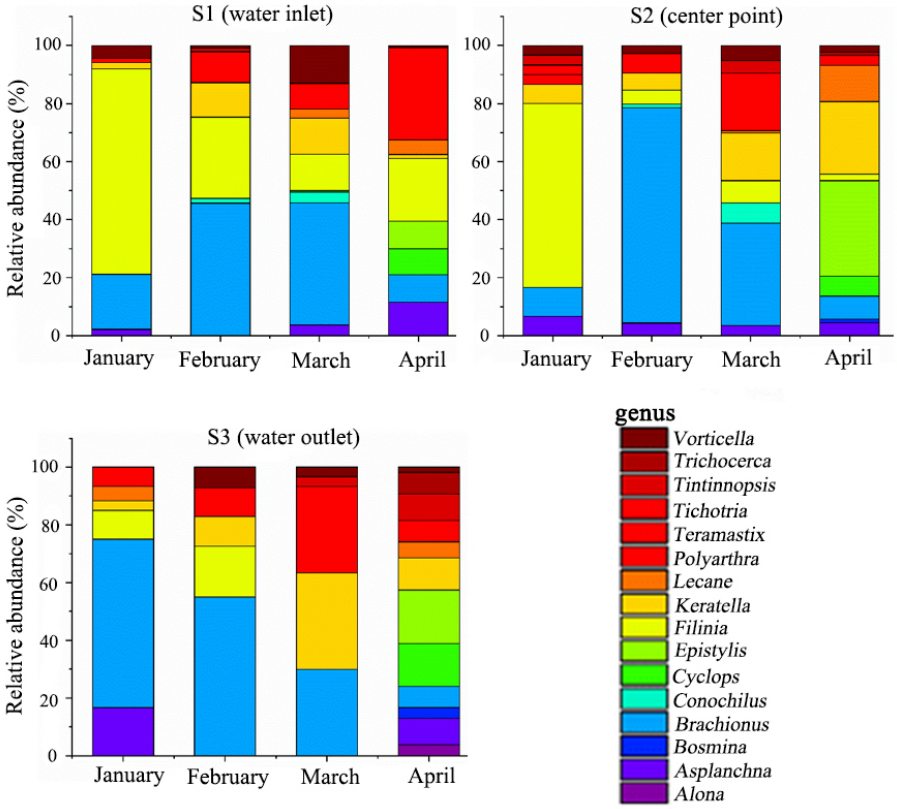

Figure 31. Relative abundance of zooplankton at three sampling points from January to April 2019.

In May 2020, the types of phytoplankton have also been identified. There are 22 genera of phytoplankton. Figure 32 shows the main genus of phytoplankton in the Moon Lake. The relative abundance of phytoplankton was also investigated. Figure 33 shows the relative abundance of phytoplankton in the three sampling sites of the Moon Lake in January, February, June and July 2020. In general, the composition of phytoplankton in Moon Lake is quite different in winter, and smaller in summer. The relative abundance of *Cyclotella* is greater in January and February, while *Schroederia* is greater in June. In July, the relative abundance of *Chroomonas*, *Cyclotella* and *Schroederia* was large, and the proportion of phytoplankton genera tended to be balanced.

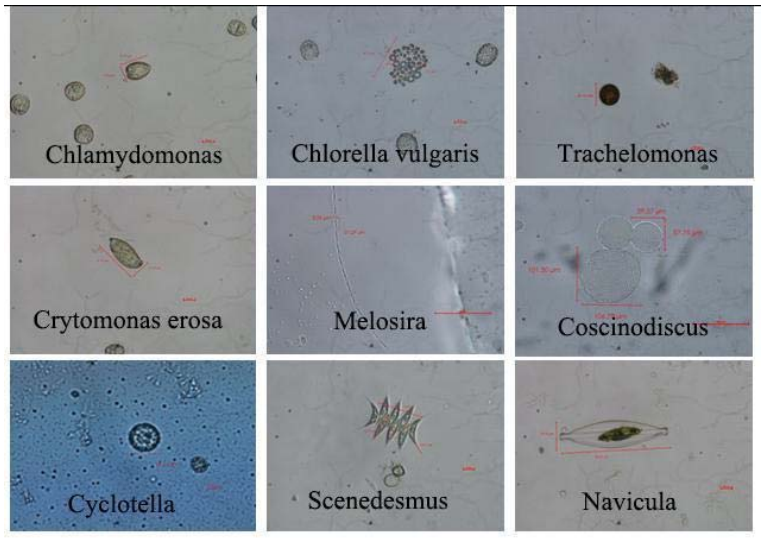

Figure 32. The main phytoplankton genus in the Moon Lake.

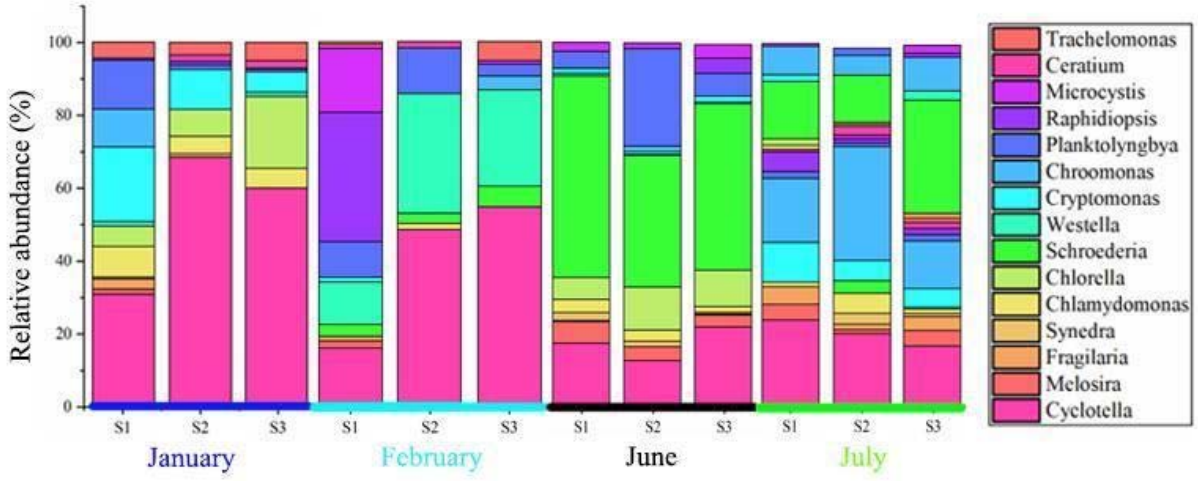

Figure 33. Relative abundance of phytoplankton at three sampling points in January, February, June and July 2020.

Tool J - Water Quality

Water quality monitoring is conducted in Ningbo by IUE-CAS, starting from January 2019, once a week. Water quality sampling points are consistent with plankton sampling points. Ningbo began to monitor the water quality of Moon Lake in January 2019 to assess water quality management. Due to the impact of COVID-19, sampling was interrupted from January to July 2020. Ammonia nitrogen (NH_3-N), chlorophyll-a (Chl-a), total phosphorus (TP), total nitrogen (TN), and total suspended solids (TSS) are the five commonly used indicators. Figure 35 shows the water quality data from January 2019 to March 2021.

Water with quality in Class III (TN≤1mg/L, TP≤0.05 mg/L, NH_3-N≤1 mg/L) is mainly suitable for centralized domestic and drinking water surface water source areas, secondary protection areas, fish and shrimp wintering grounds, migration channels, aquaculture areas and other fishery waters and swimming areas.

Water with quality in Class IV (TN≤1.5 mg/L, TP≤0.1 mg/L, NH_3-N≤1.5 mg/L) is mainly suitable for general industrial water areas and recreational water areas where the human body is not directly contacted.

Since 2019, the NH_3-N content at three sampling points was in the Class IV water standard, while after 2020, it has basically reached the Class III water standard.

TP and TN can already reach Class IV water standards, and even meet Class III water standards in some periods, from the end of 2020.

The high content of Chl-a in 2019 showed that the eutrophication of the water quality of Moon Lake was serious, but after July 2020, the content of Chl-a dropped sharply.

TSS index does not change significantly over time, except for the absence of outliers It shows that more enhancements are needed in the removal of TSS in water.

Figure 34. The researcher is collecting water samples (image © IUE-CAS).

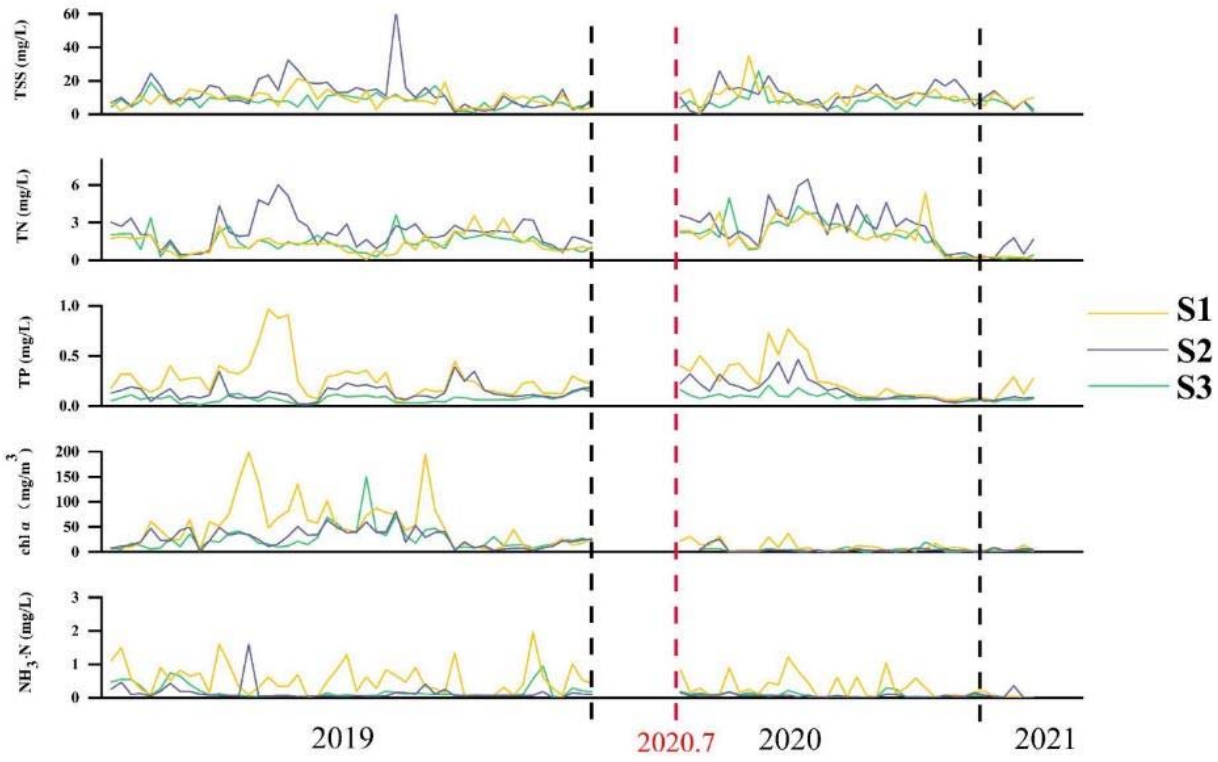

Figure 35. Five water quality indicators at three sampling points of Moon Lake.

5.7. Ningbo NBS7: Procedures for environmental compensation

The environmental compensation procedure in Ningbo is actually the operation process of the PPP (public-private-partnership) model. The local government (the government of Haishu District) has signed a PPP agreement with private enterprise (Tianhe Aquatic Ecosystems Engineering Co.Ltd) to treat the Moon Lake Park. In the agreement, the governance and maintenance period of the project is ten years. The local government paid compensation to private enterprises in 8 instalments, for a total of 750,000 euros. The assessment is divided into two aspects: water quality and greening quality.

In terms of water quality, three fixed sampling points have been set up in Moon Lake. If the water quality meets the following requirements, the private enterprise can successfully receive the government compensation: (1) The main water quality index assessment is better than Class IV (i.e., potassium permanganate index ≤ 10, NH3-N ≤1.5mg/L, TP≤0.1mg/L). (2) Two years after the end of the project renovation period, the main water quality indicators have reached Class III (i.e., potassium permanganate index ≤ 6, NH3-N≤ 1.0mg/L, and TP ≤ 0.05mg/L).

In terms of greening quality, the assessment includes landscape effects, plant maintenance, pest control, water and land sanitation management, garden landscape lights, railings, and other facilities maintenance. For each item specific scoring standards have been developed.

So far, private enterprise has been able to receive compensation in each phase. This is a successful case of a PPP project.

The Economic and Labour Market Questionnaire created by STARLAB, in collaboration with partners from SWUAS, will be administered during October 2021.

5.8. Turin NBS2: New soil production in Sangone Park

The aim of New Soil is the creation of an area of "urban forest" of 2000 sqm. along the banks of the Sangone river through the use of regenerated soil (New Soil), based on excavated material with the addition of compost from organic fraction of municipal solid waste, zeolites and innovative biostimulants. The composition of the New Soil has been defined with the main scope of minimizing maintenance needs. The new soil realization was completed in February 2020. The works fort this NBS were coordinated by Environment Park with the contribution of several partners: Dual Srl (realization of the construction site); UNITO (monitoring activity); ACEA (compost provider); CCS (biotic compound provider); City of Turin, Città Metropolitana di Torino and the Regional Agency for the Protection of the Environment (ARPA) Piemonte (administrative procedures).

Figure 36. The New Soil site (image © City of Turin).

Tool B - SOPARC

The New Soil NBS site is mainly used by males during the day, adults are the most common users during lunchtime and evenings, and seniors in the morning and afternoon. A very small proportion of children and teenages use the NBS site. The site is mostly used for walking during morning and evenings, while lunchtime and evening show the highest proportion of vigorous physical activity. Results are shown in Figure 37.

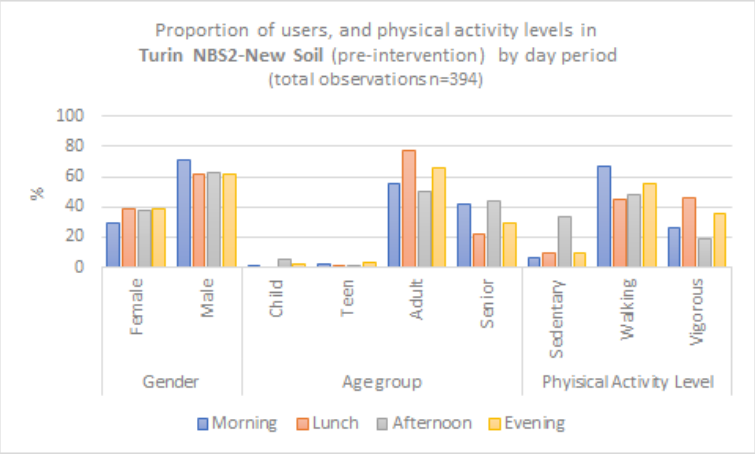

Figure 37. User groups and physical activity levels for NBS2 in Turin LL in the two observation days of the pre-implementation SOPARC assessment (12,13 October 2019).

Tool E - Air Quality

Passive samplers for O_3 and NO_2 were exposed in the NBS2 area and control points from 18/06/2019 to 9/7/2019 to have the baseline data of these selected air pollutants (Figure 38). At the beginning of summer 2021 the measurement campaign has been repeated and the samples are under analysis in the lab.

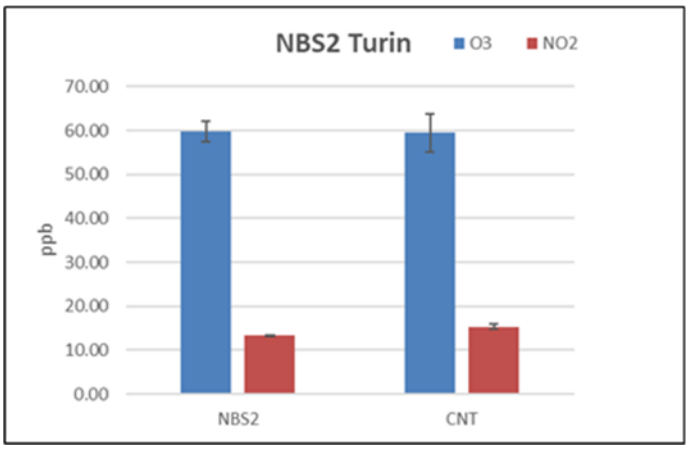

Figure 38. Concentrations (ppb) of O3 (blue columns) and NO2 (red columns) in NBS2 and Control for baseline measurement. Vertical bars represent the standard error of the mean (n=3).

Tool F- Air Temperature

Air temperature was monitored in NBS2 and a control point at three different stages (Figure 39). The combined presence of 3 sample points for each measurement point allowed a preliminary statistical analysis. No statistical differences were evidenced by the ANOVA test. The time course of daily maximum, minimum, and the daily temperature ranges for NBS2 and control point are shown in Figure 40 and 41. The statistical analysis did not show any significant effect of the NBS on these variables. Additional data collection and analysis are required to better understand the effect of NBS2 on local air temperature.

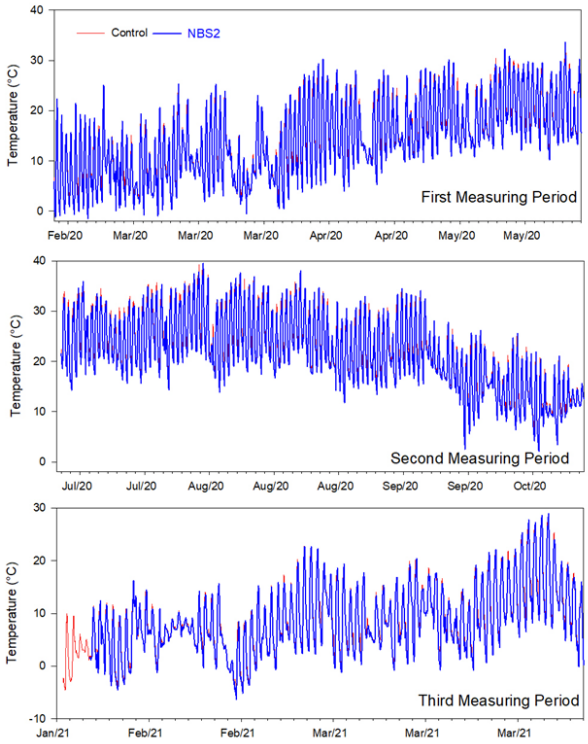

Figure 39. Hourly mean of air temperature recorded in control points (red line), NBS2 (blue line) in the three different measurement stages (one stage each panel).

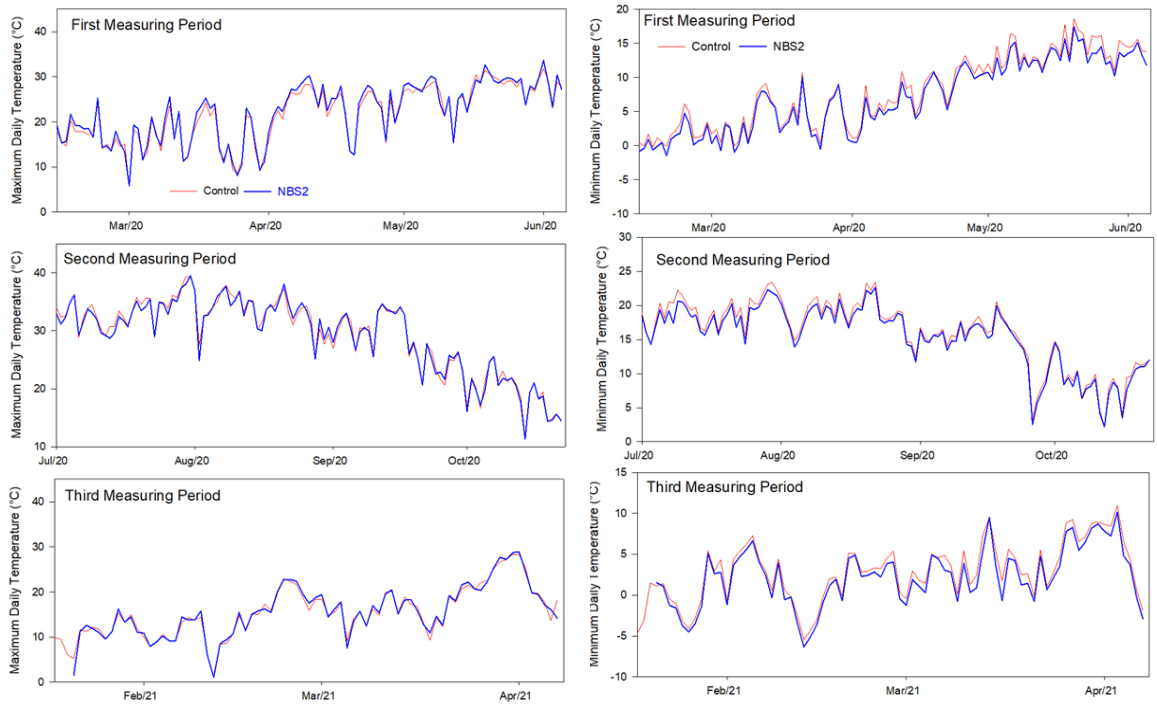

Figure 40. Left side: Daily maximum temperature recorded in control points (red line) and NBS2 (blue line) in the three different measurement stages (one stage each panel). Right side: Daily minimum temperature recorded in control points (red line) and NBS2 (blue line) in the three different measurement stages (one stage each panel).

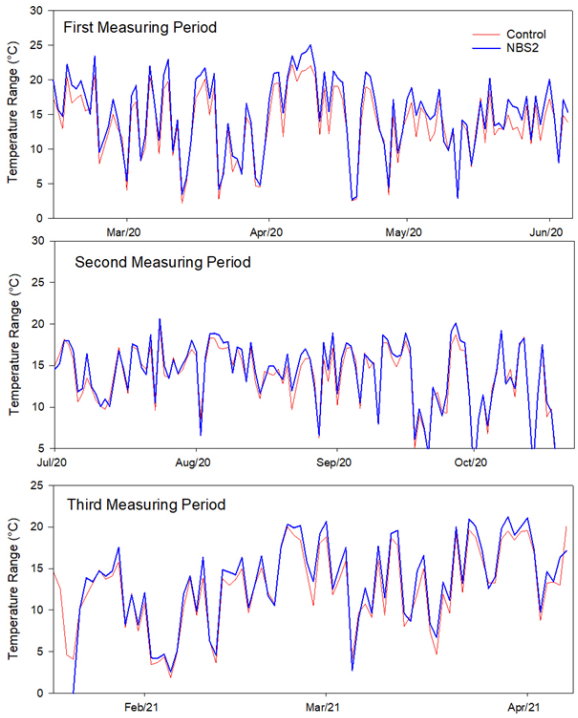

Figure 41. Daily temperature ranges recorded in control points (red line) and NBS2 (blue line) in the three different measurement stages (one stage each panel).

Tool G - PM Biomonitoring

PM biomonitoring was assessed through the sampling of leaves from newly-planted species within this NBS. To this aim, three species were chosen, namely *C. australis* L., *M. evereste* L. and *Q. ilex*. L.. From each of these species, three plants were individuated and two leaves from each of them were subsequently analysed by SEM/EDX, for a total of six leaves for species. In order to reduce and exclude as much as possible the potential influence of soil resuspension on the detected PM leaf deposition, all the sampled leaves were collected at the top of the plants (about 3 meters from the ground). Biometric information, such as tree height (in meter) and DHB (diameter of the trunk at 1.3 m height from the ground, expressed in centimetre) were also collected, for each sampled tree and with upscale purposes. Results obtained through SEM/EDX microanalysis of leaves, which are relative to leaf deposited particles density (number of particles per unit leaf area in mm^2), chemical composition and weight (µg per unit leaf area in cm^2) are reported in the following figures (Figure 42, 43 and 44). Also in this case, results are reported as a function of sampled species and particle size.

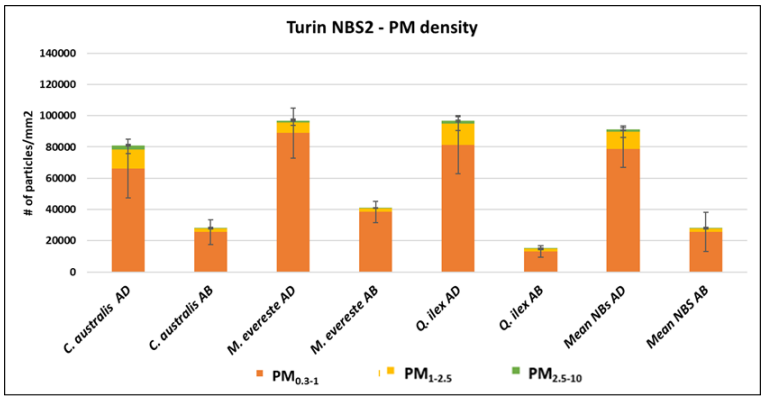

Figure 42. Mean species-specific particle densities (number of particles *mm^{-2}), with standard deviations, on the adaxial (AD) and abaxial (AB) sides, for the three PM size fractions (PM0.3-10 PM1-2.5, PM2.5-10). Results averaged over the four species are also reported as mean NBS values.

