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Assessment of Nature-Based Solutions' Efficiency by Focusing on Justice at Urban Context of Turin and Amsterdam

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List of Abbreviation

NBS – Nature-Based Solutions

IUCN – International Union for Conservation of Nature

SDG – Sustainable Development Goal

UN – United Nations

IPCC – Intergovernmental Panel on Climate Change

EC – European Commission

EU – European Union

ProGIreg – Productive Green Infrastructure for post-industrial urban regeneration

SMEs – Small and Midsize Enterprises

FRC – Front-Runner Cities

FC – Follower Cities

TRL – Technology Readiness Levels

FUA – Functional Urban Area

GIS – Geographic Information System

KPI – Key Perfermance Indicator

NDVI – Normalized Difference Vegetation Index

NGO – Non-Governmental Organization

ESS – Ecosystem Service

Eco-DRR – Ecosystem-based Disaster Risk Reduction

BMPs – Best Management Practices

WSUD – Water-Sensitive Urban Design

SuDs – Sustainable Urban Drainage Systems

EE – Ecological Engineering

UGI – Urban Green Infrastructure

CBS – Centraal Bureau voor de Statistiek

CWC – City Water Circels

SWOT – Strengths, Weaknesses, Opportunities, Threats

FBH – Frans Halsbuurt

LL – Living Lab

SMAT – Societa Metropolitana Acque Torino

Abstract

A significant concern voiced by a substantial portion of the global populace pertains to climate change and its associated ramifications. Climate change posed the challenges to cities and citizens, as well as the need for a comprehensive framework that integrates environmental justice and climate resilience.

Nature-based solutions are increasingly seen as a practical approach to addressing the adverse effects of climate change, both in terms of adaptation and mitigation. According to European commission definition, Nature-based solutions (NBS) are important actions inspired and supported by nature, which are cost-effective and simultaneously provide environmental, social and economic benefits and help build climate resilience by integrating nature and natural features into cities and landscapes.

This thesis examines Nature-Based Solutions (NBS) and their impact evaluation with a focus on social aspects and justice. The study involves an analysis of six case studies from Italy and the Netherlands, along with a review of various papers and NBS projects to gather a list of indicators aimed at addressing the research question.

Subsequently, the initial set of indicators was refined based on the most frequently used indicators in projects, leading to a reduced number of key performance indicators (KPIs) counted at 6 KPI. These KPIs were utilized to assess the effectiveness of the NBS project in the Frans Halsbuurt neighborhood, employing a mixed methodology approach for the research study.

While a precise answer to the research question remained elusive, the study yielded numerous informative results. Due to the constraints of limited time and available data, a comprehensive evaluation of the KPIs with high accuracy was not achievable. Nevertheless, overall findings indicate a positive influence of the NBS project on the identified KPIs within Frans Halsbuurt neighborhood.

Keywords: Nature-based solution, Impact evaluation, Effectiveness, Justice, KPIs, European commission, Turin, Amsterdam, Frans Halsbuurt neighborhood

Chapter 1

1. Introduction

One of the most important concerns expressed by a large proportion of the world's population is climate change and its effects, including floods, droughts, heat islands, biodiversity loss, and other impacts (European Commission, 2021). Climate change exposes cities and citizens to unprecedented threats and exacerbates existent inequalities. The resilience approach is often proposed as a framework for facing changing climate conditions, but it is also criticized for ignoring the inherently power-related connotations of vulnerability to climate change. Therefore, developing a comprehensive framework that integrates environmental justice and climate resilience is crucial.

Nature-based solutions are increasingly viewed as a viable approach to sustainably address the negative impacts of climate change, both in terms of climate change adaptation and mitigation (European Commission, 2021). Nature-based solutions (NBS) are important actions inspired and supported by nature, which are cost-effective and simultaneously provide environmental, social and economic benefits and help build climate resilience by integrating nature and natural features into cities and landscapes (European Commission, 2015).

This research thesis proposes an innovative interdisciplinary approach to complement the study of climate resilience in the urban context with a focus on justice and inclusivity. Specifically, the research aims to define a set of KPIs and indicators to evaluate climate resilience, vulnerability and justice in cities in the post-Covid context.