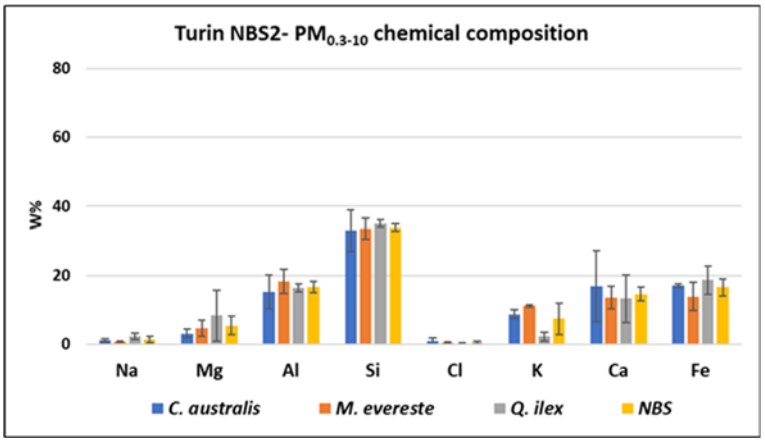

Figure 43. Relative chemical composition and standard deviations, as estimated by the W% obtained from the SEM/ EDX analysis, for PM0.3-10 for all the species sampled. Results averaged over the four species are also reported as mean NBS values.

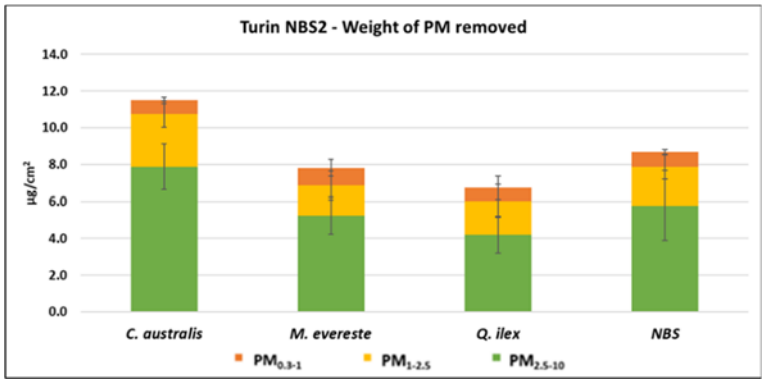

Figure 44. Weight of PM removed (µg cm^{-2}), as obtained from SEM/EDX, through the combination of PM density and chemical composition results. Results averaged over the four species are also reported as mean NBS values. Standard deviations are given for each size fraction and each species.

5.9. Turin NBS3.2: Gardens in Cascina Piemonte (Orti Generali)

Orti Generali was born with the aim of building a model of enterprise for the transformation and management of post-industrial and metropolitan residual agricultural areas based on ecological sustainability and social equity. The implementation of this NBS was concluded in November 2019, in an area of 12.000 sqm. surrounding Cascina Piemonte in Mirafiori Sud district.

Figure 45. Overview of the Orti Generali site (image © City of Turin).

Tool B - SOPARC

The Orti Generali NBS site is mainly used by males during the day, adults are the most common users across time periods, followed by seniors in the morning and afternoon. A very small proportion of children and teens use the NBS site. During the morning the site is mostly used for walking and vigorous physical activity. Sedentary physical activity is more frequently observed during the afternoon, and vigorous at lunchtime and the evening. Results are shown in Figure 46.

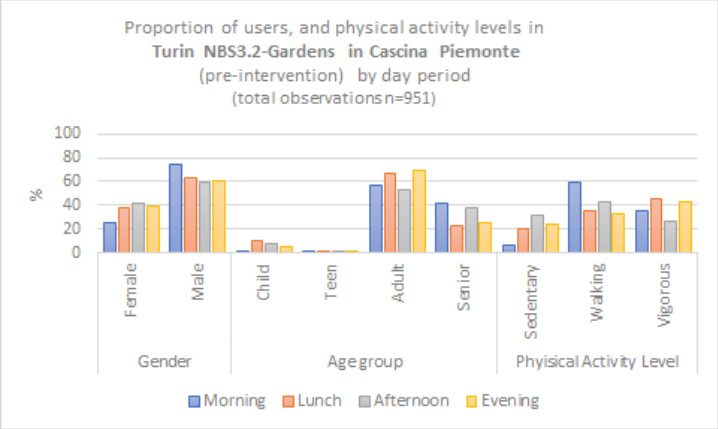

Figure 46. User groups and physical activity levels for NBS3.2 in Turin LL in the three observation days of the pre-implementation SOPARC assessment (12,13,17 October 2019).

Tool E - Air Quality

Passive samplers for O_3 and NO_2 were exposed in the NBS3.2 area and control points from 18/06/2019 to 9/7/2019 to have the baseline data of these selected air pollutants (Figure 47). At the beginning of summer 2021 the measurement campaign has been repeated and the samples are under analysis in the lab.

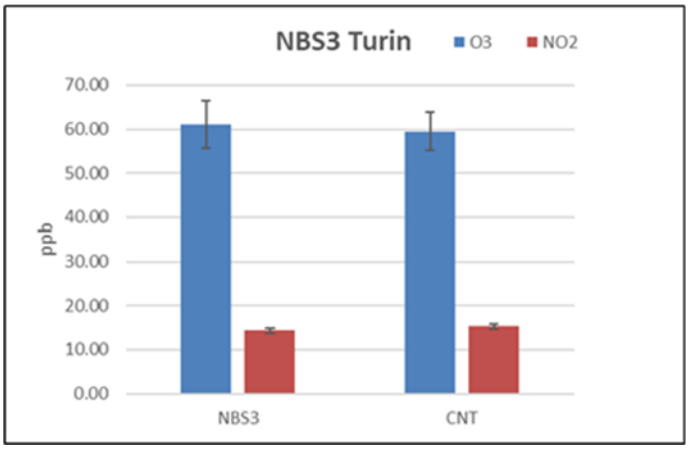

Figure 47. Concentrations (ppb) of O_3 (blue columns) and NO_2 (red columns) in NBS3 and Control for baseline measurement. Vertical bars represent the standard error of the mean (n=3).

Tool F - Air Temperature

Air temperature was monitored in NBS3.2 and control point at three different stages (Figure 48). The combined presence of 3 sample points for each measurement point allowed a preliminary statistical analysis. No statistical differences were evidenced by the ANOVA test. The time course of daily maximum, minimum, and the daily temperature ranges for NBS3.2 and control point are shown in Figure 49 and 50. The statistical analysis did not show any significant effect of NBS on these variables. Additional data collection and analysis are required to better understand the effect of NBS3.2 on local air temperature.

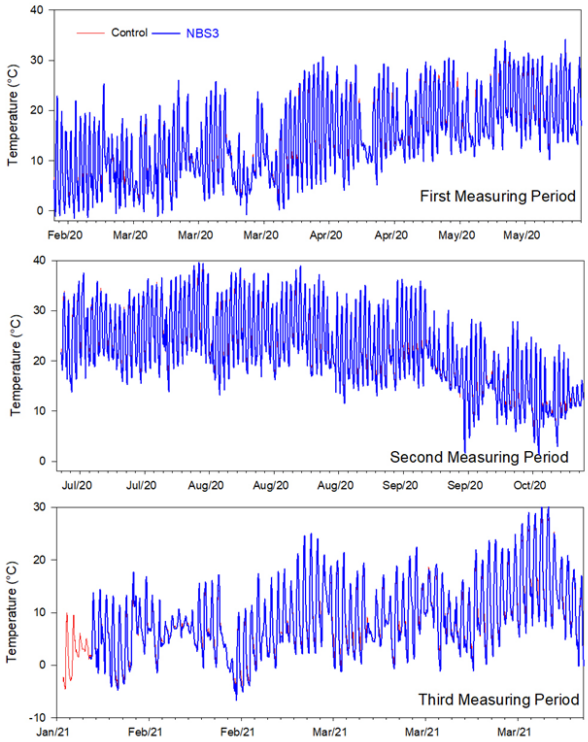

Figure 48. Hourly mean of air temperature recorded in control points (red line), NBS3 (blue line) in the three different measurement stages (one stage each panel).

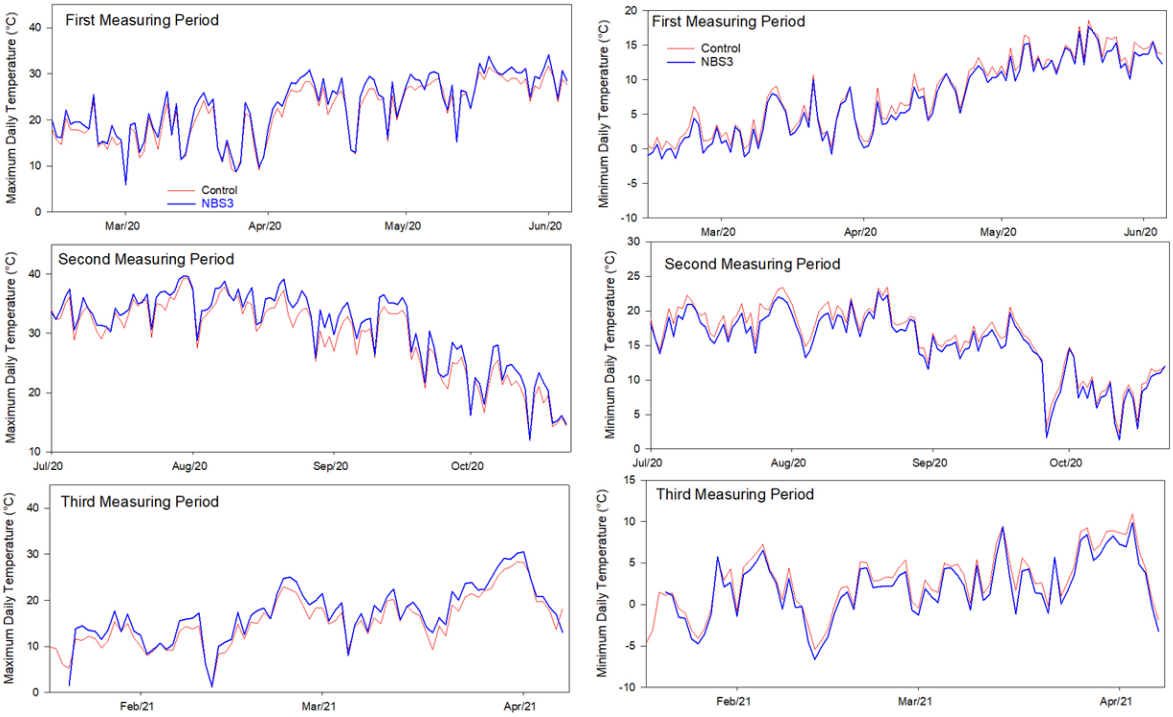

Figure 49. Left side: Daily maximum temperature recorded in control points (red line) and NBS3 (blue line) in the three different measurement stages (one stage each panel). Right side: Daily minimum temperature recorded in control points (red line) and NBS3 (blue line) in the three different measurement stages (one stage each panel).

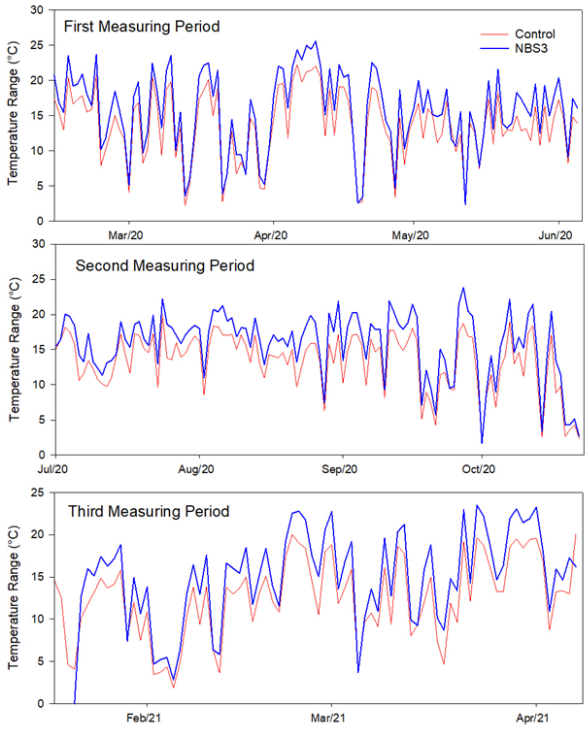

Figure 50. Daily temperature ranges recorded in control points (red line) and NBS3 (blue line) in the three different measurement stages (one stage each panel).

Tool G - PM Biomonitoring

At this NBS3.2, leaf samplings were conducted in July 2020, for the PM biomonitoring task. Leaves from *M. domestica* L., *M. nigra* and *Prunus* spp. were sampled according to protocols and analysed by SEM/EDX, as specified in the previous sections. Data elaboration and assessment of leaf deposited PM density, chemical composition and weight of removed particles, as a function of sampled species and particles size provided crucial information on the species-specific affinity towards the removal and the abatement of this harmful atmospheric pollutant. Preliminary results on leaf deposited PM density and chemical composition and weight of removed particles, which are relative to Turin NBS3.2 Gardens in Cascina Piemonte are available, as shown in the following figures (Figure 51, 52 and 53).

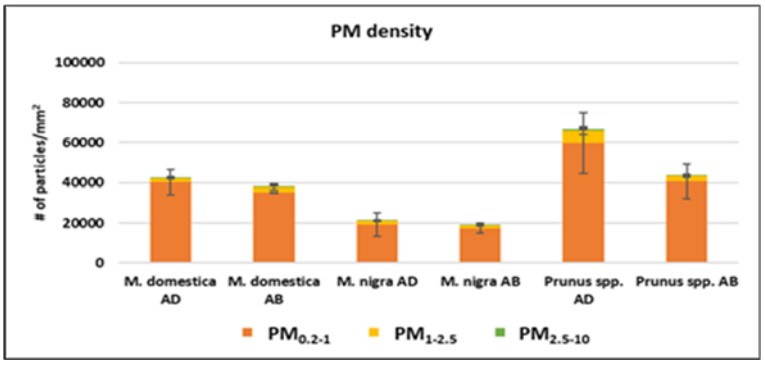

Figure 51. Leaf PM deposition density (# of particles per unit leaf area in mm^2) on three species from NBS3.2 Gardens in Cascina Piemonte, Turin. Averaged results relative to the adaxial (AD) and abaxial (AB) leaf surfaces are reported as a function of size fraction ($PM_{0.3-1}$, $PM_{1-2.5}$ and $PM_{2.5-10}$).

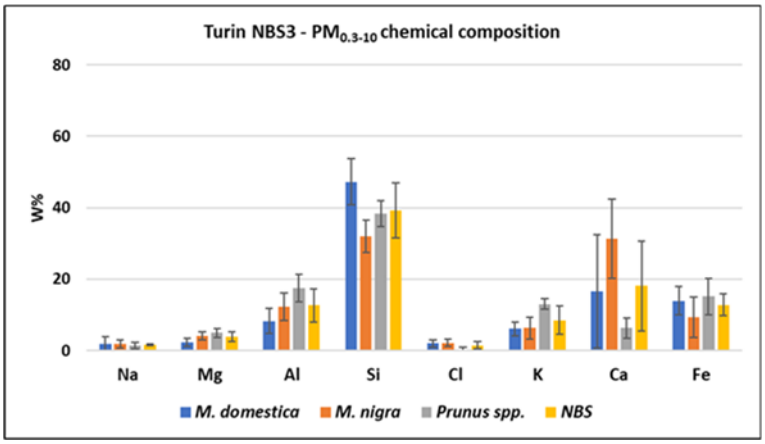

Figure 52. Relative chemical composition and standard deviations, as estimated by the W% obtained from the SEM/ EDX analysis, for $PM_{0.3-10}$ for all the species sampled. Results averaged over the four species are also reported as mean NBS values.

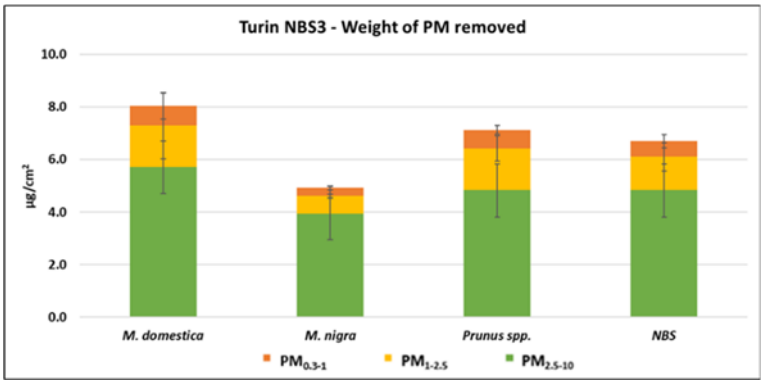

Figure 53. Weight of PM removed (µg cm^{-2}), as obtained from SEM/EDX, through the combination of PM density and chemical composition results. Results averaged over the four species are also reported as mean NBS values. Standard deviations are given for each size fraction and each species.

In Turin, additional atmospheric PM_{10} active samplings were performed in three monitoring sites as shown in Figure 54, in collaboration with the Department of Chemistry of University of Rome “La Sapienza”, Orti Generali Association, Fondazione Bela Rosin and INRIM (National Institute of Metrologic Research). Two HSRS (High Spatial Resolution Samplers, FAI INSTRUMENTS, Fonte Nuova (RM), Italy) with a flow rate of 0.5 l/min, were installed in each site for two-months sampling periods. Teflon and Quartz filters were used for the chemical characterization of the inorganic (with details on the water-soluble and insoluble fraction) and organic components of atmospheric PM_{10}. These monitoring sites were individuated at high proximity to the NBSs where tool G (PM Biomonitoring) was already planned (NBS2 New Forest and NBS3 Gardens in Cascina Piemonte), in order to achieve additional data on the atmospheric concentrations of PM, which could be compared with leaf deposition data. These sampling results will be useful also for the evaluation of seasonal variability of this specific atmospheric pollution, and for the assessment of the role and impact of different natural/anthropogenic emission sources.

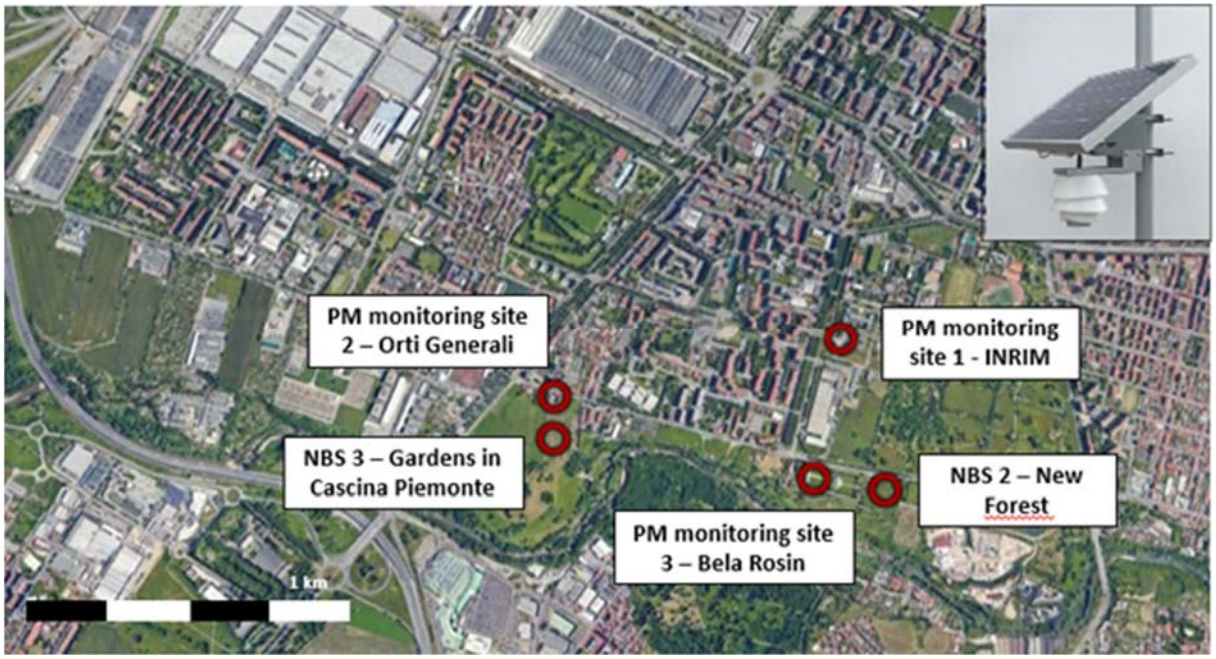

Figure 54. Monitoring sites in Turin where active sampling of atmospheric PM was performed through the utilization of innovative samplers (HSRS – High Spatial Resolution Samplers, FAI Instruments, Roma, Italy).

Preliminary, and through the chemical characterization of sampled PM_{10} Teflon membranes, it was possible to evaluate the spatial and temporal trends of some of the main and inorganic elemental components of this atmospheric pollutant. Additional information was also retrieved on the solubility of each component, through the application of a chemical

fractionation procedure[12], which can be used to increase their selectivity as source tracers for specific emission sources (natural or anthropogenic). As shown in Figure 55 (upper panels), similar trends were individuated for elements such as Iron (Fe) and Tin (Sn), mainly emitted in their insoluble fraction. These elements, together with Copper (Cu) and Antimonium (Sb) are usually associated to the emission role of vehicular traffic and used as efficient tracers for this anthropogenic and urban PM_{10} source, being also known components of tyres and brakes. On the other hand, results relative to elemental components such as Tallium (Tl) and Rubidium (Rb) (Figure 55, lower panel), can be used to prove the efficiency of the applied analytical procedure. In fact, while the insoluble fraction of these elements is known and largely used to trace the impact of soil resuspension, their soluble fraction can be mostly associated with the impact of biomass burning[13]. This is also confirmed by the fact, that these elements resulted to mainly emitted in their soluble fractions during winter (October and January), while in summer months such as July, mostly in their insoluble fractions, when the resuspension of dry soil (both natural and favoured by vehicular traffic) is most likely to happen.

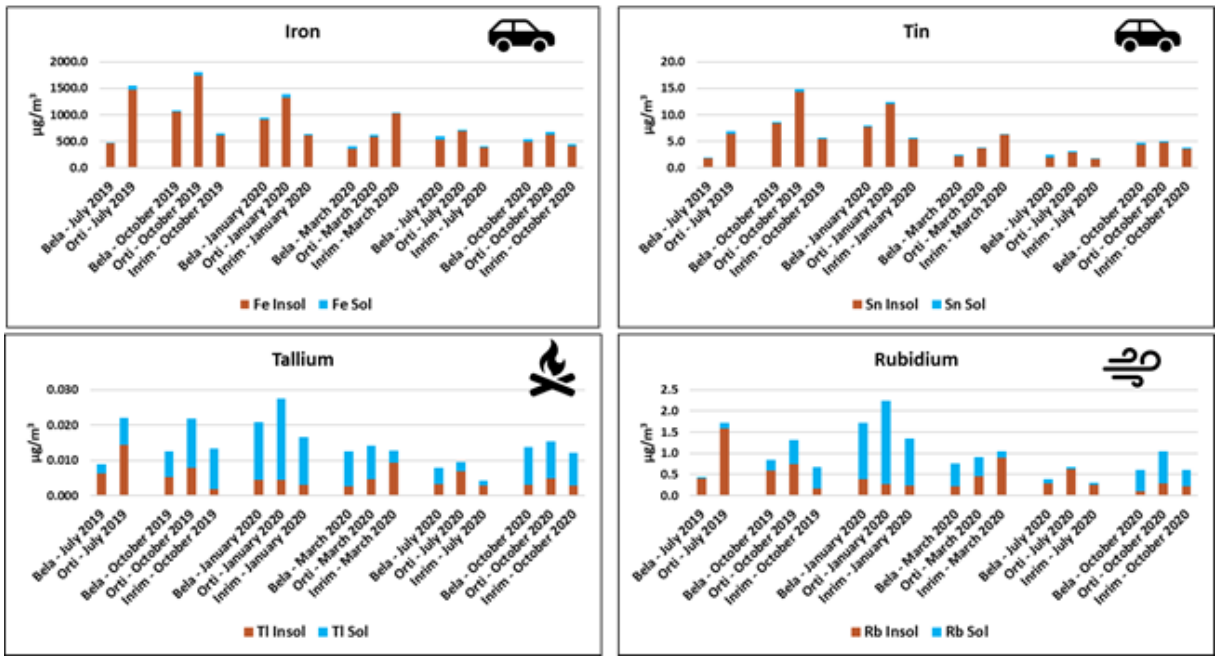

Figure 55. Results relative to concentrations of elemental and inorganic components of PM_{10} sampled on Teflon filters and through HSRS samplers. For each PM_{10} elemental component, concentrations in both the insoluble and the soluble fraction are reported.

[12] Canepari, S.; Cardarelli, E.; Giuliano, A.; Pietrodangelo, A. Determination of metals, metalloids and non-volatile ions in airborne particulate matter by a new two-step sequential leaching procedure Part A: Experimental design and optimization. Talanta 2006, 69, 581–587.
[13] L. Massimi, M. Ristorini, M. L. Astolfi, C. Perrino, S. Canepari,
High resolution spatial mapping of element concentrations in PM10: A powerful tool for localization of emission sources, Atmospheric Research, 244, 2020

Tool I – Biodiversity

Biodiversity monitoring in "Orti Generali" is in charge of UNITO. In according to EU Pollinators Initiative[14] and European Pollinator Monitoring Scheme (EU-PoMS)[15],in 2018-2019-2020-2021 the researchers have applied a protocol (fixed transect walk) to monitor pollinator communities (butterflies and bees) and their interaction with the flora. Butterfly, bee and flower surveys were carried out in order to evaluate the success of NBS implemented, by combining butterfly and bee responses at community level. Surveys were conducted along two transects (T1 and T2, shown in Figure 56) with different ecological characteristics. The first (T1) is characterised by a transitional environment (ecotone) between the river and open grazed meadow; the second one (T2) is conducted between urban gardens, where a "pollinators avenue" has been implemented. In 2020, an additional transect walk for monitoring butterflies' richness and abundance was carried out.

Butterfly surveys: semi-quantitative surveys were performed by experts walking along fixed-route 300 m transects[16] along T1 and T2. Butterfly species were identified, and individuals of each species counted. The observations were conducted between 10:00 am and 3:00 pm.

Bee surveys: 250 m long linear transects were walked in 50 min. Each transect start point and direction walked were randomly determined[17, 18, 19]. All unambiguously identifiable bees were recorded and all others that could not be identified in the field were caught with a hand net and identified in the laboratory. Observation sets were conducted between 9:00 am and 5:00 pm.

Flower surveys: larval food plants of butterflies as well as flower surveys to identify plants visited by bees and/or butterflies for nectar, and pollen and honeydew for bees were carried out in parallel to the bee and butterfly surveys along the transects. Plant species were collected and identified according to Pignatti (2018)[20].

[14] Underwood, Darwin, Gerritsen, (2017), Pollinator initiatives in EU Member States: Success factors and gaps. Report for European Commission under contract for provision of technical support related to Target 2 of the EU Biodiversity Strategy to 2020 – maintaining and restoring ecosystems and their services. ENV.B.2/SER/2016/0018. Institute for European Environmental Policy, Brussels.
[15] Potts, Dauber, Hochkirch, Oteman, Roy,Ahnre, Biesmeier, Breeze, Carvell, Ferreira, Fitzpatrick, Isaac, Kuussaari, Ljubomirov, Maes, Ngo, Pardo, Polce, Quaranta, Settele, Sorg, Stefanescu, Vujic, (2020), Proposal for an EU Pollinator Monitoring Scheme, EUR 30416 EN, Publications Office of the European Union, Luxembourg.
[16] Pollard E. and Yates T.J. (1993). Monitoring butterflies for ecology and conservation. Chapman & Hall, NY.
[17] Quaranta M., Ambroselli S., Barro P., et al. (2004) Wild bees in agroecosystems and semi-natural landscapes. 1997-2000 collection period in Italy. Bulletin of Insectology 57(1):11-61.
[18] Westphal C., Bommarco R., Carré G., Lamborn E., et. al. (2008). Measuring bee diversity in different European habitats and biogeographical regions. Ecological Society of America, 78 (4): 653-671.
Westphal C., Bommarco R., Carré G., Lamborn E., et. al. (2008). Measuring bee diversity in different European habitats and biogeographical regions. Ecological Society of America, 78 (4): 653-671.
[19] Nielsen A., Steffan-Dewenter I., Westphal C., et al. (2011). Ecol Res, 26(5): 969-983.
[20] Pignatti, S. (2018). Flora d'Italia, seconda edizione, Vols. 2–3. Edagricole, Milan

Figure 56. Scheme of the transects (T1 and T2) used for butterfly, bee and flower monitoring for the NBS3.2 in the Cascina Piemonte Park, Mirafiori Sud, Turin.

The surveys took place from April to September, about twice per month, to cover the main flowering period and the fly season of bees and butterflies in Turin. In 2020, despite Covid-19 pandemic situation, all the monitoring transects have been carried out, facing the additional challenges of getting the required authorizations in order to move freely within the Turin borders, and working in a lockdown context. However, this has been possible only from May to September 2020. The 2021 last surveys are in progress.

Shannon Diversity Index and Shannon Evenness Index were calculated for butterflies and bees in order to quantify the biodiversity in a community and the homogeneity of individual distribution between species in the community respectively. Shannon Diversity Index and Shannon Evenness Index provide valuable information about the fauna richness and composition and they take into consideration both the number of different species observed and their relative abundances. Both the indexes used turned out to be repeatable and standardized, easily applicable to different fauna taxonomic groups; the data collection has been cheap and quick.

The Shannon Diversity index and the Shannon Evenness index values calculated using the data collected from June to September 2018-2019-2020 (butterflies) and from April to September 2019-2020 (bees) are shown in the following Figures. In 2019 it was not possible to calculate the indexes concerning the diversity of the bees as few species and individuals were recording.

The values of indices calculated using data collected in 2019-2020 (butterflies' diversity) and in 2019 -2020 (bee diversity) are shown in the following Figure 57. Regarding the monitoring transects (T1 and T2), results show that, in general, the trend in indices does not increase during the 3 years. Nevertheless, the number of species and individuals per species is increasing since 2018. In total 34 butterfly species were counted. The most abundant

species resulted to be *Pieris rapae* and *P. napi,* both associated with cultivated brassicaceae. We observed a remarkable number of individuals of *Polyommatus icarus* and *Cupido argiades, Melitaea didyma*, *Plebejus argus*, *Colias crocea*, etc. For the bee surveys, the most abundant species recorded were *Apis mellifera*, *Bombus terrestris* and *Halictus scabiosae*, with the highest number of specimens registered for *Apis mellifera*. We also report an appreciable abundance of other *Bombus* spp., *Halicutus* spp. and *Lasioglossum* spp. specimens as well as individuals belonging to *Anthophora*, *Xylocopa*, *Andrena*, Anthidium and *Anthidiellum* genera (Figure 58). In total 21 bee species were counted.

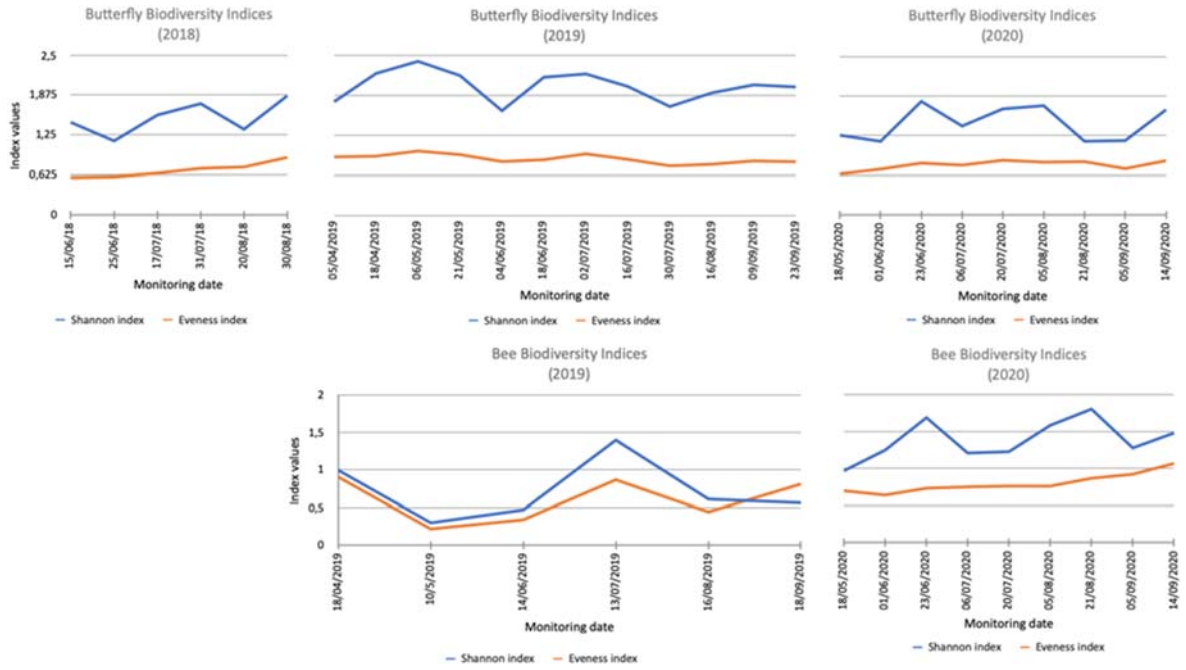

Figure 57. A) The lines show Butterfly Biodiversity Indices trends during the 2018-2020 sampling period and Bee Biodiversity Indices trends during the 2019-2020 period: Species Richness Index (S) - blue line, Shannon Index (H') - orange line.

Figure 58. Some pollinators detecting in the survey A) A male of *Anthocharis cardamines*; B) *Pieris rapae*; C) *Apis mellifera* visiting *Cucurbita maxima*; D) *Bombus terrestris* foraging on *Helianthus annuus* (images @ UNITO).

Regarding the survey of the flora recorded along the transect walks, the number of plant species in flowering registered in the monitored period and the relative visit carried out by pollinators are incremented, particularly in the urban gardens. These species supply resources for development and survival of pollinators as food plants, nectar, pollen and honeydew. Biodiversity surveys in Cascina Piemonte is the first Italian urban transect to be part of the European Butterfly Monitoring Scheme (eBMS)[21], and it represents the only example of coupled monitoring between butterflies and bees in an urban context.

5.10. Turin NBS5.2: Green wall indoor at school

The project foresees the preparation and construction of a green wall with dimensions of 20 sqm. within a school based in Mirafiori Sud district. It was positioned at a height between 0 and 3 m above the ground floor in a hallway corridor with a large roof-window. Site works ended in December 2020, everything was done in one week, during the Christmas holiday, when the school was closed to students. Children from 8 to 12 years old are attending the school in proximity of the green wall.

Figure 59. Green Wall in the school based in the Mirafiori Sud district in Turin (image © City of Turin).

[21] https://butterfly-monitoring.net/it/italy-bms

Tool A - NBS-visitor questionnaire

It is now consolidated in the literature that participation in activities in environments that allow contact with natural elements promotes healthy development and, in general, a feeling of well-being on a psycho-physical level for children. The purpose of the NBS-visitor questionnaire for children is to monitor any changes in the child's well-being in terms of pro-environmental behaviours of children and their perceived well-being in relation to the performance of activities inside the school where elements that recall natural environments are present. Children are asked to answer some questions under the supervision and support of teachers. Baseline data was acquired, and scoring is currently ongoing. Indicators assessed at the baseline are pro-environmental behaviour and attitude. During the follow-up, a change in the aforementioned indicators will be evaluated. Furthermore, perceived restorativeness of NBS will be acquired through an adaptation of the version for adults used in the NBS-visitor questionnaire (see Annex 2 for more details). Post-implementation data is scheduled to be acquired after one year from the baseline; however, due to Covid-19-related restrictive measures, the follow-up has been postponed in the next academic year.

Tool E - Air Quality

The Regional Agency for the Protection of the Environment (ARPA) of Piemonte (Italy) performed an air quality monitoring in the proximity of the Turin NBS5.2 at the end of 2020 (pre-implementation) and beginning 2021 (post-implementation). This monitoring campaign was designed to assess the influence of the newly implemented green wall on the indoor air quality. Specifically, concentrations of atmospheric and gaseous pollutants such as, VOCs (Volatile Organic Compound), formaldehyde and higher aldehydes and nitrogen dioxide NO2 were evaluated during this campaign, before and after the NBS implementation. The measurements, carried out before and after the green wall installation in three sampling locations (two indoor and one outdoor), did not show any significant impact of the green wall in the concentration of the monitored air pollutants. The indoor concentration was comparable with the outdoor ones. The increased ventilation, due to the COVID-19 contrast measures for indoor and public spaces, together with the not confined hallway where the green wall is located, may have generated homogeneous conditions and reduce the possibility to evaluate any potential effect of the green wall on the indoor air quality.

5.11. Turin NBS5.3: Green wall outdoor on a homeless dormitory

A Green wall of 80 sqm, 3 meters high, constructed as a self-supporting structure set-off from the wall of the building, was installed in November 2020, outside a homeless shelter in Mirafiori.

Figure 60. The Green Wall realized on the homeless dormitory in Turin (image © City of Turin).

Tool A - NBS-visitor Questionnaire

Preparation of the NBS-visitor questionnaire for the green wall on the homeless dormitory building is currently ongoing. The reason for this delay lies in the heterogeneity of the target population, with a wide range of disabilities. Partners from UNIBA and ISGlobal are currently in contact with the City of Turin and involved stakeholders in order to retrieve useful information on the potential study sample and evaluate the feasibility of a data collection on the NBS site.

Tool F - Air Temperature

Air Temperature has been monitored at the Homeless Shelter in Turin by the Regional Agency for the Protection of the Environment (ARPA) since August 2020, thus since before the installation of NBS5.3, to evaluate the abatement of the internal air temperature due to the new NBS. Specifically, 2 dataloggers have been installed for measuring the temperature and relative humidity on the internal wall of the building (ONSET, HOBO MX1101, with display) and on the same wall outside the building in front of which the green wall was then installed in November (ONSET, HOBO MX2301A, without display because it ensures greater impermeability). The dataloggers are managed through an app and Bluetooth connection, which allows any smartphone or PC to connect to the data logger by placing a few meters away and act on the configuration / display of data and graphics / download data in .csv or .xlsx format / send data. The datalogger has been configured to record temperature and relative humidity data every hour (the data per hour, the average, the max value and the min value and the standard deviation are recorded) and in this configuration the internal memory of the datalogger should be enough for 1 year of data. The internal batteries should also have a duration of at least 1 year (the duration obviously also depends on the configuration and how many times the sensors are "interrogated").

Data analyses have been carried out considering two separate sampling periods: August 2020 and August 2021. Data collected during winter seasons have been initially excluded, due to the presence of the indoor heating system. In absolute terms, the two sampling periods, are characterized by different mean temperatures. August 2020 is characterized by a mean temperature of 24.79 °C, while August 2021 has a mean temperature of 23.81 °C. Specifically, August 2020 is characterized by a positive thermal anomaly of 1.5 °C with respect to the average value over the period 1981-2010, thus being the 10° hottest August in the last 63 years.

The indoor (Ti) and outdoor (Te) temperatures, measured by the two dataloggers at the homeless shelter, were compared with those measured by the reference monitoring station (Tsm) for the City of Turin of ARPA. Through this comparison, it was possible to highlight the effect of the green wall on the indoor and outdoor temperatures. Results are presented in Figures 61 and 62.

As shown in Figure 61, the maximum values of the difference between indoor temperatures (Ti) and reference one (Tsm) are generally measured during the night and during the hours with lower irradiation of the wall (early morning and evening). Such difference is higher during August 2020 with respect to August 2021, due to the higher indoor temperatures registered before the installation of the outdoor green wall. On the other hand, also the minimum values of this difference, which are measured during the day, result to be less accentuated and sometimes negative during August 2021, with indoor temperatures being lower than those detected during August 2020.

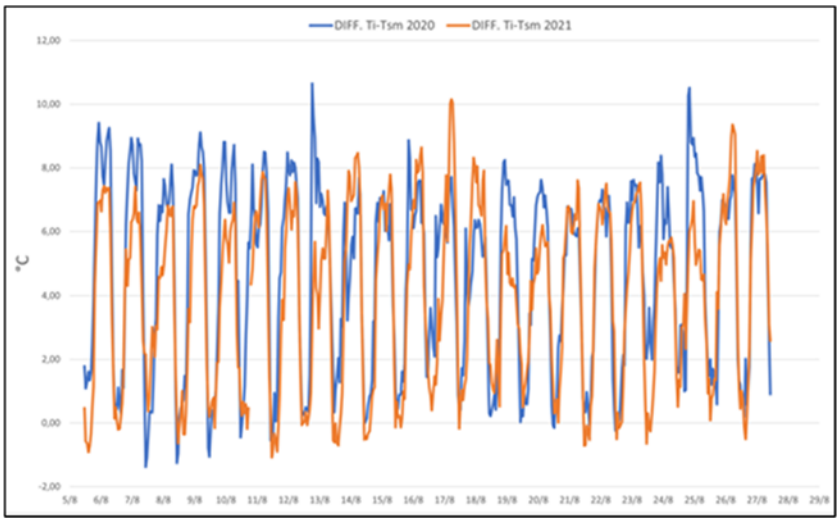

Figure 61. Comparison between measured indoor temperatures at the homeless shelter (Ti) and the reference monitoring station of Turin City (Tsm), in August 2020 and 2021.

Similarly, the maximum values of the difference between measured outdoor temperature (Te) and reference one (Tsm) are generally observed during the hottest hours of the day, due to the higher temperatures measured in proximity of the building with respect to the reference air temperature (Figure 62). These values are also more accentuated during August 2020, before the green wall installation, with respect to August 2021. On the other hand, the minimum values of this difference are generally measured during the night and early morning

and are less accentuated and sometimes negative during August 2021 (after the green wall installation). This latter result probably underlines the influence of the green wall in reducing the building heat dispersion by radiation during the night.

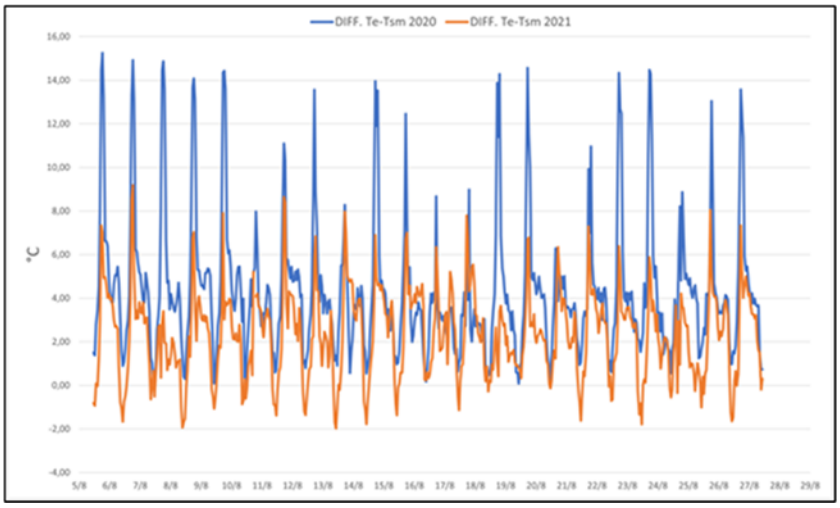

Figure 62. Differences between measured outdoor temperatures at the homeless shelter (Te) and the reference monitoring station of Turin City (Tsm), in August 2020 and 2021.

5.12. Turin NBS5.4: New green roof at WOW

The project concerns the realization of an extensive green roof of 140 sqm. on a public but currently abandoned building. The green roof is intended to be a “natural lawn” obtained by sowing a mixture of seeds from stable meadows of northern Italy that can be calibrated to be used from the plain to the mountain areas.

Figure 63. Overview of the Green Roof realized on the WOW building in Turin (image © City of Turin).

Tool E - Air Quality

Passive samplers for O_3 and NO_2 were exposed in the NBS5.4 area and control points from 18/06/2019 to 9/7/2019 to have the baseline data of these selected air pollutants (Figure 64). At the beginning of summer 2021 the measurement campaign has been repeated and the samples are under analysis in the lab.

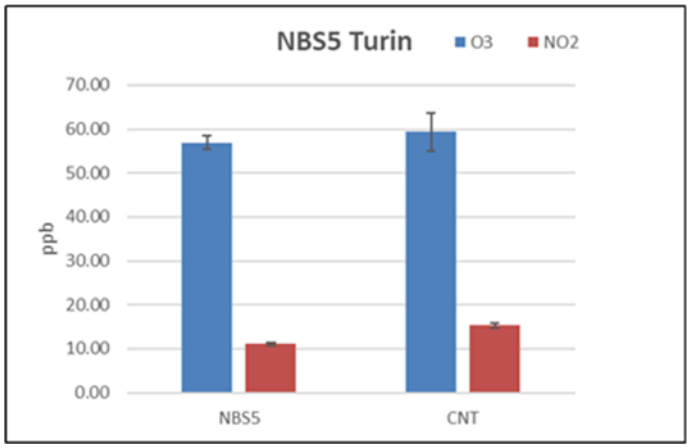

Figure 64. Concentrations (ppb) of O_3 (blu columns) and NO_2 (red columns) in NBS5.4 and Control for baseline measurement. Vertical bars represent the standard error of the mean (n=3).

Tool F - Air Temperature

Air temperature was monitored in NBS5.4 and control point at three different stages (Figure 65). The combined presence of 3 sample points for each measurement point allowed a preliminary statistical analysis. The analysis of variance showed that before and at the beginning of the installation of the green roof the temperatures at the WOW site were significantly higher than at the control site (Figure 65). This was mainly due to the higher maximum temperature registered (Figure 66), while the minimum daily temperatures were similar between the NBS and the control site (Figure 65). As a consequence, the temperature ranges calculated were significantly higher during the first stage of the measurement (Figure 67). During the second and third stage of measurement, the NBS site temperature was comparable with the one of the control site, demonstrating the positive effect of Green Roof installation on microclimatic conditions. To better evidence this effect Figure 68 shows the delta on temperature range (range NBS – range control) for the same period (day of the year 45-98) of year 2020 (prior and beginning of green roof installation) and year 2021 (green roof fully implemented and running).

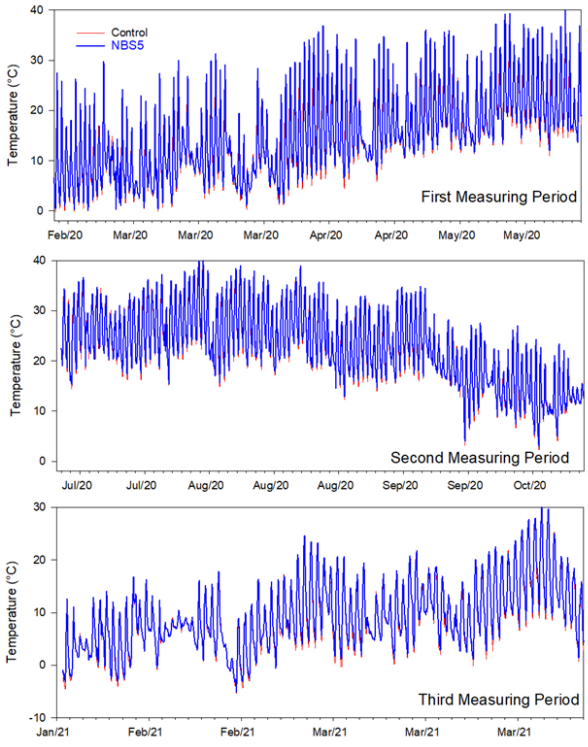

Figure 65. Hourly mean of air temperature recorded in control points (red line), NBS5 (blue line) in the three different measurement stages (one stage each panel).

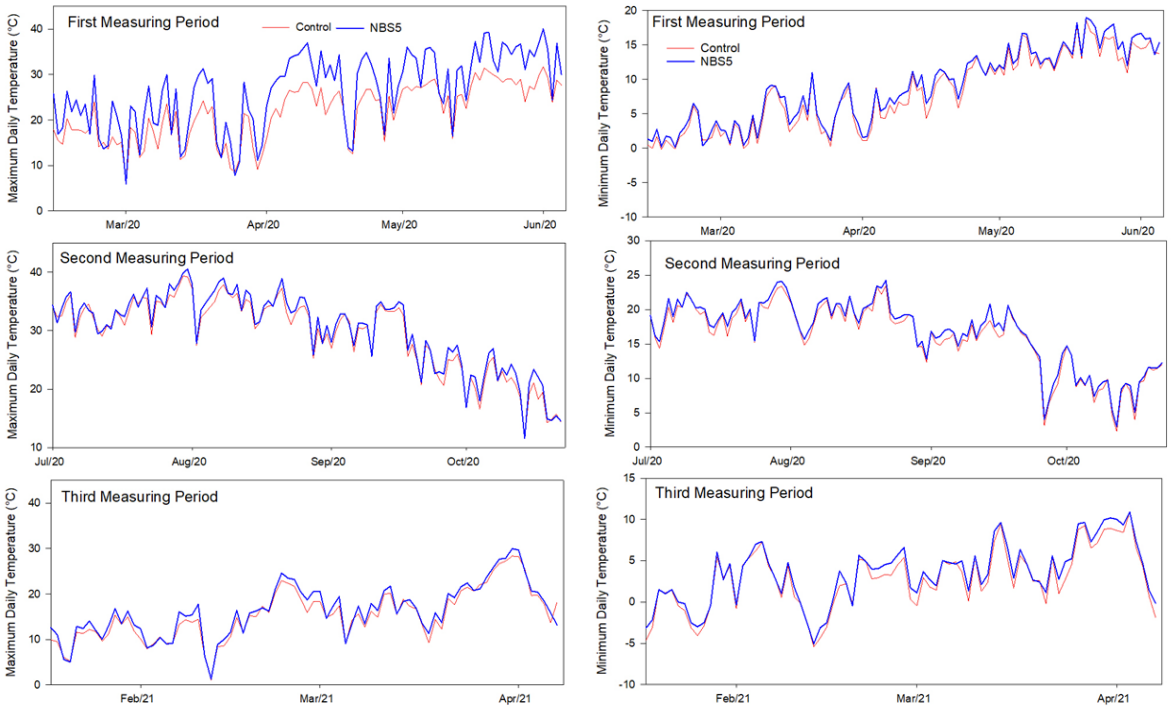

Figure 66. Left side: Daily maximum temperature recorded in control points (red line) and NBS5 (blue line) in the three different measurement stages (one stage each panel). Right side: Daily minimum temperature recorded in control points (red line) and NBS5 (blue line) in the three different measurement stages (one stage each panel).