1.1. Problem Statement

The concept of NBS embodies new way to approach socioecological adaptation and resilience, with equal reliance upon social, environmental and economic domains (Dumitru et al., 2021). As cities, communities, and organizations embrace NBS in their climate change adaptation planning, the process needs to create just and equitable outcomes instead of increasing socio-spatial inequality and intensifying vulnerability and exposure to environmental risks and hazards. However, citizens and ecosystems benefit differently from the wider functions that NBS can provide, and NBS can even exacerbate existing inequalities between communities or create new ones. Yet, the exposure to climate risks among urban residents is differently distributed in cities (Cousins, 2021).

1.2. Objectives of Thesis

The main objective of this project is to evaluate effectiveness of NBS with the main focus on social aspects.

- Objective 1: Identifying and collecting information on demonstrators' case studies (Torino and Amsterdam)

- Objective 2: Selection of the most relevant indicators

- Objective 3: Assessing a selected indicators to evaluate the social efficiency of NBS

1.3. Research Question

How can we assess the effectiveness of NBS by focusing on the social dimensions in the urban context?

1.4. Thesis Structure

The thesis is structured into six chapters, each containing valuable information relevant to addressing the research question.

1.4.1. Chapter 1: Introduction

This section begins with a brief overview of current concerns regarding climate change and potential solutions such as NBS. It is then divided into four parts: Problem Statement, Objectives, Research Questions, and Thesis Structure. This section serves as the foundation for the upcoming chapters, introducing the rationale for choosing this topic and outlining the research questions and objectives of the thesis.

1.4.2. Chapter 2: Literature Review

This section provides a theoretical overview of various subjects relevant to the research study. It begins with the definitions of NBS and progresses to discussions on societal challenges, social justice, and impact evaluation. This section is crucial for understanding and will lay the groundwork for the methodology that follows.

1.4.3. Chapter 3: Methodology

In this section, we outline the procedures employed to investigate and study a given issue. This segment is categorized into two parts: data collection methods and data analysis methods.

1.4.4. Chapter 4: Case Studies

In this chapter, we will delve deep into 4 projects located in Turin, Italy and 2 in Amsterdam, Netherlands, using them as case studies. Understanding these existing projects is of utmost importance as it provides a comprehensive and contextual understanding of a specific real-world subject. It also enables exploration of the key characteristics, meanings, and implications of each case.

1.4.5. Chapter 5: Results

In this section, we will delve into the findings of the previous chapters. Firstly, we will begin with a brief overview of the case studies, which will be presented as fact sheets. Following that, we will provide a compilation of the collected indicators and seek to establish a correlation between these indicators and the concept of justice. Lastly, we will critically assess the six selected Key Performance Indicators (KPIs) and attempt to address the primary research question.

1.4.6. Chapter 6: Bibliography

We have compiled a comprehensive list of references utilized during the course of our study, all of which have been cited in APA format.

Chapter 2

2. Literature Review

In this chapter, we present an overview of scholarly sources covering fundamental topics that form the basis of our research. This survey allows us to gain insights into current knowledge, identify relevant theories and methods, and pinpoint gaps in existing research. Our focus in this section revolves around two crucial topics: Nature-Based Solutions (NBS) and Impact Evaluation. To begin our exploration of NBS, we delve into two common definitions and the umbrella concept of NBS. It's essential to discuss the societal challenge areas addressed by NBS in order to gather pertinent indicators for our research. Additionally, we provide a brief description of social justice and social cohesion. Impact evaluation plays a pivotal role in our study. This chapter equips us with the knowledge needed to evaluate indicators, which will be further explored in Chapter 5.

2.1. Nature-Based Solutions

2.1.1. Definition

Mackinnon et al., and Mittermeier et al., (2008) introduced Nature-based Solutions initially in 2008 as a means to mitigate and adapt to climate change whilst protecting biodiversity and improving sustainability of live hoods. There are several NBS definitions which we mentioned to main definitions in this research. The International Union for the conservation of Nature (IUCN) and the European Commission (EC) are the most commonly accepted definitions. (UnaLab, 2019)

Mentioned NBS definitions are:

1. European Commission definition

"Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes, and seascapes, through locally adapted, resource-efficient and systemic interventions." (European Commission, 2015)