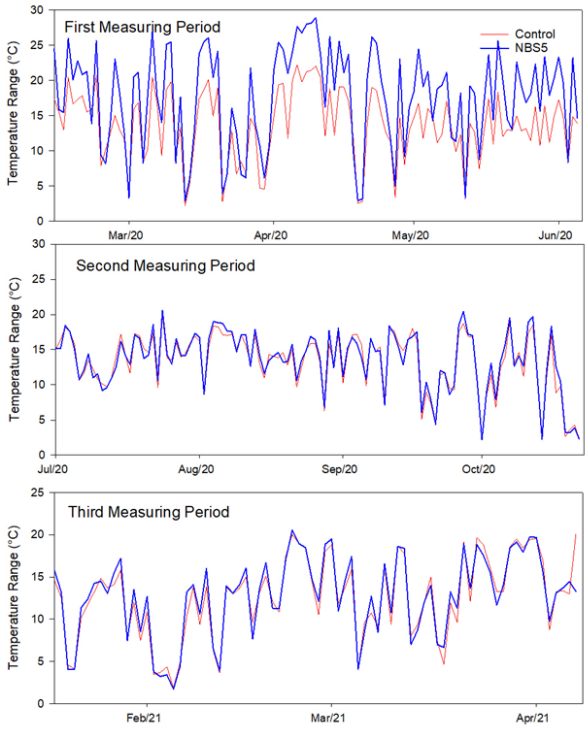

Figure 67. Daily temperature ranges recorded in control points (red line) and NBS5 (blue line) in the three different measurement stages (one stage each panel).

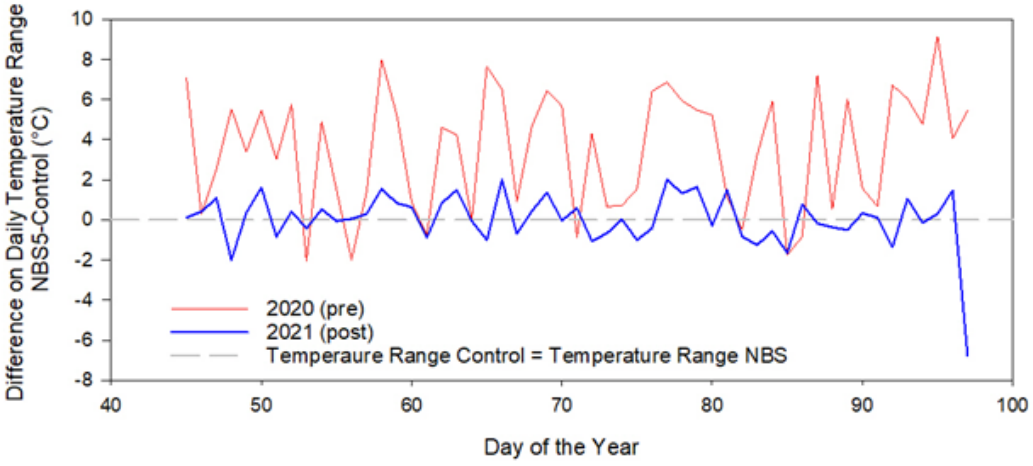

Figure 68. Difference on daily temperature ranges between NBS5 and control recorded between day of the year 45 and 98 of 2020 (red line) and 2021 (blue line). The dashed grey line represents the delta zero.

5.13. Turin NBS6.1: Green corridor

The Green Corridor will consist of an ecosystem path of about 275 m, capable of redeveloping areas that don't have a strong identity and show climatic criticalities such being at risk of "heat island". Thanks to such corridor, pollinating insects will enter urban areas, producing a vital pollination action. Moreover, it will foster processes of involvement,

participation, and awareness in the residents. The "Green Corridor" is developed by incremental area steps inside the Mirafiori district. The area has been identified as part of a series of actions already in place by proGIreg: the development of community farming (NBS3.2) and beekeeping activities (NBS8.1), the organization of crop boxes with the involvement of citizens living in the neighbourhood (NBS3.7).

Figure 69. The Green Corridor in Turin (image © Monica Vercelli).

Tool B - SOPARC

The Green Corridor NBS site is similarly used by men and women, mostly adults and seniors across day periods. Teenages use the site more frequently in the afternoon and evening, and seniors during the morning. The main physical activity performed during the day is walking. Results are shown in Figure 70.

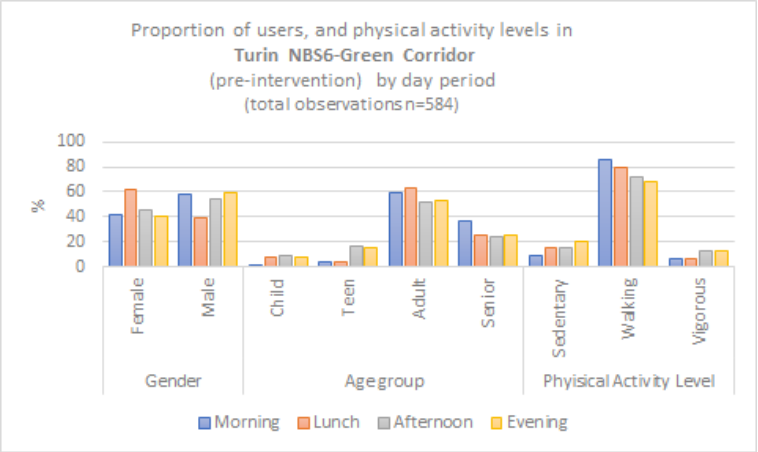

Figure 70. User groups and physical activity levels for NBS6 in Turin LL in the four observation days of the pre-implementation SOPARC assessment (29 September, 1,3,4 October 2020).

Tool I - Biodiversity

In 2020, a transect walk for monitoring butterfly richness and abundance in NBS6.1 was defined and carried out. The “Green Corridor” transect follows the same protocol of the other transects, the fixed route is about 810 m long and totally immersed in an urban environment (Figure 71). This monitoring aims to understand the impact of Green Corridors (NBS6) in the butterfly community and their dispersal abilities in crossing the urban matrix. The green corridor (NBS6), co-designed and planned for 2020, connects Cascina Piemonte with another green area (Colonnetti park). In this first year of the sampling (2020), in the “Green Corridor” transect few butterfly species (4) with low abundances were found, and thus biodiversity indexes cannot be calculated. The most common species that can cross the urban matrix are *Pieris rapae*, *Pieris napi* and *Melitaea didyma*. On the other hand, in 2021 (monitoring in progress) an incredible increase of species was observed (12 in total) and individuals have been recorded allowing the diversity indices calculation. The most common species are still *Pieris spp* but also *Polyommatus icarus* were fund in abundance. Thanks to the involvement of the Citizen Science project "Farfalle in ToUr" (NBS8), in the future this transect could be monitored by volunteers, and in turn they could involve other citizens in the monitoring, after a specific training session focused on species identifications and sampling method. The future citizen science data collection will complement the data collected by proGIreg research partners in 2020 and 2021

Figure 71. Scheme of the “Green corridor” transect for butterfly count in Mirafiori Sud.

5.14. Turin NBS8: Butterfly gardens for disadvantaged people

The goal is to promote the presence of butterflies in the city of Turin through the creation of a network of green areas which, with proper management and with the presence of suitable plants (food plants and nectar sources) for the insect life cycle, allows butterflies to cross the urban area, otherwise presenting a barrier to these insects. At the same time, the project aims to promote social inclusiveness for disadvantaged people through their active participation in all phases. In particular, Turin NBS8 involves people with mental diseases that work in the project since the Butterfly gardens co-design, and especially they are focused on involving local citizens and municipality in the management of ornamental and public green following pollinators needs.

Figure 72. Overview of the activities developed within NBS8 (image © City of Turin).

Benefits produced by NBS8 are strictly connected with the activity carried on with the users of “La Rondine” and “Il Margine” care institutions, which are involved in the project Farfalle in ToUr during 2019, 2020 and 2021. In this period, 12 users have been involved in the activities focused on Butterfly Oasis building and dissemination events with citizens, other disadvantaged backgrounds, and schools.

In 2020 because of the COVID-19 pandemic, all activities were carried out through social networks, seminars, and activities online. Otherwise, in 2021 patients took part in school activities (4 lessons) and dissemination workshops (4 events) in presence.

The school activities are part of the initiative “Le farfalle vanno a scuola (Butterflies go to school)”, during which children learned the biology and the ecology of butterflies through a direct experience of butterfly breeding. In each school, a new Butterfly Oasis (garden hosting plants useful for pollinators) was created and became part of the green network for connecting the pollinator-friendly gardens built inside the city. In 2021, Farfalle in ToUr involved 25 students and 2 teachers in a 4-lessons course (about 8h of frontal lessons plus 10h for the activities organization). In general, the awareness about pollinators and their essential function in the ecosystem increased in both teachers and students, after this experience.

In cooperation with other proGIreg partners, Farfalle in ToUr organized 4 workshops (8h) addressed to families and children for discovering the urban butterfly community and its richness. 48 children became scientists for a day learning about insects monitoring and butterflies’ conservation.

An overall assessment of the benefits produced will be accomplished later during the project, by an adapted version of the Economic and Labour Market Questionnaire synergically developed by partners involved in the NBS8 management and partners responsible for the social and economic assessment domains.

5.15. Zagreb NBS3.1: Modernization of existing urban garden

The "City Gardens" project is an example of sustainable land use in Zagreb, improving the quality of life of citizens and the spatial quality and functions of the urban environment. The aim of the project is to enable citizens to produce food (vegetables and strawberries), herbs and flowers for their own need. City gardens, besides providing space for healthy food and improving the home budget of citizens, also offer the possibility of traditional food production and coexistence with nature. They enable quality use of leisure time and augment the quality of life of citizens in a social, economic and healthy way. The "City Gardens" project started in September 2013.

Arable land consists of garden plots up to 50 m2 and common parts with common equipment (access roads and paths, wooden and prefabricated storage of tools and organic fertilizers, composters, benches and waste bins, garden gazebos and canopies). The areas of all City Gardens are fenced, and the common part is intended for socializing and recreation of users, for education and workshops.

The existing Sesvete city garden has been upgraded with solar purifying water pumps, as the garden is watered directly with underground water. Spores were detected in the water used for the gardens, so it needs to be purified. Application of the CPC photoreactor with flexible supported catalyst technology as innovative solution for water purification in the city garden was implemented.

Figure 73. The modernized urban garden in Sesvete (image © City of Zagreb).

Tool B - SOPARC

The changes proposed to update the urban existing garden are mainly at the technical level and not crucial changes in spatial activities, therefore no significant changes in the users' habits are expected. Instead, we have monitored the people walking through a walkway nearby, called “The Vuger walkaway” (Figure 74), where some containers with flowers will be moved at some point of the project. At this point the post monitoring assessment will be performed to evaluate the change in people using the “renovated” walkway.

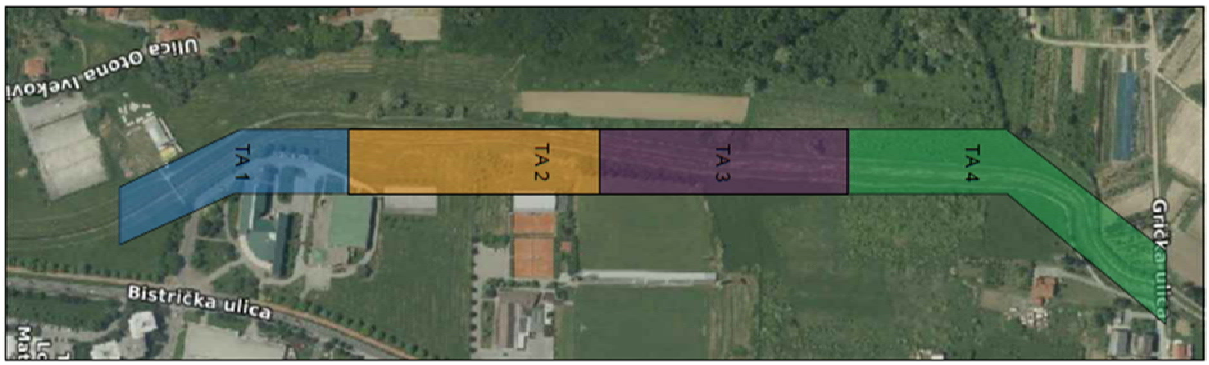

Figure 74. The Vuger walkaway in Sesvete urban garden in NBS3.1 in Zagreb LL.

Currently, as shown in Figure 75, the proportion of male using the walkway is higher than women across the day. Teenagers, adults and seniors are the most common users. A low proportion of children has been observed in the site. Sedentary and walking are the most

common physical activity levels, in the morning and in the afternoon and evening respectively.

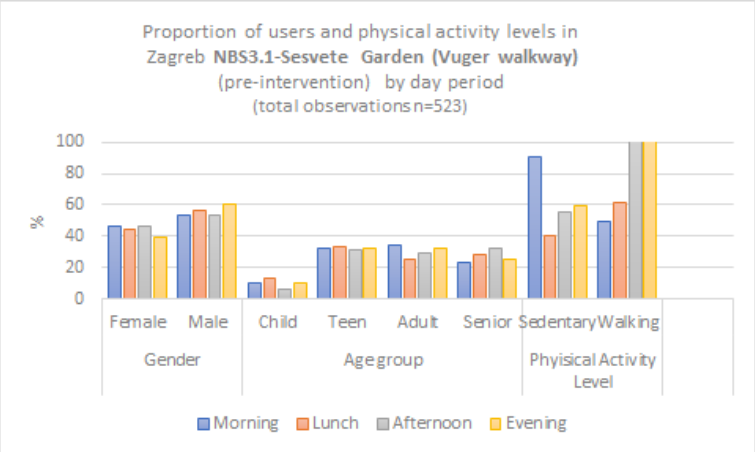

Figure 75. User groups in the Vuger walkaway in Sesvete urban garden in NBS3.1 in Zagreb LL in the four observation days of the pre-implementation SOPARC assessment (16,19,20,21 March 2021).

Tool E - Air Quality

Passive samplers for O_3 and NO_2 were exposed in the NBS3.1 area of and control points from 12/06/2019 to 3/7/2019 to have the baseline data of these selected air pollutants (Figure 76). At the beginning of summer 2021 the measurement campaign should be repeated but it has been shifted to summer 2022 due to administrative reasons.

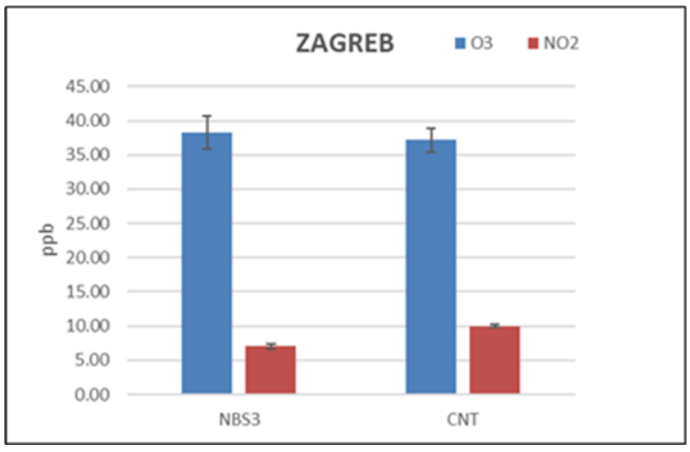

Figure 76. Concentrations (ppb) of O_3 (blu columns) and NO_2 (red columns) in NBS3.1 and Control for baseline measurement. Vertical bars represent the standard error of the mean (n=3).

Tool G - PM Biomonitoring

Leaf sampling for the PM biomonitoring task has been performed at this NBS3.1 in August 2020. Two woody species were identified, based on their relative presence in the site, namely *J. regia L.* and *A. saccharinum L.* For each species, three plants were identified, and three branches were sampled from each of them, on three different points of the crown. Then, per each branch, the youngest leaves (top of the sampled branches) were analysed, in order to ensure homogeneity between the considered samples. Six over the nine sampled leaves were analysed for each species, for a total of 12 leaves analysed over the 18 collected in this NBS (two species per three plants per three leaves). This sampling should be repeated in 2022. SEM/EDX leaf microanalysis has been completed, while the elaboration of data relative to density, chemical composition and weight of leaf deposited PM is still in progress and will be presented in the future.

5.16. Zagreb NBS3.2: New therapy garden in Sesvete

Instead of originally planned new urban gardens, a new therapeutic garden is planned to the south of the former factory. While the project implementation started, the idea of conceiving the new garden as therapy garden came up and was welcomed by the partners and local community alike. The codesign workshops were used as opportunity to gather the potential stakeholders and to include them in the planning phase, ensuring that the garden is planned adequately to cater to the needs of all possible users, including local people with various disabilities. There are plenty of potential users in the neighbouring area (including war veterans and several housing communities of people with autism). The new garden is planned in a way that it can meet the needs of all potential users in the neighbourhood and beyond. The garden opened in May 2021. It has been in use since and tended to every day.

Figure 77. The new therapeutic garden in Sesvete (image © Iva Bedenko).

Tool A - NBS-visitor Questionnaire

Preparation of the NBS-visitor questionnaire for the new therapy garden is currently ongoing. The reason for this delay lies in the heterogeneity of the target population (both adults and children) with a wide range of mental and physical disabilities. Partners from UNIBA and ISGlobal are currently in contact with the city of Zagreb in order to retrieve useful information on the potential study sample and evaluate the feasibility of a data collection on the NBS site.

Tool B - SOPARC

The site was previously an inaccessible brownfield. Thus, the pre-implementation SOPARC assessment has been cancelled. Only post-implementation assessment will be performed following the monitoring plans.

Tool E - Air Quality

Passive samplers for O_3 and NO_2 were exposed in the NBS3.2 area of and control points from 12/06/2019 to 3/7/2019 to have the baseline data of these selected air pollutants (Figure 78). At the beginning of summer 2021 the measurement campaign should be repeated but it has been shifted to summer 2022 due to administrative reasons.

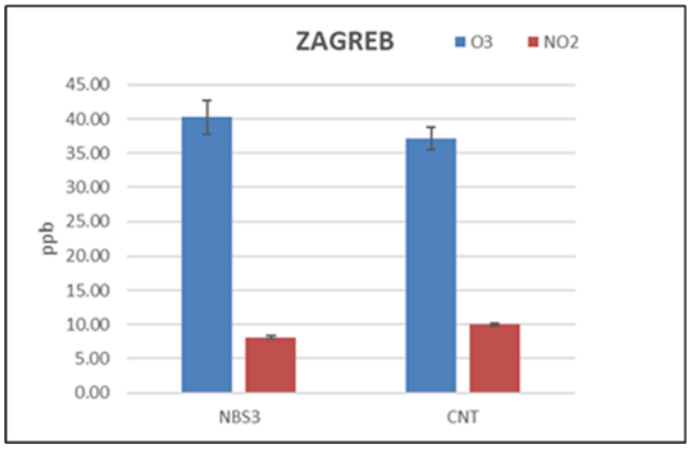

Figure 78. Concentrations (ppb) of O_3 (blu columns) and NO_2 (red columns) in NBS3.2 and Control for baseline measurement. Vertical bars represent the standard error of the mean (n=3).

Tool F - Air Temperature

Preliminary air temperature data acquisition has been performed since October 2020, but with not homogeneous conditions. Sensors have been properly installed in August 2021 and are currently running.

Tool G - PM Biomonitoring

PM biomonitoring has been performed at this NBS3.2 in August 2020. To this aim, two woody species were identified, namely *J. regia* and *P. cerasifera.* Leaf sampling and subsequent SEM/EDX were conducted as reported in the previous section for Zagreb NBS3.1.

This task should be repeated after two years in 2022. However, the *J. regia* trees have been cut down. A further *J. regia* tree has been identified close to the Zagreb NBS5 site, at 50 m from the Therapy Garden. SEM/EDX microanalysis of leaves sampled at this site has been completed, while the elaboration of data relative to leaf deposited PM density, chemical composition and weight is still in progress.

5.17. Zagreb NBS5: Seedling factory with aquaponics installations and green roof

The mini urban farm is designed as a new complete solution that integrates green roof, green wall and aquaponics technologies. The implemented farm is a green technology centre in the Sljeme factory area and has both commercial and educational functions. The basic components of such a stand-alone system are one unit measuring 6 x 6 m, an example of green wall and roof, an aquaponic system inside, a microclimate automation and control and irrigation systems.

The farm contains the aquaponic system with water quality management equipment for fish, processing area, storage area, and packaging area, and growing plants. This farm will be used for education, mini market, workshops, plant transplanting etc. A green wall structure has been erected on two sides of the unit, to protect the area from the sun and to collect the excess rainfall for later use.

Figure 79. The seedling factory in Sesvete (image © Martina Ristorini).

The implementation of the green wall has been finished in August 2021, together with the installation of the sensors (temperature and relative humidity) for the Air Temperature task, planned for this solution. Specifically, three replicate sensors have been installed with shelters, on the wall, where the green wall was planned to be implemented, one week previous to the end of works. Another set of sensors has been also installed on the opposite wall of the container. Due to its high proximity to this site, the control site previously identified for the Therapy Garden, will be used also for the green wall and the green roof implemented in this NBS5. Leaf samplings have been conducted in September 2021, for the PM biomonitoring task. Six species have been sampled (*Thymus vulgaris* L., *Origanum* spp., *Ocimum basilicum* L., *Salvia officinalis* L., *Allium schoenoprasum* L. e *Capsicum* spp.), thus identifying three plants for each species and collecting two leaves from each of them for SEM/EDX microanalysis. The implementation of the green roof is expected to be finished in September with plantation procedures. Air temperature and relative humidity sensors have been already installed on the roof from August 2021, for the PRE evaluation of the Air Temperature monitoring task.

5.18. Zagreb NBS6: New cycling track

A new 850 m long cycling path will connect Sljeme brownfield area with Novi Jelkovec neighbourhood. The cycling track is part of the newly planned road, defined in the detailed plan of the former factory area.

Figure 80. A view of the site where the cycling track will be realized (image © Marijo Spajić/ZIPS).

Tool B - SOPARC

Currently, the area is used by adult men in a high proportion, across day periods. Teenagers are more frequent in the morning and seniors in the afternoon and evening. Sedentary activities and walking are the most common physical activity levels during the day. Results are shown in Figure 81.

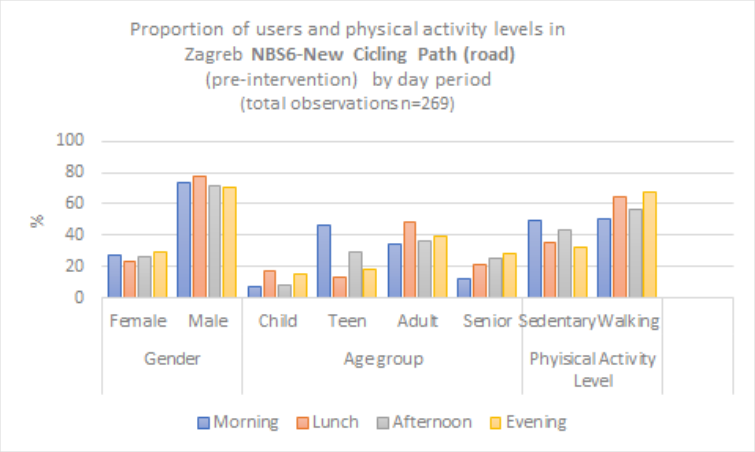

Figure 81. User groups and physical activity levels for NBS6 in Zagreb LL in the four observation days of the pre-implementation SOPARC assessment (16,169,2021 March 2021).

6. Benefits' assessment at the district level

The benefits produced by the implemented NBS at the LL district level are assessed by using both spatial data from existing databases (Section 6.1), that are collected both at the city and at the LL district scale, and new experimental data (Section 6.2) collected in the LL district and in a control district suitably selected.

The city level data are used only to upscale and compare the LL district results, since no direct effect of the proGIreg implementations is expected at the city level due to the small size and number of the NBS.

The analysis of district level data, instead, provide specific indicators for each of the four assessment domains in proGIreg. The selected indicators have been reviewed in accordance with the guidelines reported in the Handbook from the EC NBS Impact Evaluation Taskforce[3]. These indicators are easy-to-use descriptor tools, to be further used to compare proGIreg results with those from other sister projects.

6.1. Spatial data

6.1.1. Spatial data from existing administrative databases

A first version of the list of spatial data from existing administrative databases (BASE) needed for benefit assessment and upscaling has been presented in proGIreg D2.1[22]. However, not all the requested data could be provided by the European FRC, as shown by D2.2[4]. The list of spatial data from existing databases has been reviewed by research partners (UNIBA, ISGlobal, SL and CNR; coordinated by SL) in 2020, according to three criteria: the list of the data already obtained by WP2 in 2018; the real need of the research partners based on the indicators selected in 2019 while reviewing D4.3[5]; the statistical data needed for the upscaling. The spatial data to be collected are now 69, compared to initially 85 listed in D2.2[4]. The updated list of the required data is reported in Table 5. Data has been recollected, as planned, on a yearly basis, at the end of 2020/beginning of 2021, by the FRCs, at both the city and the LL district level, to provide indicators and to be used for the upscaling. All the four FRC have sent the updated list of the spatial data from existing databases to be recollected. SL has coordinated the data collection and is working on collecting missing data from the FRCs and organizing them for publication on the data platform.

[22] Elisei, P; Leopa, S. (2018): Methodology on spatial analysis in front-runner and follower cities, D2.1, proGIreg. Horizon 2020 Grant Agreement No 776528, European Commission, 53 pp.

Table 5. Spatial data from existing databases to be collected by the FRC on a yearly basis to provide indicators and parameters to be further used for indicator upscaling.

REF. DOMAIN	SUBDOMAIN	INDICATOR	DESCRIPTION	SCALE
1. Socio-cultural inclusiveness	1.1 Demographics	1.1.1 Total population	Total number of persons living in the specific area. Indicator should be collected for both the city/MA scale and the LL/regeneration area district scale.	CITY
				LL
		1.1.2 Population density	Number of persons per square km of land area. Indicator should be collected for both the city/MA scale and the LL/regeneration area district scale.	CITY
				LL
		1.1.3 Population growth rate	Average annual rate of change of population size (%). Data should be collected for both the city/MA scale and the LL/regeneration area district scale.	CITY
				LL
		1.1.4 Migration rate	Net number of migrants (immigrants – emigrants) per 1,000 population. Data should be collected for both the city/MA scale and the LL/regeneration area district scale.	CITY
				LL
	1.2 Social and cultural inclusiveness	1.2.1 Material deprivation rate	Material deprivation rates gauge the proportion of people whose living conditions are severely affected by a lack of resources	CITY
				LL
		1.2.2 Work intensity	% employed out of total economically active population (15-64 years of age)	CITY
				LL
		1.2.3a Diversity statistics	% foreign born residents (if available, for both scales, or)	CITY
				LL
		1.2.3b Diversity statistics	Population by ethnicity	CITY
				LL
	1.3 Education and access to social and cultural	1.3.1 Educational attainment	Average level of education completed by the 20-64-year-old population	CITY
				LL
				CITY

	services and amenities	***1.3.2 Recreational or cultural facilities***	*Relevant for LL/regeneration level: no. and identification of recreational and / or cultural facilities*	***LL***
		1.3.3 Accessibility of public urban green spaces	*% population having access to green space within a 30 minutes walking distance or within 30 minutes travel time by public transportation.*	***CITY***
				LL
	1.4 Housing	***1.4.1 Housing quality***	*Average useful floor area per person, calculated in sqm*	***CITY***
				LL
		1.4.2 Public housing	*Percentage of residents in public housing*	***CITY***
				LL
		1.4.3 Housing affordability	*Homeownership rate*	***CITY***
				LL
		1.4.4 Density of the built environment	*Building Coverage Ratio, or if unavailable, Floor Area Ratio (Total residential floor area divided by total residential area surface)*	***CITY***
				LL
2. Human health and well-being	***2.1 Health***	***2.1.1 Incidence of cardio and respiratory diseases***	*Rate of new (or newly diagnosed) cases of the disease per 1,000 persons*	***CITY***
				LL
		2.1.2 Incidence of allergic disease	*Rate of new (or newly diagnosed) cases of the disease per 1,000 persons*	***CITY***
				LL
		2.1.3 Incidence of chronic stress, stress-related diseases, mental health diseases and NCDs	*Rate of new (or newly diagnosed) cases of the disease per 1,000 persons*	***CITY***
				LL
		2.1.4 Obesity rate	**Possibly available by region / in specific studies (or possibly at school level)*	***CITY***
				LL
		2.1.5 Life expectancy at birth	*Average life expectancy (possibly available at higher levels / regional level)*	***CITY***
				LL
	2.2 Wellbeing	***2.2.1 Green space per capita***	*Sqm of green space / person*	***CITY***
				LL
		2.2.2 Urban safety – crime		***CITY***

			Yearly number of reported crimes per 1,000 persons	***LL***
		2.2.3 Urban safety – accidents	*Yearly number of reported road accidents involving pedestrians and / or bicyclists*	***CITY***
				LL
3. Ecological and environmental restoration	***3.1 Land use and Vegetation***	***3.1.1 % of green spaces***	*% of total surface which is destined for green spaces*	***CITY***
				LL
		3.1.2 structure of green spaces	*% of tree covered areas*	***CITY***
				LL
		3.1.3 structure of green spaces	*% of shrub covered areas*	***CITY***
				LL
		3.1.4 structure of green spaces	*% of meadow covered areas*	***CITY***
				LL
		3.1.5 % Surface of brownfields	*Total surface which is destined for brownfield areas*	***CITY***
				LL
		3.1.6 % Surface of polluted brownfield areas	*% of polluted brownfield areas*	***CITY***
				LL
	3.2 Climate / Meteorological data	***3.2.1 Precipitation***	*Average annual precipitation (mm)*	***CITY***
				LL
		3.2.2 Relative humidity	*Relative humidity*	***CITY***
				LL
		3.2.3a Air temperature	*Annual mean temperature (°C)*	***CITY***
				LL
		3.2.3b Air temperature	*Winter mean temperature (°C)*	***CITY***
				LL
		3.2.3c Air temperature	*Spring mean temperature (°C)*	***CITY***
				LL
		3.2.3d Air temperature	*Summer mean temperature (°C)*	***CITY***
				LL

		3.2.3e Air temperature	*Fall mean temperature (°)*	***CITY***
				LL
		3.2.4 Wind strength	*Wind intensity (km/h)*	***CITY***
				LL
		3.2.5 Wind direction	*Main wind direction*	***CITY***
				LL
	3.3 Air Quality	***3.3.1 Ozone concentration***	*µg/m3 / ppb*	***CITY***
				LL
		3.3.2 NOx concentration	*µg/m3 / ppb*	***CITY***
				LL
		3.3.3 PM 2.5 concentration	*µg/m3 / ppb*	***CITY***
				LL
		3.3.4 PM10 concentration	*µg/m3 / ppb*	***CITY***
				LL
		3.3.5 VOC Concentration	*µg/m3 / ppb*	***CITY***
				LL
		3.3.6 GHG inventory	*Inventory of greenhouse gases (GHG) emission at city level and LL level*	***CITY***
				LL
4. Economic and labour market	***4.1 Market labour and economy indicators***	***4.1.1 GDP per capita***	*GDP (PPP), Euro*	***CITY***
				LL
		4.1.2 Businesses in the area - Industrial	*Amount of Industrial companies per 1,000 inhabitants*	***CITY***
				LL
		4.1.3 Businesses in the area - Commercial	*Amount of commercial companies per 1,000 inhabitants*	***CITY***
				LL
		4.1.4 Businesses in the area - Offices	*Total amount of offices companies per 1,000 inhabitants*	***CITY***
				LL
		4.1.5 Public jobs		***CITY***

			- Total number of jobs in public sector	***LL***
		4.1.6 Private jobs	*- Total number of jobs in private sector*	***CITY***
				LL
		4.1.7 Public green jobs	*- Total number of public green jobs*	***CITY***
				LL
		4.1.8 Private green jobs	*- Total number of private green jobs*	***CITY***
				LL
		4.1.9 Qualified Jobs	*- Total number of qualified jobs*	***CITY***
				LL
		4.1.10 Non qualified jobs	*- Total number of non-qualified jobs*	***CITY***
				LL
		4.1.11 Turnover in green sector	*Green companies' turnover in EUR*	***CITY***
				LL
	4.2 Gentrification indicators	***4.2.1 Employment rate***	*the proportion of employed adults in the working age (20-64 years)*	***CITY***
				LL
		4.2.2 Unemployment rate	*the proportion of unemployed adults in the working age (20-64 years)*	***CITY***
				LL
		4.2.3 Revenues by household	*Average household disposable income*	***CITY***
				LL
		4.2.4a Current property sale value for residential use	*Property value, average, EUR/sqm, for single- and collective housing, sale price*	***CITY***
				LL
		4.2.4b Current property rental value for residential use	*Property value, average, EUR/sqm, for single- and collective housing, renting (monthly)*	***CITY***
				LL
		4.2.5a Current property value for commercial/ industrial/ office use	*Property value, average, EUR/sqm, sale price*	***CITY***
				LL
		4.2.5b Current property rental value for commercial/ industrial/ office use	*Property value, average, EUR/sqm, renting (monthly)*	***CITY***
				LL

		4.2.6 Free services	*Total number of free services (parks, librairies, cycle trials, skate parks…)*	***CITY***
				LL
		4.2.7 Basic utilities	*Monthly cost of basic utilities (Electricity, water, Garbage…)*	***CITY***
				LL
	4.3 Tourism and attractiveness indicators	***4.3.1 Current number of tourists***	*Measured as average number of overnight stays in tourism accommodations*	***CITY***
				LL
		4.3.2 Number of temporary events	*Trade Fairs, Congresses, Symposiums, Concerts, Parades before NBS application (in number)*	***CITY***
				LL
		4.3.3 No. of foreign students	*% of foreign students out of total enrolled higher education students*	***CITY***
				LL
		4.3.4 Local expenses	*Expenses in local retail businesses*	***CITY***
				LL
	4.4 Taxes, Investment & Financing	***4.4.1 Local taxes***	*Average local taxes per capita*	***CITY***
				LL
		4.4.2 Green investment programs/funds	*Public investment programs, and investment funds*	***CITY***
				LL

Most of this information are required data to develop comparisons among the cities, such as: (1) total population; (2) population density; (3) migration rate; (4) material deprivation rate; (5) diversity statistics; (6) educational attainment; (7) recreational or cultural facilities; (8) accessibility of public urban green space; and (9) density of the built environment. They represent intervening variables, or covariates which will be controlled during the comparison analysis among the different cities.

Other data are indeed required for indicator calculation. From the analysis of the BASE data at the LL district level, the following KPIs will be assessed at the end of the project (Table 6).

Table 6. Key performance indicators assessed at the LL district level from BASE data, with corresponding assessment domain, societal challenge area and the indication if it is a "Recommended" (R) or an "Addition" (A) one, based on the guidelines reported in the EC Taskforce Handbook[3].

Indicator Name	Description	Assessment domain in proGIreg	Societal Challenge Area	R/A
12.7 Concentration of particulate matter (PM10 and PM2.5), NO2, and O3 in ambient air	Concentration of PM2.5, PM10, NO_2 and ground-level O_3 ($\mu g/m^3$) in ambient air	Ecological and environmental restoration (Task 4.3)	6. Air Quality	A
14.12. Population growth (Natality + Immigration)	Average annual rate of change of population size (%).	Socio-cultural inclusiveness (Task 4.1)	7. Place regeneration	A
23.2.1 Change in mean house prices /rental markets	Rental and market prices for homes and retail/commercial spaces can be seen as a good barometer of economic prosperity. A wealth of data exists illustrating the association between high quality green space and NBS and increased real estate values. Research suggests that prices can increase by up to 20% of home or retail spaces overlook or are located near to high quality green and open spaces. It has also been reported that an improved physical environment in terms of aesthetic quality is used by businesses when deciding to locate to an area. Thus, with interventions in NBS there is a potential for improved economic development activities to be situated in each of the demo sites. Such data would also allow the municipality to think more strategically about how they align their economic development targets with their understanding of how, where and NBS could be implemented in the future.	Economy and labour market benefits (Task 4.4)	12. New Economic Opportunities and Green Jobs	R
24.18 Number of new jobs in green sector	Total number of green jobs in the LL area.	Economy and labour market benefits (Task 4.4)	12. New Economic Opportunities and Green Jobs	A
24.21 Turnover in the green sector	This indicator aims to detect how business activity has evolved in the "green sector" during the time before and after NBS implementations by ProGIreg. Measuring the change in economic activity can be done by looking at several economic outputs: turnover, employment creation, gross value added and the relations between them.	Economy and labour market benefits (Task 4.4)	12. New Economic Opportunities and Green Jobs	A

Employment rate	The percentage of employed persons in relation to the comparable total population in the LL area	Economy and labour market benefits (Task 4.4)	
Unemployment rate	The number of people unemployed as a percentage of the labour force, according to the Eurostat/ILO definition, in the LL area	Economy and labour market benefits (Task 4.4)	

6.1.2. GIS-derived spatial data

Starting from GIS-derived data, UNIBA worked on the production of Walkability index and of Normalized Difference Vegetation Index (NDVI), both at the city and at the LL district scale. Walkability and NDVI are both related to valuable KPIs, whose description is reported in Table 7.

Table 7. Key performance indicators assessed at the LL district level from GIS-derived data, with corresponding assessment domain, societal challenge area and the indication if it is a "Recommended" (R) or an "Addition" (A) one, based on the guidelines reported in the EC Taskforce Handbook[3].

Indicator Name	Description	Assessment domain in proGIreg	Societal Challenge Area	R/A
8.37 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)	Socio-cultural inclusiveness (Task 4.1)	4. Green Space Management	A
8.2 Annual trend in vegetation cover in urban green infrastructure	This indicator examines how and in which direction vegetation cover changes within the Urban Green Infrastructure. Trend detection in Normalized Difference Vegetation Index (NDVI) time series can help to identify and quantify recent changes in ecosystem properties.	Ecological and environmental restoration (Task 4.3)	4. Green Space Management	A

Walkability index calculation

The Walkability index expresses the likelihood that a particular area will be walked by people. It provides useful information on the urban structure of a city and, in turn, of individual districts. For example, it can be useful to assess the effects of Land use changes (pre/post intervention). The Walkability index is not related to individuals' preferences but mainly to their needs since GIS data used for the calculation of Walkability does not include cycling paths or pedestrian areas (see below). For example, highly populated areas or city hotspots (e.g., city

centre) have generally higher Walkability than urban parks. Under an urban planning point of view, it can be used to make a more efficient choice on the location of a new NBS. Additionally, the Walkability index can be an important mediator when analysing the direct and indirect pathways between the presence of nature-based solutions and indicators of socio-cultural inclusiveness.

Data used for the Walkability index calculation includes: Population Density map; Road Network; Public Transit (including stops and routes); Land Use and zoning: residential, commercial and office, industrial, institutional (e.g., schools, libraries, kindergartens), green/park area, and water and wetland; and Digital elevation model. The Walkability index is calculated in the Living Lab district of each FRC before and after the implementation of the NBS. In general, for the calculation of the Walkability index, we followed the method developed by Fan et al. (2018)[23] although we used a buffer of 300 m as opposed to the 500 m used in the study. This makes it possible to record limited land use changes such as those generated in the Living Lab districts.

Data needed for the calculation of Walkability at the LL district scale (shape files) have been provided by Zagreb, Dortmund, and Turin. Data from Dortmund and Turin were initially incomplete and thus the Walkability Index has been calculated so far only for the city of Zagreb, as shown in Figure 82. This data has also been included as a case study in the EC Taskforce 2 Handbook[3]. In February 2021, corrected data for the Walkability calculation in Dortmund and Turin were provided, thus the Walkability for Dortmund and Turin is currently under calculation. Partners from the city of Ningbo are currently providing requested data.

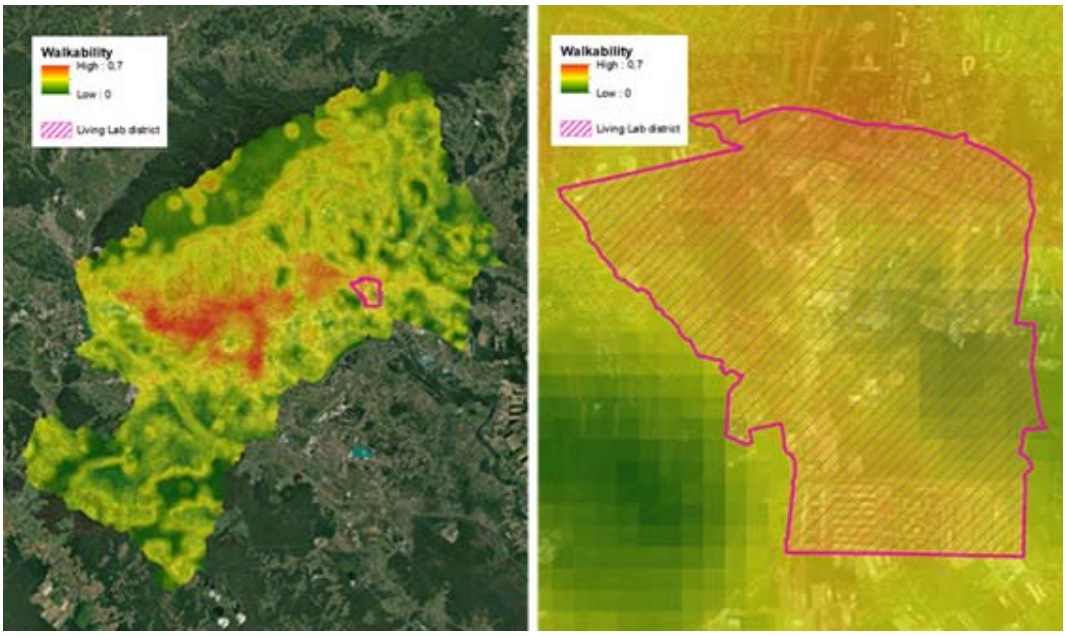

Figure 82. Walkability index calculated at the city and at the Living Lab district level for Zagreb FRC.

[23] Fan, P., Wan, G., Xu, L. et al. Walkability in urban landscapes: a comparative study of four large cities in China. Landscape Ecol 33, 323–340 (2018).

Normalized Difference Vegetation Index (NDVI) calculation

NDVI is a simple index, derived from multispectral remote sensing data, expressing the vegetation health status. Here we adopted the index to assess the annual trend of vegetation cover in urban green infrastructure for each FRC. To this aim, we calculated NDVI at city and district level for every year starting from 2018 and assessed the NDVI year-to-year variation. Similarly to the *Annual trend in vegetation cover by urban green infrastructure* indicator, we estimated the temporal variation of NDVI at multiple spatial scales (i.e. city and Living Lab District level) for multiple years (2018-20).

In particular, we used Google Earth Engine to select a series of radiometrically and atmospherically Sentinel 2 corrected images (Sentinel 2 level 2A, ESA Copernicus project) for each year of interest (2018, 2019 and 2020). After masking out clouds and shadows using the "Sentinel-2: Cloud Probability" layer (ESA Copernicus project), we calculated the NDVI for each image and then obtained a mosaic composed by the median yearly NDVI value for each pixel. For each city, two areas of interest were considered: the administrative city borders, and the Living Lab district. Zonal statistics were calculated over the city and the Living Lab district to provide useful insight on the spatial distribution of NDVI across the FRC. The NDVI calculated for Zagreb city and Sesvete district are reported as an example in Figure 83. Moreover, the yearly NDVI data at city level and district level was used to assess the variation of the NDVI index through time for all the FRCs. As an example, the difference between 2018 and 2019 NDVI data, per each FRC, is shown in Figure 84, while the mean NDVI calculated at city and Living Lab district level across the FRC and the year-to-year variation in the years 2018, 2019 and 2020 is shown in Figure 85.

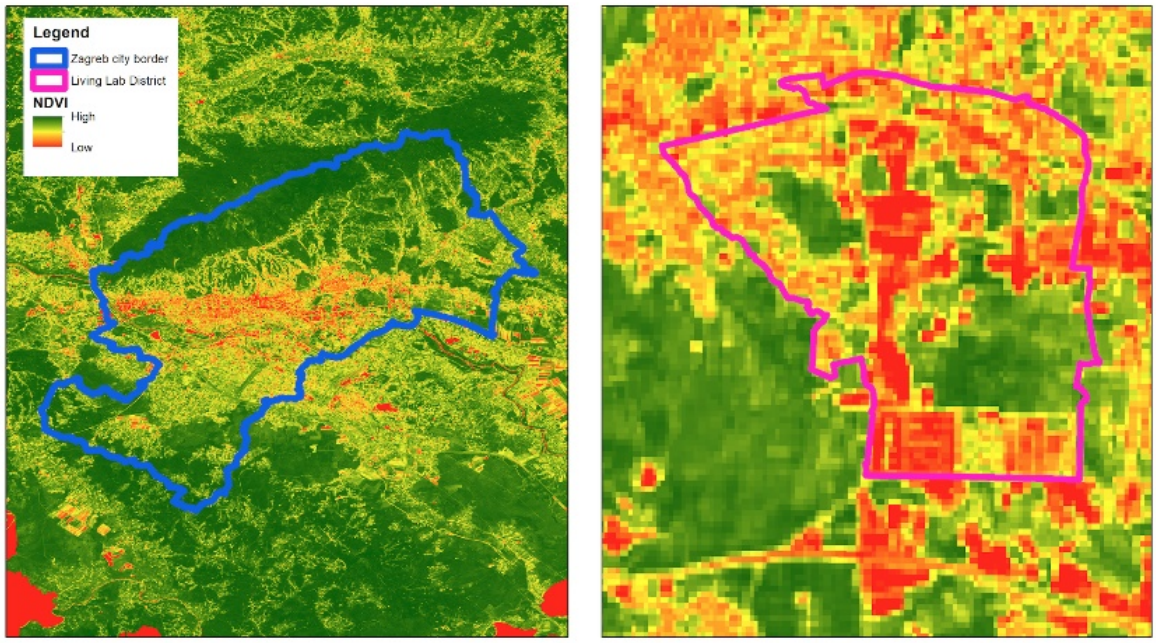

Figure 83. NDVI calculated at the city and at the Living Lab district level for Zagreb FRC.

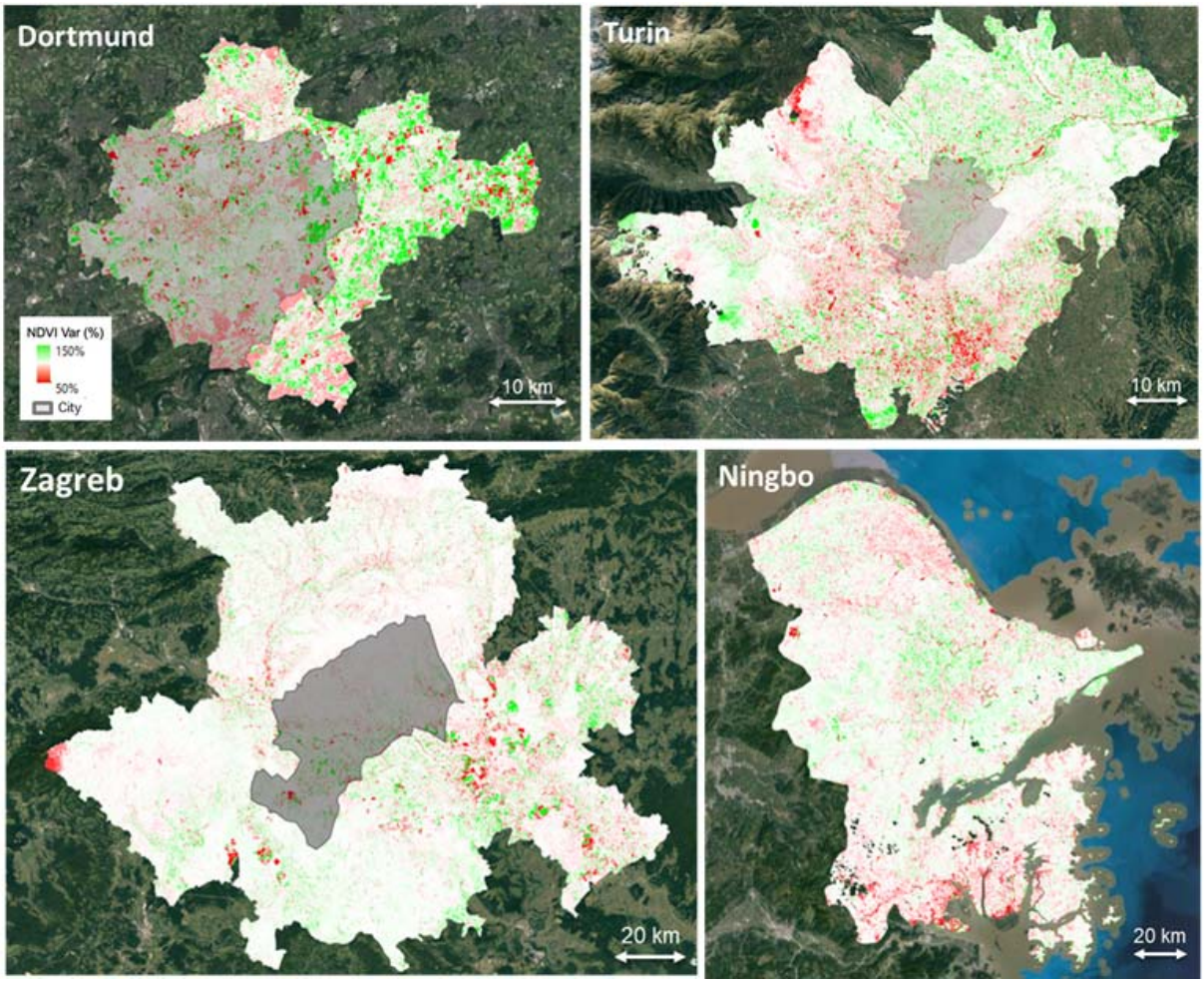

Figure 84. Visual comparison among NDVI index calculated per FRC in 2018 and 2019. Green areas represent an increase in NDVI, while in red areas NDVI decreased.