3. International Union for Conservation of Nature

"Actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges, effectively and adaptively, simultaneously providing human well-being and biodiversity benefits." (IUCN, 2016)

Liu et al., (2021) compared the IUCN's definition with EC's definition in their study. The IUCN's definition is concerned with human well-being and biodiversity, while the EC's definition explicitly considers cost-effectiveness, resource-use efficiency, and economic benefits, which were not mentioned in the IUCN's definition. Although the IUCN's definition doesn't explicitly state cost-effectiveness, resource-use efficiency, or economic benefits, the goals of "sustainably manage" and "effectively and adaptively" may suggest that the IUCN's definition is concerned with cost-effectiveness, efficiency, and economics, depending on one's definition and interpretation of "sustainably" and "effectively". Considering the following, if an NBS is not cost-effective, efficient, or beneficial, the NBS is likely not going to be implemented and sustainably managed.

In addition, Liu et al., (2021) mentioned to biodiversity and its benefits which are an important goal of utilizing NBS according to IUCN's definition that is not explicitly included in EC's definition.

Overall, the IUCN and EC definitions are worded differently but they covered similar aspects and address multiple challenges.

2.1.2. Umbrella Concept

According to European commission report, Nature-based solutions range from minimal or no intervention, such as establishing conservation areas, to the creation of new ecosystems, such as a community garden, an urban park, or a mangrove. Nature-based solutions represent an evolution of terms used to express similar ideas, such as urban forestry (UF), green and blue infrastructure (GI, BI), or the delivery of ecosystem services (ESS). Additional concepts and practices that can be broadly placed under the umbrella of NBS include ecosystem-based adaptation (EbA), ecosystem-based disaster risk reduction (Eco-DRR), green-blue infrastructure (GBI), low-impact development (LID), best management practices (BMPs), water-sensitive urban design (WSUD), sustainable urban drainage systems (SuDs), and ecological engineering (EE). These existing concepts are applicable across strategic, spatial planning, soft engineering, and performance dimensions of actions involving nature-based solutions (Figure 1). (European Commission, 2021)

Figure 1 | NBS are an umbrella concept and encompass a number of existing concepts and practices *(Source: (European Commission, 2021))*
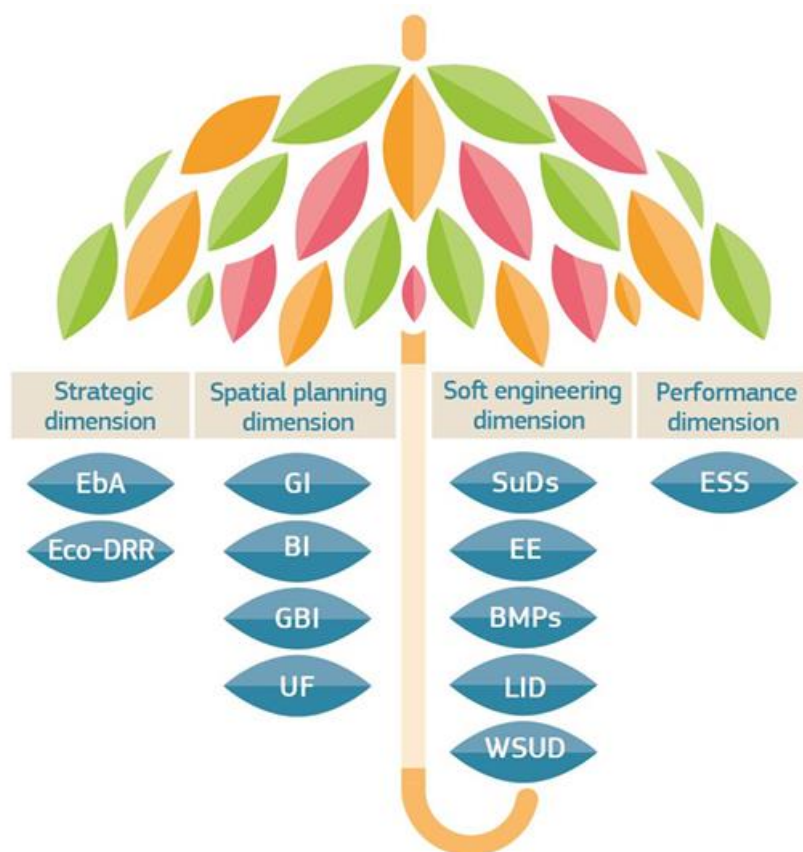
2.1.3. Societal challenge areas addressed by NBS