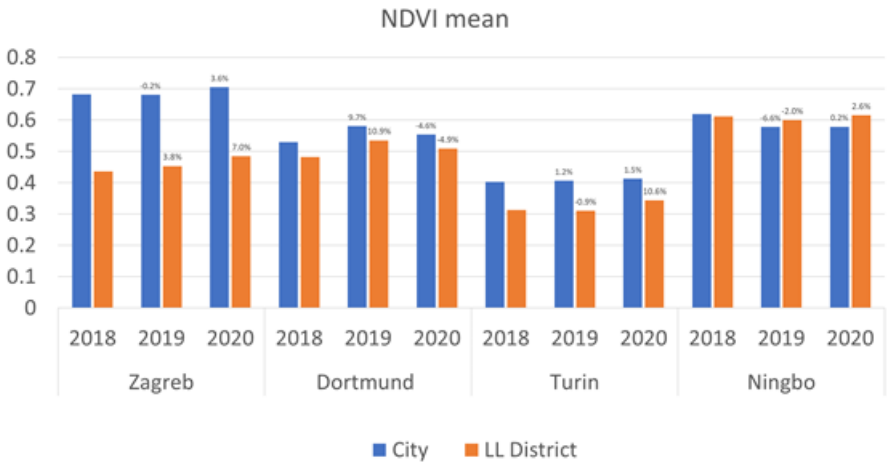

Figure 85. Mean NDVI in the city area and in the Living Lab District and year-to-year variation expressed in percentage.

6.2. Experimental data: the "*General Questionnaire*"

A survey called the "*General Questionnaire*" (GQ) is conducted at the LL district level, where residents are likely to benefit from the NBS implemented by proGIreg, to collect data to assess social, health, and economic indicators. The indicators that are obtained by the GQ are listed in Table 8, with their description and the corresponding proGIreg assessment domain and EC Taskforce Handbook societal challenge area.

Table 8. Key performance indicators assessed at the LL district level from the *General Questionnaire*, with corresponding assessment domain, societal challenge area and the indication if it is a "Recommended" (R) or an "Addition" (A) one, based on the guidelines reported in the EC Taskforce Handbook[3]

Indicator Name	Description	Assessment domain in proGIreg	Societal Challenge Area	R/A
16.3 / 22.11 Mindfulness	Ability of being conscious or aware of something within the environment	Socio-cultural inclusiveness (Task 4.1)	8. Knowledge and Social Capacity Building 11. Health and Wellbeing	A
20.2 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)	Socio-cultural inclusiveness (Task 4.1)	10. Social Justice and Social Cohesion	A
20.4.2 / 22.14 Perceived social support	Perception of various ways in which individuals aid others	Socio-cultural inclusiveness (Task 4.1)	10. Social Justice and Social Cohesion 11. Health and Wellbeing	A
20.5 Perceived social cohesion	Social cohesion indicates the set of behaviours and bonds of affinity and solidarity between individuals or groups	Socio-cultural inclusiveness (Task 4.1)	10. Social Justice and Social Cohesion	A
22.13 Perceived restorativeness of public green space/NBS	Perception of restoration coming from an NBS	Socio-cultural inclusiveness (Task 4.1)	11. Health and Wellbeing	A
22.15 Connectedness to nature	Sense of connectedness and oneness to nature	Socio-cultural inclusiveness (Task 4.1)	11. Health and Wellbeing	A
8.31.1 Number of and reasons for visits to an NBS area	Visits means discretionary time, ranging from a few minutes out of the home to an all-day trip; visits may include time spent close to home or further afield, potentially while on holiday	Human health and wellbeing (Task 4.2)	4. Green Space Management	A

8.31.4 Frequency of use of green and blue spaces	Self-reported time spent in green and blue spaces in hours per week, separately during summer and winter	Human health and wellbeing (Task 4.2)	4. Green Space Management	A
8.32 Visual access to green space	Self-reported amount of green space in the view from windows at home and the frequency of looking at the view	Human health and wellbeing (Task 4.2)	4. Green Space Management	A
8.33 Satisfaction with green and blue spaces	Self-reported satisfaction with the green and blue spaces in the neighbourhood	Human health and wellbeing (Task 4.2)	4. Green Space Management	A
21.2 Perceived stress	Perceived stress on a scale from 0 (low stress) to 4 (high stress)	Human health and wellbeing (Task 4.2)	11. Health and Wellbeing	R
21.2 Perceived stress	Perceived stress on a scale from 0 (low stress) to 4 (high stress)	Human health and wellbeing (Task 4.2)	11. Health and Wellbeing	R
22.1 Self-reported physical activity	Physical activity levels, calculated as the metabolic equivalent of task (MET) minutes per week	Human health and wellbeing (Task 4.2)	11. Health and Wellbeing	A
22.4 Incidence of obesity	Obesity is defined as a measure of Body Mass Index (BMI) - a ratio of weight to height that is calculated by the following formula: BMI = weight (kg) ÷ height (m)²	Human health and wellbeing (Task 4.2)	11. Health and Wellbeing	A
22.10 Somatisation	Somatisation (scale 0 to 3) and category (low, moderately high, very high)	Human health and wellbeing (Task 4.2)	11. Health and Wellbeing	A
22.18 Self-reported anxiety	Self-reported anxiety score on a scale from 0 to 3 and by category (mild, moderate, or severe anxiety)	Human health and wellbeing (Task 4.2)	11. Health and Wellbeing	A
22.21 Prevalence of autoimmune diseases (asthma/allergies)	Number of participants with asthma or allergy attacks/episode	Human health and wellbeing (Task 4.2)	11. Health and Wellbeing	A
Self-reported depression	Number of participants reporting depression	Human health and wellbeing (Task 4.2)		
Perceived improvement in neighbourhoods	Number of participants perceiving an improvement in the Living Lab neighbourhood	Human health and wellbeing (Task 4.2)		
23.2.1 Change in mean house	This KPI will assess the Rental and market prices for homes and retail/commercial spaces through questionnaires and municipality data	Economy and labour market benefits	12. New Economic	R

prices/ rental markets	collection and the influence of the GI or NBS on it	(Task 4.4)	Opportunities and Green Jobs	
24.18 Number of new jobs in green sector	Total number or per cent increase in the (new) jobs related to environmental service activities that contribute substantially to preserving or restoring environmental quality	Economy and labour market benefits (Task 4.4)	12. New Economic Opportunities and Green Jobs	A
24.28 Population mobility	The % of people whose last move was in the past 1 year, 2 years and 5 years.	Economy and labour market benefits (Task 4.4)	12. New Economic Opportunities and Green Jobs	A

The GQ follows a pre/post-implementation data collection. Pre-implementation data have been collected in 2019, as much as possible, before the starting of the proGIreg NBS implementations. Post-implementation data will be collected in 2022, with a 36-months temporal delay. To disentangle the change attributable to the newly implemented NBS from the general temporal trend in the city, an identical survey is conducted in a control district. The control district, selected by the cities, is very similar to the LL district in terms of socioeconomic and demographic characteristics but will not have any NBS (or minimal NBS) planned to be conducted during the proGIreg project.

To ensure scientific validity, the GQ is compiled of validated questionnaires/scales when available. A validated questionnaire refers to a questionnaire or scale that has been developed and administered to a representative study population. The validation process confirms that: a) the measuring instrument covers the full range of the issues being measured; b) the measuring instruments appears understandable and doable on its surface; c) the measuring instruments predicts behaviour or ability in a given area; and, most importantly, d) it measures the theoretical construct that it is designed to measure. Also, a validated measure assures a good reliability (i.e. it is consistent), reproducibility, and comparability between studies. Furthermore, validated instruments may properly validate translations that can be applied in different countries. In case no validated questionnaire was available, we applied example questionnaires that have been successfully used in previous projects. The GQ has been reviewed and rendered suitable to FRC requirements (e.g., ethical/legal and non-intrusiveness).

The GQ is administered by the FRCs, who can involve the NGOs and other stakeholders in this task. The questionnaire is administered through face-to-face interviews of about 30-35 minutes. Two different questionnaires have been developed for the pre-implementation and the post-implementation analysis. WP4 partners have trained the interviewers for this task and provide detailed guidebooks for the interviewers, as well as informed consent forms and questionnaire sheets. The data are collected using the “EU-Survey” tool on a tablet or notebook. “EUSurvey” is a free, online platform for survey provided by the EC, which allows data collection, processing and upload.

The GQ ideal target is composed by 600 participants in each city (300 from the LL and 300 from the control district). The same participants should be contacted for the pre- and the

post-implementation survey. Further details on identification and recruitment of participants and on data anonymization and storage are reported in D4.1[4].

The methodology developed during the preparation of the GQ will be published in a paper named “Development and implementation of a general questionnaire for the proGIreg study: Evaluating health, social, and economic benefits of nature-based interventions in three European cities”. This paper intends to introduce the new measurement tool to assess citizen’s self-reported health, social, and economic benefits.

The pre-implementation GQ data collection

The pre-implementation GQ survey has been conducted in Zagreb between July and September 2019, in Turin between June and August 2019 and between October and December of the same year, and in Dortmund between October and December 2019. The European FRC provided their final reports on the pre-implementation GQ data collection, which have been merged into a single report by partners in UNIBA, with the collaboration of partners from ISGLOBAL and SL (see Annex 3).

In the city of Zagreb, a total of 7652 leaflets were distributed, containing a letter describing the proGIreg project and an invitation to participate to the survey, signed by the Head of Office. Interviewers tried to persuade residents to participate by visiting households and they get 300 questionnaires compiled, per district.

In the city of Turin, 4,000 invitation letters were sent to the residents of Mirafiori Sud and 4,000 to the residents of Barriera di Milano (control district). The city of Turin received responses from around 200 residents that agreed to be interviewed. The other interviews were collected through a “searching activity” held in the field by the interviewers.

In the city of Dortmund, 4,000 invitation letters were sent to the residents of the experimental districts and 4,000 to the residents of the control district on September 25, 2019. The City of Dortmund received responses from 258 residents within the first few weeks after sending the letters. However, out of the 258 responses, 140 appointments were organized for the interviews.

Thus, despite strong efforts made in this task by both the FRC and the research partners, Turin and Dortmund couldn’t achieve the target of 600 questionnaires for the pre-implementation GQ survey, while Zagreb strategy was very successful: the incidence of consent ranged from about 15% to 25%, and the required target of 600 participants was achieved. Table 9 presents the sample size of the pre-implementation questionnaire. Detailed information on recruiting strategies, challenges encountered, participants’ feedback, and city efforts are presented in Annex 3.

Despite the different approaches to recruitment, timings, locations, and sample sizes that have characterized the data collection among the three FRC, this will not affect the results as the same tool (i.e., the *General Questionnaire*) was implemented from all the FRC. However,

a power analysis will be conducted after the post-implementation evaluation data collection to evaluate if the sample size is sufficient to get statistically robust results. In case the sample size is too small, its yield will be maximized using appropriate statistical methods.

Table 9. Sample size of the pre-implementation *General Questionnaire* data collection.

	DORTMUND				**TURIN**				**ZAGREB**			
	LL		CD		LL		CD		LL		CD	
	N	%	N	%	N	%	N	%	N	%	N	%
GENDER												
Female	26	49%	50	40%	112	53.33%	81	49%	177	59%	185	59%
Male	27	51%	39	60%	98	47.67%	82	51%	125	41%	127	41%
Third gender	n/A		n/A		n/A		n/A		n/A		n/A	
AGE												
<25	3	7.69%	3	3.37%	61	30.81%	38	24.68%	28	9%	18	6.04%
25-35	6	15.38%	5	5.62%	17	8.59%	25	16.23%	63	20%	43	14.43%
36-45	7	17.95%	15	16.85%	17	8.59%	17	11.04%	63	20%	51	17.11%
46-55	8	20.51%	23	25.84%	22	11.11%	20	12.99%	69	22%	85	28.52%
56-65	3	8.33%	23	25.84%	28	14.14%	27	17.53%	61	19%	50	16.78%
>65	12	30.77%	20	22.47%	53	26.77%	27	17.53%	32	10%	51	17.11%
TOTAL	53		89		210		163		302		312	
	142				373				614			

The **main challenges** encountered in administering the interviews were: (a) low response rate, (b) complaining on questions and/or procedure, and (c) lack of trust in the interviewers and interviewing procedure itself. To overcome low response rate, additional sampling methods

were used, such as contacting twice by letter, approaching individuals in public spaces such as markets, community centres or sports clubs. Advertising door-to-door and snowball sampling was also used. For those uncomfortable questions on personal information and to overcome lack of trust, the purpose of the project was clarified. In the case of continuing to refuse answering, the question was skipped. In general, cooperation with local NGOs and associations greatly increased the likelihood of positive feedback by the respondents.

Overall, the quality of the interview was rated as positive or neutral. From 65% to 75% of participants rated the interview as “very good”, and 22% to 28% as "good" (Figure 11) In the city of Zagreb participants reported to be the most satisfied with the course of the interview (65% rated it as “easy” and 30% as “neither easy nor difficult”) (Figure 11). Among the interviewers, in Dortmund and Zagreb, 3-5% of them rated the interview as "moderate", while the same rating was provided by 15% of Turin’s interviewers. Lastly, a negligible percentage (1%) rated the interview as "poor" in Dortmund and Zagreb, compared to 4% of Turin’s interviewers (Figure 86).

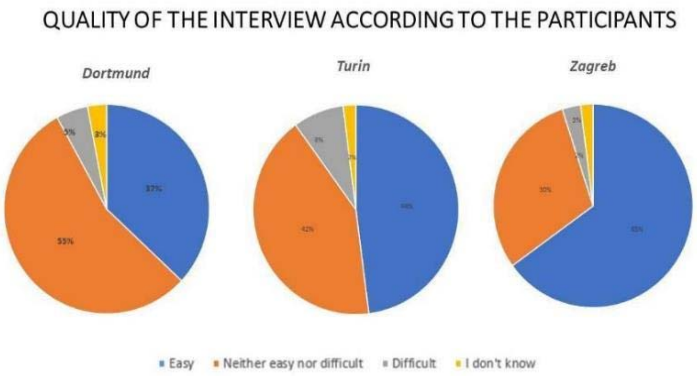

Figure 86. Distribution on response regarding the perceived quality of the interview according to the participants.

The pre-implementation GQ data analysis

Data analysis of the pre-implementation GQ data has been performed by involved partners UNIBA, ISGlobal and SL. The analysis of the pre-implementation GQ provided the statistical description of the samples, both for the LL and for the control district, in the three European FRC. This further provides information on the similarity of the two investigated districts. Descriptive and evaluation results will be made available after the post-implementation GQ data collection.

Indicators related to social aspects that have been assessed are: (1) connectedness to nature; (2) perceived social support; (3) perceived social cohesion; (4) perceived social interaction, and (5) mindfulness. The remaining indicator, i.e., perceived restorativeness will be assessed only in the follow-up (using the post-GQ). This preliminary phase is to be used as baseline data with respect to the post-implementation survey, but also to explore the similarity of the two investigated districts, as indicated by the analogous results obtained.

Preliminary analysis performed for the selected social sections of the general questionnaire, i.e., Section 3, 6, and 8 are displayed in Figure 87, 88, and 89, respectively.

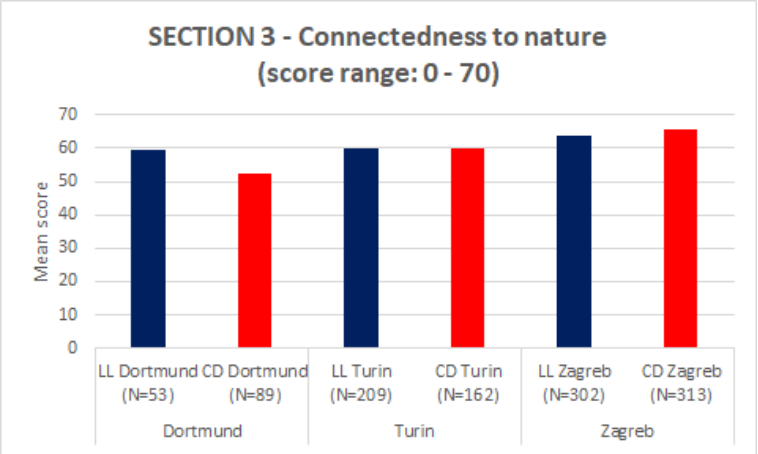

Figure 87. Mean scores of the "Connectedness to nature" scale in respondents by control district (CD) and living lab (LL) in each FRC.

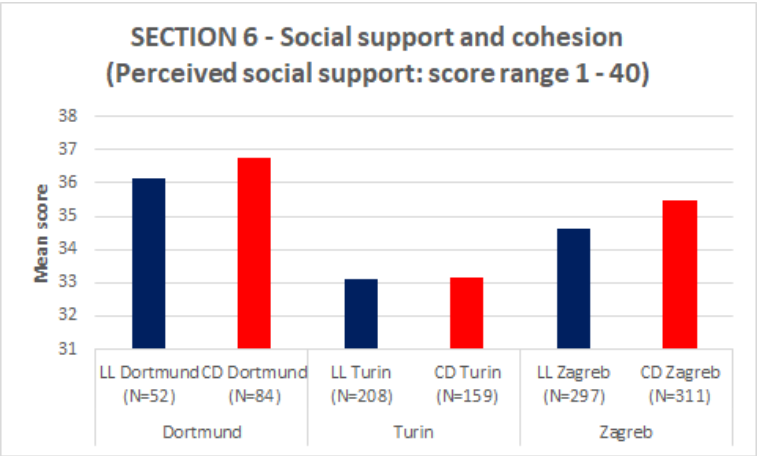

Figure 88. Mean scores of the "Perceived social support" scale in respondents by control district (CD) and living lab (LL) in each FRC.

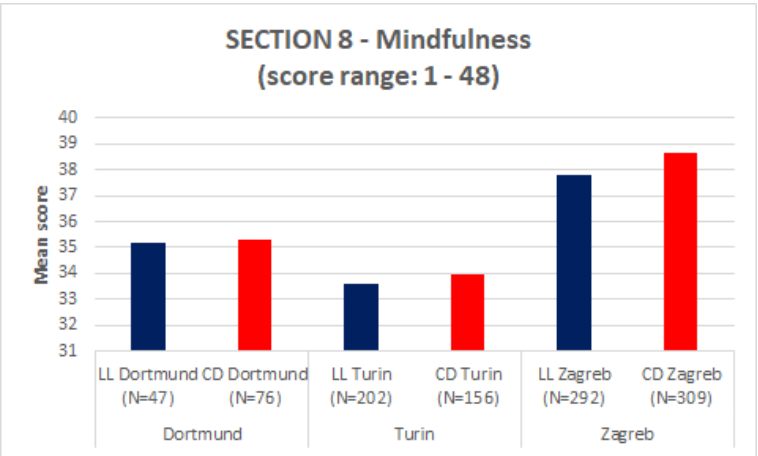

Figure 89. Mean scores of the "Mindfulness" scale in respondents by control district (CD) and living lab (LL) in each FRC.

Indicators related to health and wellbeing that have been measured are:

- Section 2-Visits and satisfaction with green and blue spaces: (1) time spent (2) satisfaction
- Section 4-General Health: (3) self-rated general health, (4) somatization, (5) obesity, (6) respiratory symptoms;
- Section 5-Mental Health and Wellbeing: (7) perceived stress, (8) anxiety, (9) depression;
- Section 7-Physical Activity: (10) physical activity levels.

This preliminary phase is to be used as baseline data with respect to the post-implementation survey, but also to explore demonstrate the similarity of the two investigated districts, as indicated by the analogous results obtained. Preliminary analysis performed for sections 2,4,5 and 7 are displayed in Figure 90 to 99.

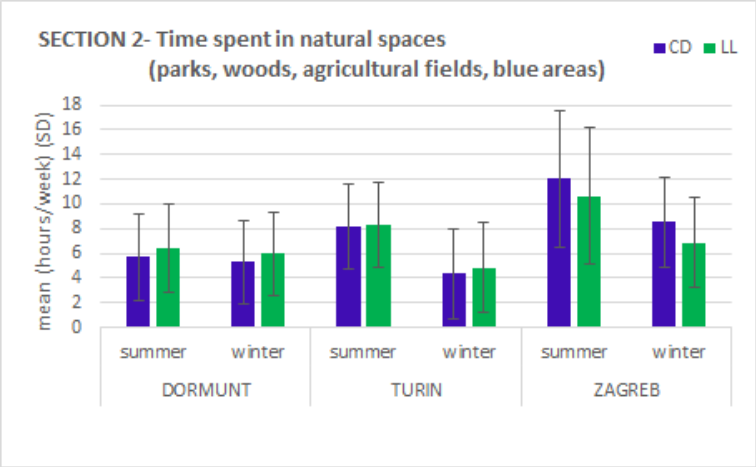

Figure 90. Mean time per week (hours) spent by respondents in natural spaces by season at the control district (CD) and living lab (LL) in each FRC.

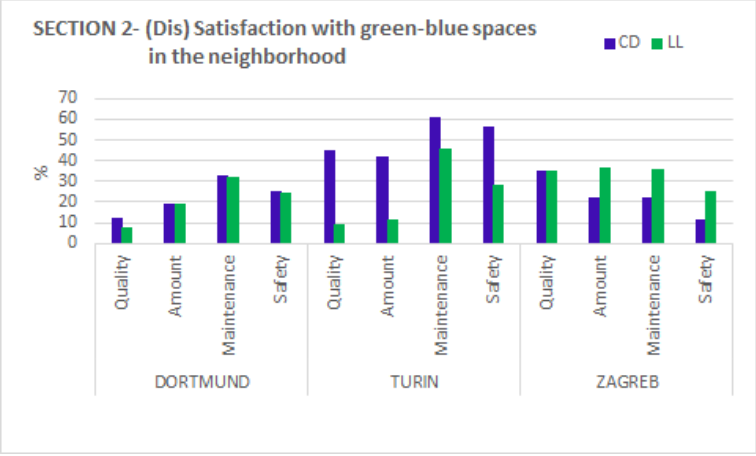

Figure 91. Proportion of respondents Very dissatisfied/Dissatisfied with green-blue spaces by control district (CD) and living lab (LL) in each FRC.

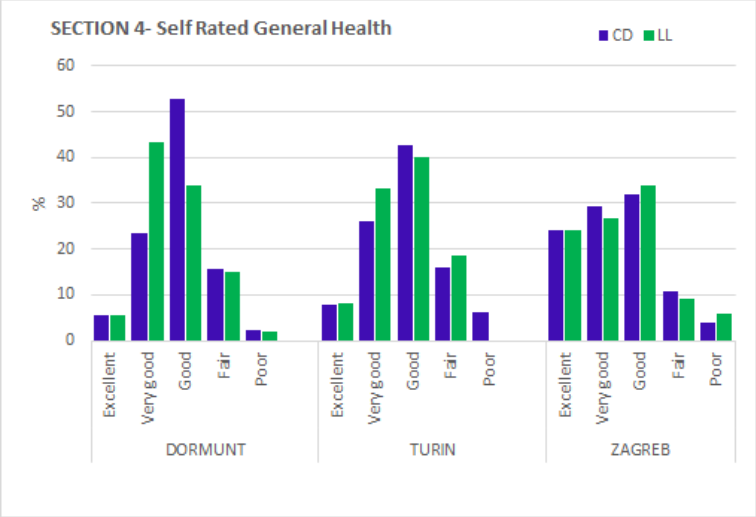

Figure 92. Proportion of respondents reporting levels of self-rated health by control district (CD) and living lab (LL) in each FRC.

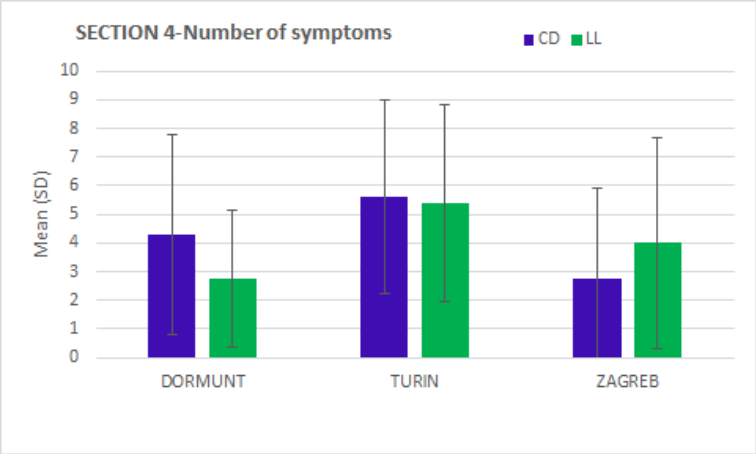

Figure 93. Median number of reported symptoms by control district (CD) and living lab (LL) in each FRC.

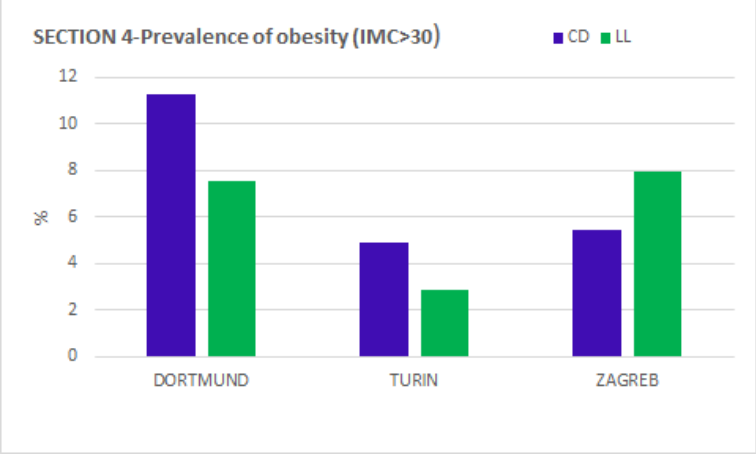

Figure 94. Prevalence of obesity by control district (CD) and living lab (LL) in each FRC.