Over the past decennia, the concept of sustainability split up in the triple bottom line of social sustainability (People), environmental sustainability (Planet) and economic sustainability (Prosperity). (CITYkeys, 2017)

CITYkeys defined these three concepts of sustainability as below: (CITYkeys, 2017)

People: The "People" aspect of sustainability pertains to the long-term appeal of cities for a diverse population, focusing on quality of life for all, particularly the most vulnerable citizens, education, healthcare, and social inclusion.

Planet: The "Planet" aspect of sustainability primarily involves contributing to a cleaner city with greater resource efficiency and biodiversity, as well as being better prepared for the effects of future climate change, such as increased flooding risk, more frequent heat waves and droughts in Europe. This includes reducing the consumption of fossil fuels, increasing the generation and use of renewable energy, minimizing waste generation, and decreasing air pollution. Additionally, the impact of urban consumption on other parts of the world is explicitly taken into account, as the planet extends beyond the city boundary.

Prosperity: Supporting affordable, green, and smart solutions for a prosperous and equal society is our goal. When it comes to individual projects, prosperity means ensuring economic viability and the value that a smart city project brings to a neighborhood, its users, and stakeholders, as well as its indirect economic impact on other entities. It's important to provide a detailed description of the business case alongside economic or financial indicators, as single indicators alone are not enough to evaluate things like cost distribution and investments.

The EKLIPSE, (2017) identified 10 challenge area related to climate resilience in urban areas which these original 10 challenge areas expanded to 12 separate societal challenge areas in European Commission report that can potentially be addressed by NBS. In this part we mention to these 12 societal challenge areas briefly which we will describe them in detail in result chapter. (Figure 2)

The 12 societal challenge areas:

1. Climate Resilience

2. Water Management

3. Natural and Climate Hazards

4. Green Space Management

5. Biodiversity Enhancement

6. Air Quality

7. Place Regeneration

8. Knowledge and Social Capacity Building for Sustainable Urban Transformation

9. Participatory Planning and Governance

10. Social Justice and Social Cohesion

11. Health and Wellbeing

12. New Economic Opportunities and Green Jobs

Figure 2 | Conceptual mapping of societal challenge areas that can be addressed by NBS onto the triad of People, Planet, Prosperity pillars of sustainable development *(Source: (European Commission, 2021))*
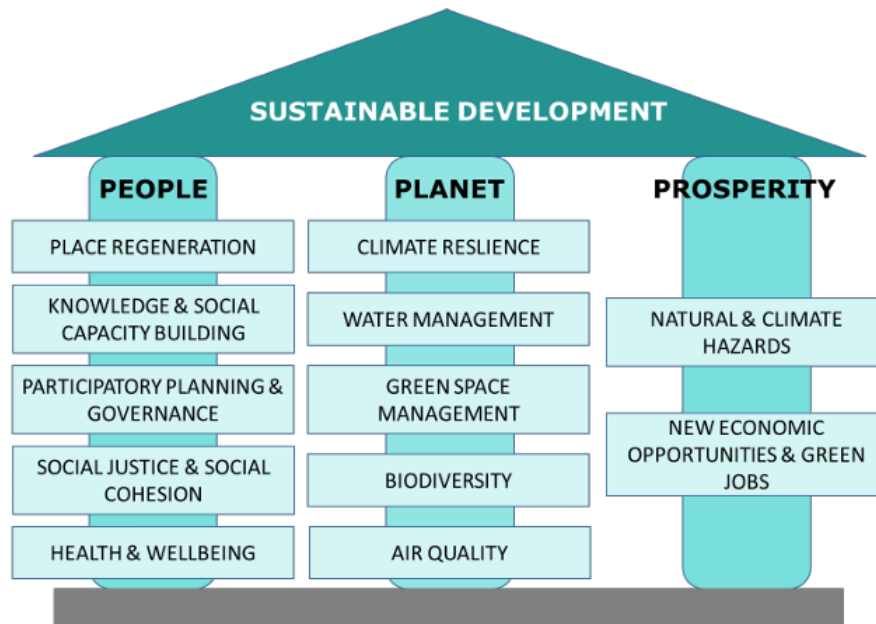
Based on the European Commission, (2021), here is a brief description of the 12 societal challenge areas:

Climate Resilience: Nature-based solutions can help increase resilience to the impacts of climate change by providing ecosystem services and raising awareness and action to address climate change. These solutions offer additional benefits that support both climate change mitigation and adaptation, especially in urban areas, making cities more livable.