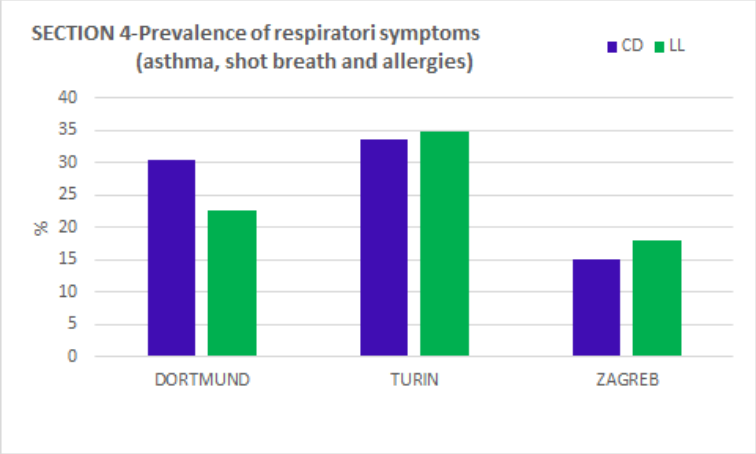

Figure 95. Prevalence of respiratory symptoms by control district (CD) and living lab (LL) in each FRC.

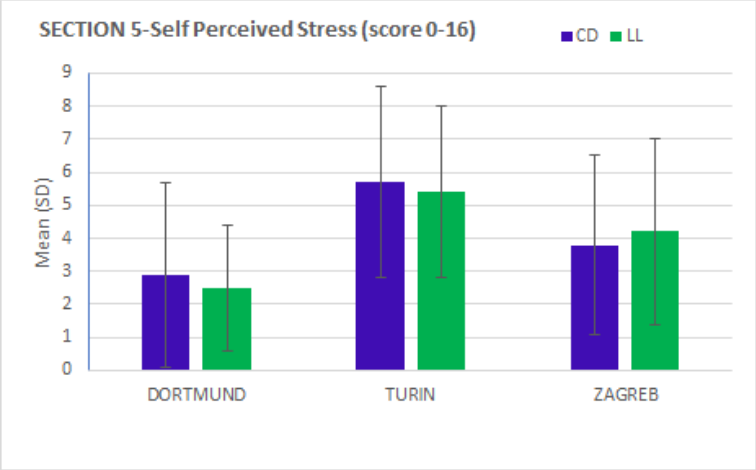

Figure 96. Perceived stress in respondents by control district (CD) and living lab (LL) in each FRC.

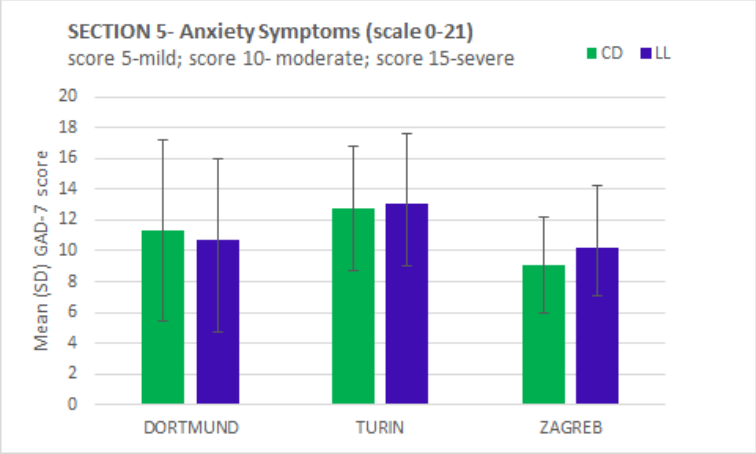

Figure 97. Generalized Anxiety Disorder-GDA score in respondents by control district (CD) and living lab (LL) in each FRC.

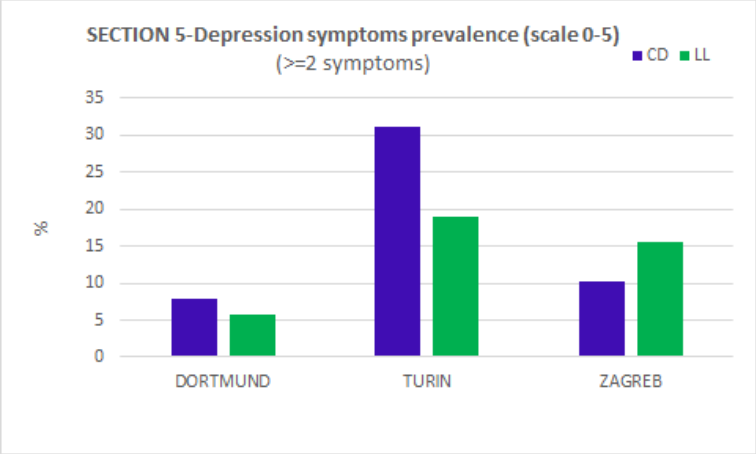

Figure 98. Prevalence of depression symptoms in respondents by control district (CD) and living lab (LL) in each FRC.

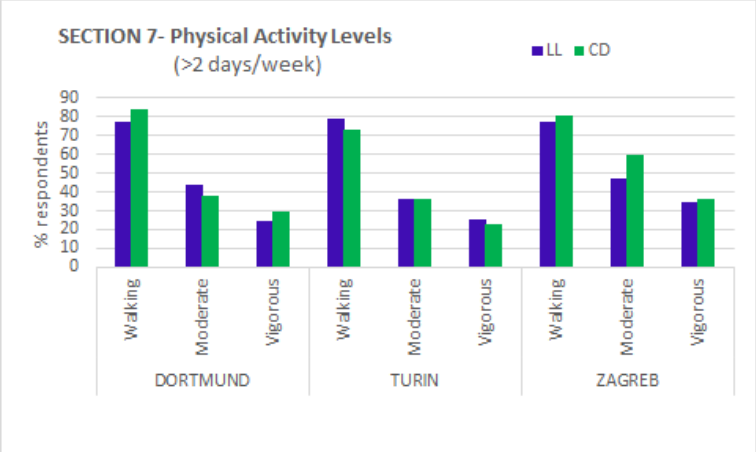

Figure 99. Proportion of respondents performing more than 2 days/week of physical activity levels by control district (CD) and living lab (LL) in each FRC.

The economic and labour sections of the *General Questionnaire* aim to quantify the benefits that can be attributed to the project in the intervention areas, such as the specific phenomena of gentrification and the creation of green jobs.

Indicators related to the economic and labour market that have been measured are:

- Employed population (workforce);
- Green Jobs;
- Properties Value (gentrification).

As an example, Figure 100 presents the statistical results of the green/environmental jobs before the NBS implementation for the living lab (LL) and the control district (CD) of the three European cities.

Post-implementation analysis will allow us to compare the different indicators and therefore analyse the impact of the NBS implemented.

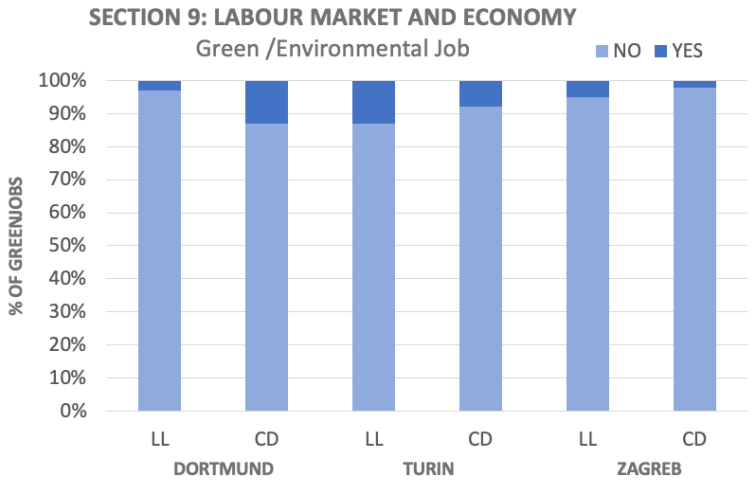

Figure 100. Green Jobs in responses by control district (CD) and Living Lab (LL) in each FRC.

7. Conclusions

ProGIreg is a 5-years project dedicated to the implementation of NBS in post-industrial sites. Assessment of the benefits produced by the implemented NBS is one of the core actions of the project. The project started in June 2018, and the first releases of the Monitoring and Assessment Plan and of the Protocol of Measurements (D4.1 and D4.3, respectively) were published in March 2019, mainly based on the description of the NBS to be implemented as reported in the GA. Immediately after, the data collection started (June 2019).

During the first 15 months, data collection proceeded simultaneously to the definition of the NBS Implementation Plan (D3.2), whose first release was published in September 2020. Due to the combination of co-design processes, administrative barriers, and natural hazards, the implemented NBS partially differ in timing, site, size, or even structure, from those described in the GA. Thus, time to time, the Protocol of Measurements was adapted, thanks to the close contacts among research partners and FRC: it was planned as a “living” document, with a high degree of flexibility, and thus displayed a high resilience. For instance, among the 56 monitoring activities planned at the NBS-level in D4.3, 9 have been deleted and 2 are under evaluation, while 2 new activities have been introduced. Thus, at least 49 activities are conducted at the NBS level, which represent the 87% of those planned in 2019.

Moreover, the Monitoring and Assessment Plan (D4.3) recently needed to be reviewed: upon the publication in May 2021 of the Handbook of the NBS Impact Assessment Taskforce, all the H2020 NBS projects had to review the list of KPIs to be assessed, to comply with those indicated by the European NBS framework. However, proGIreg data collection was already running since two years, and barely any changes could be introduced in the applied monitoring tools: the NBS were almost completed and it was impossible to repeat the pre-implementation data collection. However, due to the expertise of the research partners involved, most of the already selected tools (and corresponding collected data) were suitable: most of the indicators in D4.1 overlap or are very similar to those in the Handbook. For instance, only 1 among the 37 indicators assessed in proGIreg at the NBS level is not included in those described in the Handbook, and 10 over 37 (27%) are among the “Recommended” ones.

Whitin this framework, data collection over 21 NBS and 4 LL is in progress. Data collection for setting the baseline (pre-implementation data collection) started in June 2019 and lasted until September 2021. In few NBS case studies, also post-implementation data have been collected in this period. All these data are reported in the present document D4.5, which is an intermediate step towards NBS benefit assessment. The full benefit assessment will be presented and discussed only in D4.8, at the end of the project, when the complete set of the post-implementation data will be available. Up to date, the project end is set at May 2023, but this would imply that data collection should end within November 2022, meaning, in some NBS case studies, to not respect the 24-months delay required by the GA for the post-implementation data collection. To strengthen the benefit assessment results, a six-months project extension will be required, moving the project end to November 2023 (and the end of data collection to May 2023). The consortium will request this extension in an upcoming amendment proposal for the GA.

Annexes

Annex 1: The Economic and Labour Market Questionnaire

Economic and Labour Market Questionnaire

This task aims to quantify the **economic and labour market benefits and co-benefits of the proGIreg project in the FRC where NBS are implemented.**

It will aim to complete data on **all indicators** needed to assess the **direct and indirect economic and labour effects on the NBS implemented**

SECTION 1:

1. Which is the NBS (Nature Based Solution) to be analysed?	NBS1 - Leisure activities and clean energy on former landfills NBS2 – New regenerated soil NBS3 – Community-based urban farms and gardens NBS4 – Aquaponics NBS5 – Green walls and roofs NBS6 - Accessible green corridors NBS7 - Local environmental compensation processes NBS8 - Pollinator biodiversity
2. In which proGIreg city has this Nature Based Solution been implemented	Dortmund Ningbo Turin Zagreb

SECTION 2:

3. Interviewer's name	
4. Interviewer's affiliation	
5. Which category does your affiliation belong to?	Public authority (municipality, etc.) Private entity (company, etc.) NGO Research institute / Higher education Other:
6. What is the position and role in your affiliation? And how long have you worked on this position / on this topic, in years? (open field text)	
7. In which phases of the NBS have you been involved: Planning phase (before physical implementation) Implementation phase Operating/Maintenance phase (after physical implementation) What has been your role in the ones involved? (open field text)	

SECTION 3:

8. Please briefly describe the NBS (type, dimension, technology, location, stakeholders involved….). Please also provide pictures, if applicable. (open text field)
9. What are the reasons of the implementation of this Nature Base Solution in your local context? (open field)

SECTION 4:

On NBS implementation:

10. What was the number of FTEs (full time equivalents) and the labour cost of the planning and implementation of the NBS? (€) *(Provide list)*

OCCUPATION	NUMBER OF FTEs	PHASE	TIME		LABOUR COST
		Planning and/or implementation	Duration of the contract	Time (mm/yy) of the contract	€€€
EXAMPLE: Construction worker	0.5	Implementation	3 months	07/2020 – 10/2020	€€€€
…					

11. What was the total cost of the planning and implementation of the NBS discounting the labour costs mentioned above? (EUR)

*** *Examples costs: (Costs of permissions/licenses, construction material, equipment, land access, machinery rental, usage fees, taxes, etc.)*

COSTS DESCRIPTION	PHASE	COSTS
	Planning / Implementation	€€€
EXAMPLE: Permissions/Licenses (specify type)	Planning	€€€€
…		

12. How many jobs did this NBS create in the implementation/construction phase? (number) *(Provide lists)*

Occupation	Number of employees	Type of contract
		(Temporal, permanent, seasonal)
…		

On Long-term maintenance:

Costs:

13. What is the number of FTEs (full time equivalents) and the labour cost of the long-term maintenance of the NBS?

(provide list)

OCCUPATION	NUMBER OF FTE's	LABOUR COSTS
...		

14. What is the cost of maintaining the NBS discounting the labour costs mentioned above? (EUR)

(provide list) – Feel free to adapt or change the organisation of the table

Cost description	Category - Cost for maintenance/repair - Cost for insurances - Costs for public relations/advertisement - Cost for physical resources…	Fixed or Variable cost	€€€
...			

Benefits:

15. How many jobs did this NBS create in the post-implementation phase (long-term)? (number)

(provide list)

Occupation	Number of employees
...	

16. How much energy is produced by the NBS with photovoltaic systems? What is the energy used and energy sold to the grid? (kWh)

17. What are the financial revenues per business year you created with the NBS?
(provide list)

Revenue description	Business year	€€€
…		

18. How many and which companies are benefiting from this NBS? (open text)

19. How many individuals are benefiting from this NBS?
(please estimate the number)

20. What added value does this NBS offer to the citizens? (open text)

21. Type of consumptions before and after in the area this NBS? *(optional)*
(share of local renewable energy in the district %)

If you want to add any further information, please feel free: (open text field)

End time of the interview ___ : ___ (hh:mm local time)

Annex 2: The Indoor Green Wall Questionnaire for Children

Pre-implementation questionnaire

SECTION 1: ABOUT YOU

Participant code (Teacher, please fill in)	_____
1. How old are you?	_____ years old
2. Are you male or female?	❑ *Male* ❑ *Female*
3. What is your class?	_____

SECTION 2: ENVIRONMENTAL ATTITUDES

4. Please, answer these questions. If you don't understand something, ask for teacher's help!

		1 False	**2** I don't know	**3** True
a.	If things don't change; we will have a big disaster in the environment soon.	❑	❑	❑
b.	People will someday know enough about how nature works to be able to control it.	❑	❑	❑
c.	When people mess with nature it has bad results.	❑	❑	❑
d.	People are clever enough to keep from ruining the earth.	❑	❑	❑
e.	People are treating nature badly.	❑	❑	❑
f.	I would be willing to go to a school which has a focus on nature.	❑	❑	❑
g.	I believe that artificial light in classrooms should be generated by solar panels.	❑	❑	❑
h.	I would be willing to grow food in the school garden.	❑	❑	❑
i.	I feel more connected with nature when classes are held in outdoor spaces.	❑	❑	❑
j.	It makes me feel better when we have natural day light rather than artificial light all day in classrooms.	❑	❑	❑
k.	People must still obey the laws of nature.	❑	❑	❑
l.	Nature will survive even with our bad habits on earth.	❑	❑	❑
m.	People are supposed to rule over the rest of nature.	❑	❑	❑
n.	Plants and animals have as much right as people to live.	❑	❑	❑

SECTION 3: ENVIRONMENTAL BEHAVIOUR

5. Please, answer these questions. If you don't understand something, ask for teacher's help!

		1 Never	2 Sel-dom	3 Some-times	4 Usu-ally	5 Al-ways
a.	I participate in recycling activities at School.	❑	❑	❑	❑	❑
b.	I look at books about the environment (nature, trees, and animals).	❑	❑	❑	❑	❑
c.	I pick up litter left behind by my friends during recess and lunch breaks.	❑	❑	❑	❑	❑
d.	I don't turn on the classroom lights because there is always enough light in my classroom.	❑	❑	❑	❑	❑
e.	I leave the class window open while the heater is working.	❑	❑	❑	❑	❑
f.	I forget to turn off water after washing my hands in the school toilets.	❑	❑	❑	❑	❑
g.	I bring too much food to school and I have to throw away the extra food.	❑	❑	❑	❑	❑
h.	I turn on the air conditioner rather than opening the glass window when it is warm inside.	❑	❑	❑	❑	❑
i.	I forget to turn lights off when I leave a class-room.	❑	❑	❑	❑	❑

Post-implementation questionnaire

SECTION 1: ABOUT YOU

Participant code (Teacher, please fill in)	_____
1. How old are you?	_____ years old
2. Are you male or female?	❑ *Male* ❑ *Female*
3. What is your class?	_____

SECTION 2: ENVIRONMENTAL ATTITUDES

4. Please, answer these questions. If you don't understand something, ask for teacher's help!

		1 False	**2** I don't know	**3** True
a.	If things don't change; we will have a big disaster in the environment soon.	❑	❑	❑
b.	People will someday know enough about how nature works to be able to control it.	❑	❑	❑
c.	When people mess with nature it has bad results.	❑	❑	❑
d.	People are clever enough to keep from ruining the earth.	❑	❑	❑
e.	People are treating nature badly.	❑	❑	❑
f.	I would be willing to go to a school which has a focus on nature.	❑	❑	❑
g.	I believe that artificial light in classrooms should be generated by solar panels.	❑	❑	❑
h.	I would be willing to grow food in the school garden.	❑	❑	❑
i.	I feel more connected with nature when classes are held in outdoor spaces.	❑	❑	❑
j.	It makes me feel better when we have natural day light rather than artificial light all day in classrooms.	❑	❑	❑
k.	People must still obey the laws of nature.	❑	❑	❑
l.	Nature will survive even with our bad habits on earth.	❑	❑	❑
m.	People are supposed to rule over the rest of nature.	❑	❑	❑
n.	Plants and animals have as much right as people to live.	❑	❑	❑

SECTION 3: ENVIRONMENTAL BEHAVIOUR

5. Please, answer these questions. If you don't understand something, ask for teacher's help!

		1 Never	2 Sel-dom	3 Some-times	4 Usu-ally	5 Al-ways
a.	I participate in recycling activities at school or home.	❑	❑	❑	❑	❑
b.	I look at books about the environment (nature, trees, and animals).	❑	❑	❑	❑	❑
c.	I pick up litter left behind by my friends during recess and lunch breaks.	❑	❑	❑	❑	❑
d.	I don't turn on the classroom lights because there is always enough light in my classroom.	❑	❑	❑	❑	❑
e.	I leave the class window open while the heater is working.	❑	❑	❑	❑	❑
f.	I forget to turn off water after washing my hands in the school toilets.	❑	❑	❑	❑	❑
g.	I bring too much food to school and I have to throw away the extra food.	❑	❑	❑	❑	❑
h.	I turn on the air conditioner rather than opening the glass window when it is warm inside.	❑	❑	❑	❑	❑
i.	I forget to turn lights off when I leave a class-room.	❑	❑	❑	❑	❑

SECTION 4: PERCEIVED RESTORATION QUALITY OF THE NBS

In this place I don't think at my worries 	In this place everything is just where it should be 	This place is interesting 	In this place I think about other things, not everyday things 
In this place interesting things happen 	In this place I am free to play, run and move 	In this place I can relax mentally and physically 	This place is big enough to be explored 
In this place I don't think about things I have to do 	This place awakens my curiosity 	In this place nobody tells me what to do or think 	In this place I only think about things I like 
In this place there are lots of things to discover 	In this place I don't get bored 	I like the room where there is the green wall 	

Annex 3: Report on the pre-implementation GQ data collection

1. Introduction

The objective of this report is to detail the process of data collection through the General Questionnaire (GQ) pre-implementation across the three European Front Runner Cities (FRCs) i.e., the city of Dortmund (Germany), the city of Turin (Italy) and the city of Zagreb (Croatia). Data collection in the city of Ningbo (China) through GQ was not planned.

For each involved FRC, the whole procedure including number of collected data, timing, locations, participants' recruitment approached, challenges, and adopted strategies have been detailed. In addition, a section of feedback from participants have been included.

The entire process of data collection was coordinated by the FRCs and supervised by the research units responsible for monitoring and assessment task involved with the GQ, i.e., Task 4.1 – Socio-cultural inclusiveness; Task 4.2 – Increased human health and wellbeing; and Task 4.4 – Economic and labour market benefits.

1.1. City of Dortmund, Department of Urban Renewal

(WP4: Deliverable 4.1, Monitoring and Assessment Plan)

Background

This report documents the preparation and process of conducting the General Questionnaire (GQ) carried out by the City of Dortmund, Department of Urban Renewal.

The GQ is part of the experimental data of WP4 that aims to collect data on social, health, and economic indicators in the Living Lab (LL) at the NBS and district level before and after implementing the Nature Bases Solutions (NBS) to evaluate the change in the quality of life resulting from implementing the different NBSs.

Dortmund LL encompasses 215 ha within the Huckarde district, the post-industrial part of Dortmund, where five NBSs will be implemented and the GQ carried out prior to the implementation. While no NBSs are planned in the control district (Mengede), it is believed that the residents of the Mengede will also benefit from the NBSs and therefore the control district is included in the pre-implementation GQ.

General Overview of Preparation and Processing the GQ

- Translating the survey documents (GQ information sheet, informed consent sheet, contact information sheet, and questionnaire)
- Signing of the translated DPO letter
- Selecting and recruiting of interviewers (BSc and MSc students)
- Selecting the address (2000 addresses LL, 2000 control district)
- Posting the GQ survey announcement online (City of Dortmund homepage, Huckarde district newsletter)
- Sending the GQ invitation letter and the data protection notice (2000 LL, 2000 Control district)
- Training the interviewers
- Printing the interview documents (300 LL, 300 control district)
- Performing the field survey

Timeframe

October 7 until December 31, 2019.

Location, Sample Size, and Responses

There were 4,000 invitation letters sent to the residents of Huckarde and 4,000 to the residents of Mengede on September 25, 2019. The city of Dortmund received responses from 258 residents within the first few weeks after sending the letters. However, out of the 258 responses, 140 appointments were organized for the interviews. The persons who responded but did not participate in the survey either cancelled their interview appointments or cut the interview in the middle and did not want their personal information to be recorded or processed. Furthermore, a few residents sent written complaints to the Mayor's office that they were not interested in participating in the survey and informed the City of Dortmund not to use their contact information for the survey of the post-implementation GQ or for any survey purposes.

Info letter: 4,000

Huckarde: 2,000

Mengede: 2,000

Responses :258

Huckarde: 97

Mengede: 161

Interviews: 140

Huckarde: 48

Mengede: 92

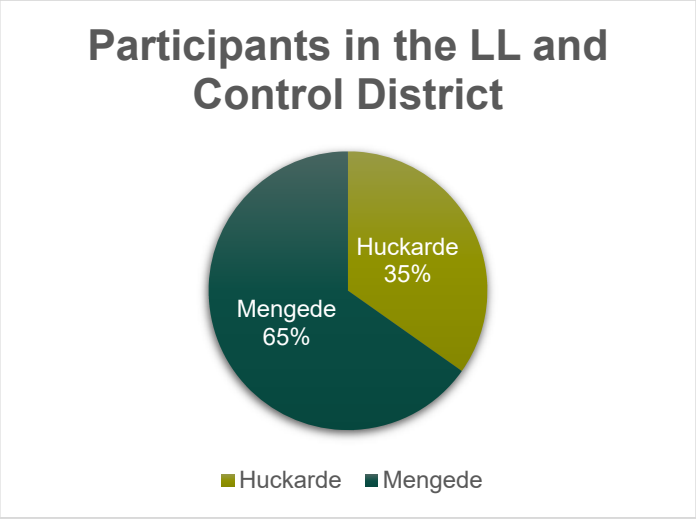

Figure 1: Conducted interviews in the LL and control district in Dortmund

Sampling Methods

- There were 65 residents (40%) who replied to the invitation letter of the GQ, either by email or by phone, and appointments were arranged accordingly.
- There were 36 residents (26%) approached through the door-to-door technique and the ones who were willing to participate were either directly interviewed or proposed an appointment according to their convenience. Many residents were not interested in participating and asked not to be approached again.
- There were 56 residents (34%) approached at public events and buildings, such as:
    1. Weekend markets- most positive responses were received at the market place
    2. Secondary schools
    3. Sport clubs
    4. Social clubs

A flyer of proGIreg was given to those who were interested, and the students informed them to contact the coordinator of the project either by email or phone if interested.

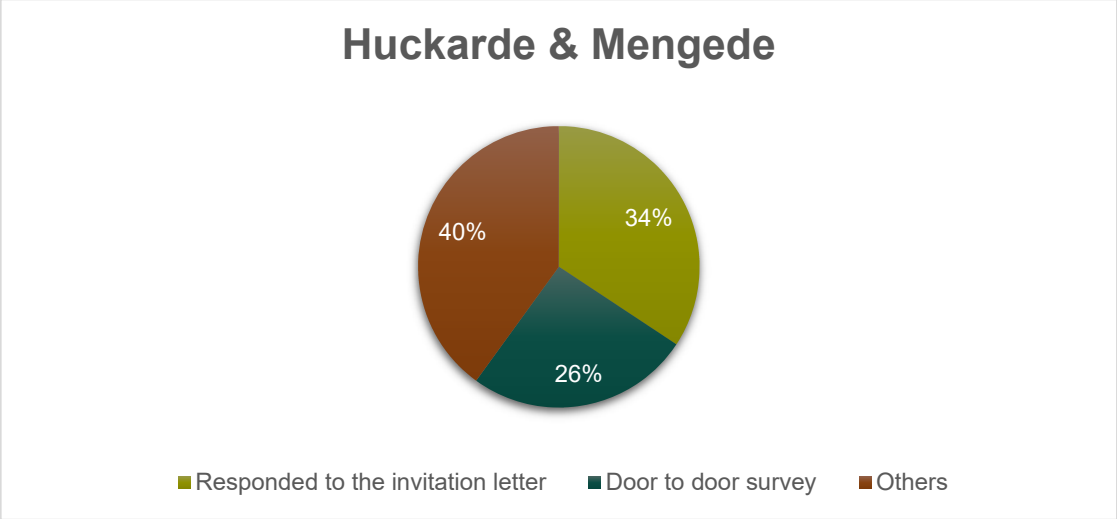

Figure 2: Conducted interviews in the LL and control district in Dortmund

Course of the Interview

Six students were recruited for the data collection, five for conducting the interviews, and one for transferring the data to the EU-Survey platform. A list of the interviewees and their contact information (paper copy) were given to the students. Identification cards were also issued to the students to be presented to the residents before starting the interview.

Interview documents included:

- GQ information sheet
- Informed consent sheet
- Contact information sheet
- Two copies of the GQ, one to be handed to the participant and a copy to remain with the interviewer for reading the questions

On the contact information sheet, respondent ID-numbers (10000-10300) were given to the residents of the LL and the respondent ID-numbers (10300-10600) to the residents of the control district.

The interview length was between 35 minutes and one hour.
Planned interviews took place on weekdays; mid-mornings and afternoons were preferred.

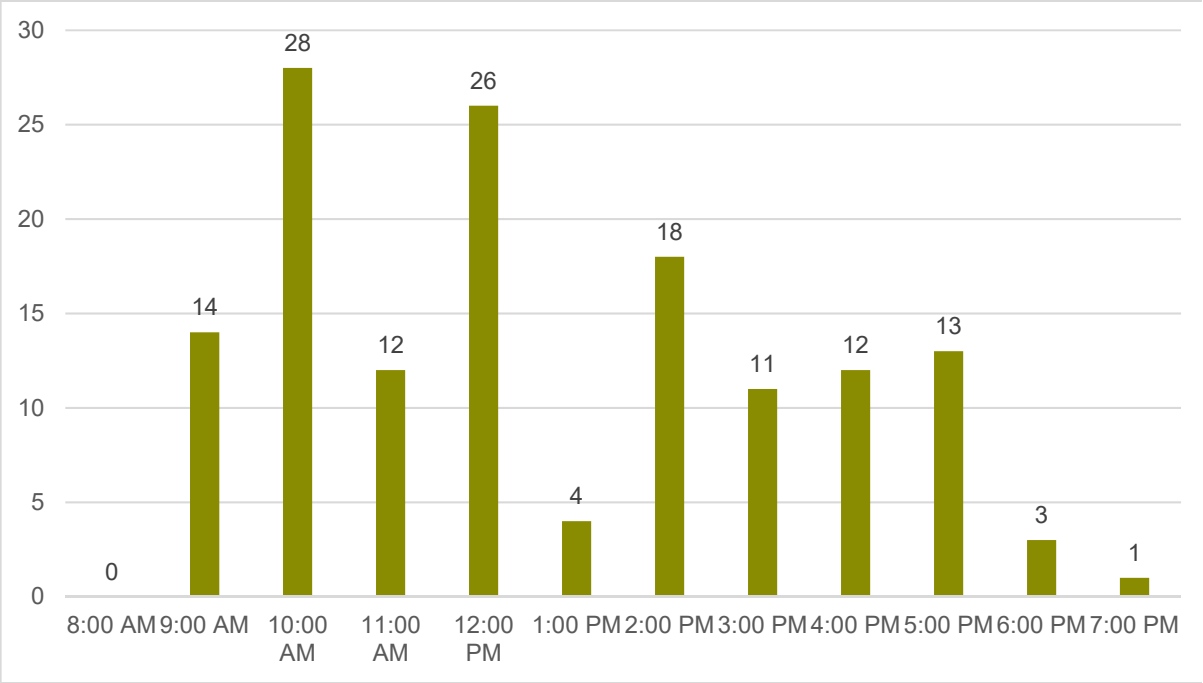

Figure 4: Time of the interviews in Dortmund

Challenges and solutions in conducting the GQ

Unfortunately, it was not possible to reach the required 600 interviews (300 LL + 300 control district) due to many reasons. Following are the main challenges confronted when conducting the GQ and the adopted strategies to increase the response rate:

Challenges	**Solutions**
Low response rate	Other sampling methods were used such as: - approaching people at public events such as weekend markets and festivals - door-to-door technique - in a few cases, interviewing more than one family member of the same household - contacting sport clubs and community centers

	- advertising the survey on the local newsletter of the target district - weekend days were suggested as an option for the interview appointments - Snowball sampling: some respondents recommended contacting other citizens who would be interested in the project, however didn't receive the invitation letter.
Respondents tended to skip certain questions on personal information	The purpose of these questions were explained to them as well as that their information will be treated with high confidentiality and the information they provided in the questionnaire will be separated from their personal data.
Answering method: writing or speaking	For those who preferred the survey not to be administrated orally, the purpose of the survey was explained to them by the interviewers and a copy of the survey documents were given to them to be either picked up to their well or to be sent to the City of Dortmund

Participant Feedback

Many participants showed enthusiasm toward taking part in the GQ. On the other hand, the proGIreg coordination office and the students received other critical feedback about the content of the GQ and the data collection methods. Following is a summary of the comments received:

- Participants showed enthusiasm towards proGIreg and the concept of the Nature Based Solutions and expressed their willingness to participate in the project's planned activities. They also would like to be updated on the progress of the project. This unfortunately was not part of the survey and that led to a sense of disappointment. Given this feedback, WP2 (Co-design) could have potentially benefited from the reflection of the participants of the GQ as a tool for community engagement.
- Most participants complained about the length of the GQ (45 – 60 minutes).
- Many participants indicated that the content of the invitation letter that described the project was not related to the content of the GQ which collected the personal information of the participants.
- Some participants of the control district argued that their district shouldn't be part of the survey as no NBSs were implemented in their area, but rather in Huckarde.
- Some participants were irritated by certain questions, especially the ones related to their mental and physical health status. A few ended the interview because they felt that the questions were very personal.

- Many participants didn't feel comfortable and/or didn't answer the questions about their financial situation (salary, rent of the house, etc.)
- Having the possibility of answering the GQ online would have increased the number of participants as many participants asked if it was possible to digitally take part in the survey according to their time of convenience, in many cases at night or at the weekend.
- In line with that, participants asked if it was possible for the students to leave them a copy of the questionnaire, and they would fill it out and send it back to the City of Dortmund at a later time.
- Some participants preferred to read and fill out the questionnaire by themselves, and it was not necessary for the students to read the questions to them. They said that they would let them know if they had any questions.
- Some participants asked if there was any kind of reward or incentives for their participation in the survey.

1.2. City of Turin, EU funds and Innovation Department WP4: Deliverable 4.1, Monitoring and Assessment Plan

Background

The GQ is part of the experimental data of WP4 that aims to collect data on social, health, and economic indicators in the Living Lab (LL) at the NBS and district level before and after implementing the Nature Based Solutions (NBS) to evaluate the change in the quality of life resulting from implementing the different NBSs.
The GQ (pre – implementation) has been submitted in the LL of Turin, Mirafiori Sud District, a post-industrial and peripheral area in Torino located in southside of the City, where all NBSs will be implemented. The control district (Barriera di Milano) has been chosen because of, supposed, similar characteristics: a peripheral area with an important post-industrial legacy. Anyway, the perception of the interviewers gave us some relevant differences between the two areas in terms of security, green areas, marginalization, poverty, and exclusion. More specifically, in Mirafiori Sud Distict people seemed higher collaborative and socially cohesive, while in Barriera di Milano emerged a larger distrust towards neighbours.

General Overview of Preparation and Processing the GQ

In Turin, this activity was held in two sessions, both managed in the same way. The first one was performed in summertime and the second one in autumn 2019.

- Selecting and recruiting of interviewers (BSc and MSc students)
- Selecting the address (2000 addresses LL, 2000 control district)
- Posting the GQ survey announcement online (Social media)
- Sending the GQ invitation letter (2000 LL, 2000 Control district)
- Training the interviewers
- Printing the interview documents
- Performing the field survey

Timeframe

First session: 18/06/2019 – 10/08/2019

Second session: 25/10/2019 – 23/12/2019

Location, Sample Size, and Responses

By summing the two periods of investigation, there were 4,000 invitation letters sent to the residents of Mirafiori Sud and 4,000 to the residents of Barriera di Milano. The city of Turin received responses from around 200 residents that agreed to be interviewed. The other interviews were collected through a "searching activity" held in the field by the interviewers (see below).

Info letter: 4,000

Mirafiori Sud: 2,000

Barriera di Milano: 2,000

Interviews: 398

Mirafiori Sud: 221

Barriera di Milano: 177

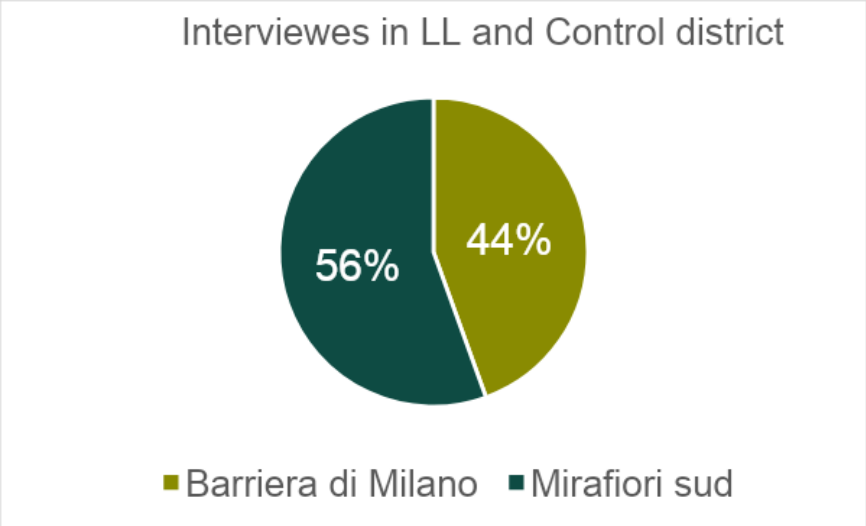

Figure 5: Conducted interviews in the LL and control district in Turin

Sampling Methods

In Turin we used three main methods to collect interviews:

1. By appointment with those who contacted us because of the letter or because of the advertising in social media websites (mainly Facebook)

2. Searching Activity. This activity was mainly conducted in two different ways:
   - Approaching citizens in some public locations previously identified (Public library, civic centre, local markets, etc.).
   - Contacting citizens during some events occurring in the two districts

3. Involving higher schools located in the two boroughs. Thanks to the collaboration of teachers and school headmasters, interviewing sessions were organized in two schools (one located in Mirafiori Sud and the other in Barriera di Milano): this made it possible to reach students over 18 that reside in the interested areas. Anyway, as the participation wasn't compulsory, we had a scarce response from the students.
   When those citizens approached during the searching activity accepted to be interviewed, interviews took place either in that moment or after arranging an appointment.
   A banner about the GQ activity was posted up in some buildings identified as a base location for the interviewers and where to conduct the interviews (called "Case del Quartiere" - Borough houses – public spaces managed by NGOs with the goal to promote social activities for the neighbourhood).
   The local NGOs contacted for the activity advised us against use door to door technique. This is due to the distrust of the residents that are scared of being defrauded and do not easily allow strangers to come into their houses, even though providing proofs of visitors' identity. It is also necessary to point out that, in some very rare cases, a couple of citizens specifically asked to be interviewed in their home or at their workplaces. This was mainly due to familiar restrictions (e.g. a close relative with disabilities or a young child). Citizens that asked for this specific arrangement have been reached both by letters and during the searching activity.
   An additional point of criticism was the low heterogeneity of NGOs and places involved in the searching activity. Even though the participation of local libraries and Borough Houses – and few additional associations – that gave us permission to carry on interviews in their buildings and look for new respondents among their clients and visitors, the possibility of reaching new residents decreased in a short period of time. In fact, these places attract very specific – and in some cases homogenous – people that are not always eligible for the survey (e.g. they work in the district and use some commodities and services provided by local associations but they are not residents). Moreover, addressing citizens in public spaces without a contact person is unsuccessful (the identification card wasn't always an effective mean). Hence, in many cases the intermediation of local NGOs made it easier to overcome initial suspiciousness towards the survey from those citizens that otherwise would have never accepted to be interviewed.

Course of the Interview

16 students were recruited for the data collection, 15 for conducting the interviews, and one for coordinating the students (back-office job). A list of the interviewees and their contact information (paper copy) were given to the students. Identification cards were also issued to the students to be presented to the residents before starting the interview.
Interview documents included:

- GQ information sheet
- Informed consent sheet
- Contact information sheet
- Two copies of the GQ, one to be handed to the participant and a copy to remain with the interviewer for reading the questions

On the contact information sheet, respondent ID-numbers were given to the residents of the LL and the respondent ID-numbers to the residents of the control district.
The interview length was between 35 minutes and one hour.

Challenges and solutions in conducting the GQ

Unfortunately, it was not possible to reach the required 600 interviews (300 LL + 300 control district) due to many reasons. The main challenges faced while conducting the GQ and the relative solutions applied to increase the response rate were:[24]

Challenges	**Solutions**
low response rate	• interviewing more than one family member in the same household • snowball sampling: some respondents recommended contacting other citizens who would be interested in the project, however, they didn't receive the invitation letter (less effective than other methods) • approaching people at public events organized by local NGOs and groups that have cooperated with us as well as events organized outside these structures • sending invitations letters twice (the first time in summer, the second in autumn). This solution actually gave a positive feedback in terms of citizens' engagement and response rate.
respondents tended to skip certain question on personal information	The purpose of these questions was explained to them as well as that their information will be treated with high confidentiality and the information they provided in the questionnaire will be separated from their personal data. However, especially when it came to information about the economic situation, some interviewees skipped the question anyway.
lack of trust in the interviewing system itself and in the interviewers	We relied upon local NGOs and groups that operate at the local level in the neighbourhoods and have already gained citizens' trust. In this way, they have advocated and promoted our initiative.

[24] Some of the following challenges and solutions are taken from the report produced by Dortmund as there are similarities between these two cities.

Participant Feedback

Many participants showed enthusiasm toward taking part in the GQ. On the other hand, the proGIreg coordination office and the students received other critical feedback about the content of the GQ and the data collection methods. Following is a summary of the comments received:

- Participants showed enthusiasm towards proGIreg and the concept of the Nature Based Solutions and expressed their willingness to participate in the project's planned activities. They also would like to be updated on the progress of the project. This unfortunately was not part of the survey and that led to a sense of disappointment. Given this feedback, WP2 (Co-design) could have potentially benefited from the reflection of the participants of the GQ as a tool for community engagement[25].
- A small number of participants interrupted the interview because they refused to give personal information (e.g. personal address, telephone number…) to be contacted in the future for the second part of the survey. This is related to a general scepticism and to a lack of trust in institutions.
- Most participants complained about the length and complexity of the GQ (45 – 60 minutes). Difficulties also regarded those questions that asked for a calculation of time spent doing some specific activities (e.g. time spent outdoor in summer/winter; hours per day spent being seated…). In many cases, this calculation was subjected to huge approximations. Also, questions concerning for example the emotional aspect or the connection with nature section were considered either too private or – in some cases - pointless, increasing a certain scepticism towards the survey. When it comes specifically to the section about each one's personal connection with nature, some interviewees were disoriented and unable to provide a significant answer.
- Many participants indicated that the content of the invitation letter that described the project was not related to the content of the GQ which collected the personal information of the participants. More specifically, many believed that the municipality wanted to ask them about their neighbourhood living conditions in an extensive way (e.g. bad maintenance of green areas or lack of public services). Also, some citizens expected interviewers to collect their complaints and suggestions about - what they perceived as - real problems and possible solutions. In some cases, this detachment between expected and real questions lead to a further disappointment.
- Some participants of the control district argued that their district should not be part of the survey as no NBSs were implemented in their area (Barriera di Milano), but rather in Mirafiori. In many cases, this led to further disappointment, especially because the invitation letter misloaded them.
- Some participants were irritated by certain questions, especially the ones related to their mental and physical health status. A few ended the interview because they felt that the questions were very personal.[23]
- Many participants did not feel comfortable and/or did not answer the questions about their financial situation (salary, rent of the house, etc.).[23]

[25] These comments are taken form Dortmund's summary as it explains perfectly feedbacks emerged in Turin

- Having the possibility of answering the GQ online would have increased the number of participants as many participants asked if it was possible to digitally take part in the survey according to their time of convenience, in many cases at night or at the weekend.[23]
- Some participants preferred to read and fill out the questionnaire by themselves, and it was not necessary for the students to read the questions to them. They said that they would let them know if they had any questions.[23]

1.3. City of Zagreb, City Office of Strategic Planning and IMPROVE
WP4: Deliverable 4.1, Monitoring and Assessment Plan

Background

The City Office for Strategic Planning and Development of the City of Zagreb is the local coordinator of the EU Project ProGIreg which began in June 2018 and is funded under the Horizon 2020 program.
The City of Zagreb implements the project activities at the site of the former Sljeme industrial plant in Sesvete.
This report documents the preparation and process of conducting the General Questionnaire (GQ) carried out by the City of Zagreb, City Office of Strategic Planning and IMPROVE.
The GQ is part of the experimental data of WP4 that aims to collect data on social, health, and economic indicators in the Living Lab (LL) at the NBS and district level before and after implementing the Nature Bases Solutions (NBS) to evaluate the change in the quality of life resulting from implementing the different NBSs.
Within the project, the first phase of surveys was conducted in the area adjacent to the former factory, and simultaneously in the control area (Španska-Jug). The purpose of the research is to determine the increase in quality of life by introducing project activities.

General Overview of Preparation and Processing the GQ

- Translating the survey documents (GQ information sheet, informed consent sheet, contact information sheet, and questionnaire)
- Signing of the translated DPO letter
- Selecting the address
- Sending the GQ invitation letter and the data protection notice
- Performing the field survey

Timeframe

From July 17, 2019. until September 15, 2019.

Location, Sample Size, and Responses

Contact area of the former factory Sljeme Sesvete: n = 302 Control area - Španska-Jug: n = 313

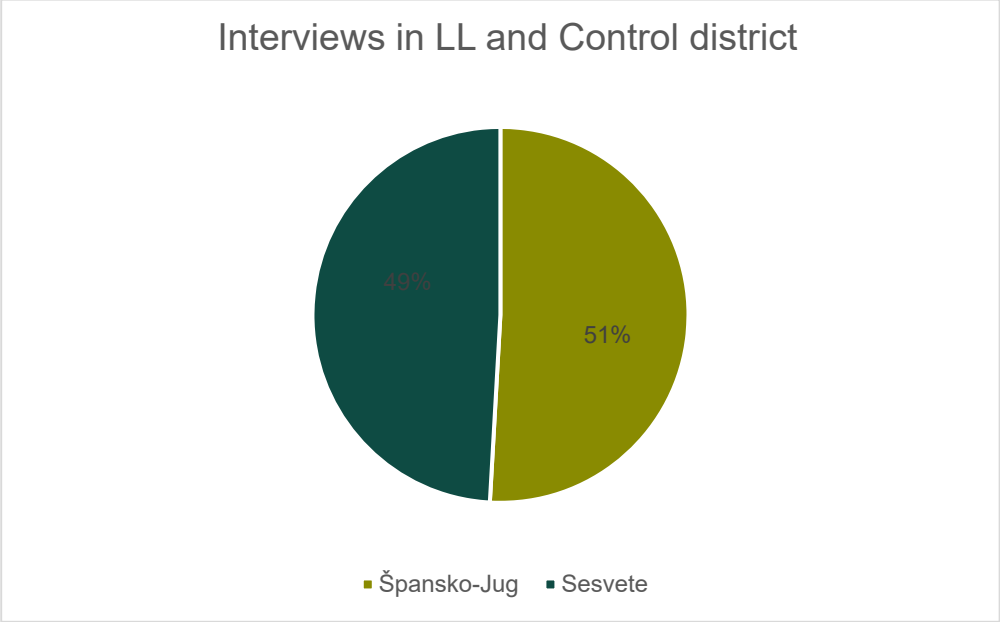

Figure 6: Conducted interviews in the LL and control district in Zagreb

Prior to the start of the survey in Sesvete, the company distributed a total of 7652 leaflets containing a letter describing the proGireg project and an invitation to participate signed by the Head of Office
It was possible to conduct the survey solely by means of interviewers visiting households and trying to persuade the citizens to cooperate. The incidence of consent was highly dependent on the interviewer and his / her approach and experience and ranged from about 15% to 25%.

Course of the Interview

When presenting, the interviewers had all the necessary materials, including the letter and a leaflet about the project.
After the respondents were introduced to the project and the survey method, and if they expressed interest in participating in the survey, the first thing the interviewers obtained was a signature on the consent form confirming the willingness to participate and a completed and signed sheet with the contact details of the respondents. Subsequently, the interviewers surveyed the respondents and guided them through the survey, explaining whatever was necessary.
Whenever possible, interviewers entered the answers directly via tablets into the EUSurvey application, and a portion of the surveys were completed on paper and subsequently entered the EUSurvey application.
After the field survey was completed, a final control of the surveys was made. The surveys entered in EUSurvey were linked with the documents (signed consents and completed contact lists).
Upon completion and after data harmonization, complete documentation (signed consent forms and completed contact information sheets) was submitted to the City of Zagreb.

Challenges and solutions in conducting the GQ

Challenges	Solutions
Lack of capacity of the partner employees to conduct such a demanding survey	In order to fulfill the demands of the project, the City Office of Strategic Planning and Development of the City of Zagreb has reallocated part of the personnel cost funds to outsourcing, i.e. we hired an outside firm that specializes in surveys to conduct the survey using the translated questionnaire, so the task was finished in planned time.
Low response rate	The surveyors have sent out a very large number of letters explaining the basic info on the project, with the emphasis on the social and other benefits that the project implementation is expected to have on the area, to convince them to participate.
Scheduling of the survey during the summer, when a large number of local residents were on holidays away from home	The survey was conducted on numerous occasions, making sure that the required number of participants are involved
Some respondents were reluctant to answer some of the questions they felt were too personal	The interviewers needed to be able to respond in an adequate manner and to explain to the respondents that they need not be afraid of anything, that the answers would not be analyzed individually, etc. In most cases the interviewers were eventually able to get all the answers.

Participant Feedback

It is important to stress that in the recent time, the trend that people are unwilling to participate in the face-to-face surveys and prefer to be questioned online, especially if the surveys take 30 minutes or longer to complete.

Some respondents were reluctant to answer some of the questions and commented that it seems like psychoanalysis session.

2. General considerations

The three European FRCs followed a standardized procedure for recruitment and data collection, in accordance with WP4. Before getting started, WP4 trained the interviewers. WP4 also supported the whole process through informal exchange of information and formal telematic meetings in order to implement strategies to reach the target number of completed questionnaires. Although the three cities reported the same difficulties, the final outcome differed. The city of Dortmund has collected 140 interviews (48 in Huckarde and 92 in Mengede), the city of Turin has collected 398 interviews (221 in Mirafiori Sud and 177 in Barriera di Milano). Only the city of Zagreb managed to reach and even exceeded the determined target number of interviews, previously set at 600 (302 from Sljeme Sesvete and 313 from Španska-Jug).

The timing for data collection varied. In Dortmund, data collection took place in the months of October, November and December 2019; in Turin from June to December 2019 with a suspension of a couple of weeks during October; in Zagreb, the entire summer season was covered, i.e., from July to September 2019. All cities sent a first information letter to the population in order to invite to participate in our research. In Turin, the invitation letters were sent a second time. As expected, the response rate was very variable between cities and was between 15% and 40%.

The information reported by the cities provides useful insights for future planning of questionnaires. Participants from each FRC complained about some aspects of the general questionnaire such as the excessive length and the presence of uncomfortable questions. The content of the invitation letters was deemed too far from the actual content of the questionnaire. Some participants proposed the use of multimedia platforms for receiving and completing the questionnaire online.

Regardless of the final outcome, the entire procedure developed by each city has strengths, briefly summarized below.

- Dortmund→ application of a door-to-door technique to directly approach the target population; organization of public events in the neighborhoods concerned in order to increase the sample size.

- Turin→ second sending of invitation letters following the unsatisfactory response of the population to the first sending; organization of public events in the neighborhoods concerned in order to increase the sample size.

- Zagreb→ hiring specialized personnel to conduct the survey using the translated questionnaire.