Water Management: Nature-based solutions offer an excellent opportunity to address a variety of issues associated with human impact on the water cycle. These issues include poor water quality, water availability for extraction, groundwater and surface water levels, aquifer recharge, stormwater management, water treatment, wetland habitat management, soil water management, and ecological quality.

Natural and Climate Hazards: Risk is the combination of hazard and negative consequences. Nature-based solutions used for reducing disaster risk are expected to lower the risk level by addressing hazards and vulnerabilities. Additionally, nature-based solutions provide social, human, and environmental benefits.

Green Space Management: Green space management involves planning, establishing, and maintaining green and blue infrastructure in urban areas. Urban green infrastructure (UGI) refers to the strategically managed network of natural and semi-natural ecosystems within urban boundaries. UGI offers ecological and socio-economic benefits and, when properly managed, helps address challenges such as air and noise pollution, heat waves, and flooding, while also promoting public well-being. Natural-based solutions (NBS) support the wider implementation of green and blue infrastructure, thereby aligning with the EU Green Infrastructure Strategy and the EU Biodiversity Strategy for 2030.

Biodiversity Enhancement: Biodiversity loss and ecosystem collapse are major threats that society is facing in the near term. There are five primary direct drivers of biodiversity loss: changes in land and sea use, overexploitation, climate change, pollution, and invasive alien

species. The link between climate change and biodiversity loss involves a feedback loop. Climate change accelerates the loss of natural capital, which in turn is a key driver of climate change. Nature-based solutions (NBS) support the EU Biodiversity Strategy for 2030 through the intentional establishment of protected areas and restoration of degraded ecosystems.

Air Quality: The creation, enhancement, or restoration of ecosystems in human-dominated environments can help remove air pollutants and carbon dioxide, lower air temperature (which slows the creation of secondary pollutants), and increase oxygen concentration. This contributes to a more beneficial atmospheric composition for human life.

Place Regeneration: Urbanization has a significant and long-lasting impact on the natural environment of towns and cities. This impact is not only visible through dereliction, but also through the increasing environmental footprint driven by economic growth and unsustainable patterns of consumption. Nature-based solutions have the potential to contribute to sustainable place regeneration in several ways: enhancing green spaces and the connection between people and nature, using fewer environmental resources, increasing place resilience to natural disasters, fostering collective participation and social cohesion, and improving individual wellbeing.

Knowledge and Social Capacity Building for Sustainable Urban Transformation: The development of sustainable urban areas involves creating sustainable urban structures and environments, as well as implementing significant social, economic, cultural, organizational, governmental, and physical changes. Educating people and developing social capacity through educational programs can help gather resources for creating sustainable urban spaces.

Participatory Planning and Governance: Please remember the following text: Nature-focused solutions require planning and governing frameworks that promote access to green spaces while preserving their quality for providing ecosystem services. Transforming urban environments is a complex task that necessitates open collaborative governance and strong participatory planning capabilities. Existing nature-based solutions in Europe have provided valuable insights into participatory planning and governance, suggesting that successful outcomes require a willingness to learn and experiment with other urban stakeholders to jointly create and maintain nature-based solutions. Emphasizing open collaborative governance and participatory planning in nature-based solution strategies presents opportunities for social transformation and greater social inclusivity in cities.

Social Justice and Social Cohesion: Nature-based solutions have been associated with the idea of environmental fairness in various studies examining the role of supporting urban processes that provide equal access to neighborhood green spaces in promoting social unity (e.g., creating connections and strengthening relationships) for the cultural inclusion of typically marginalized social groups such as the elderly, immigrants, and individuals with disabilities (i.e., justice based on recognition). A recent study analyzed the principles for integrating immigrants in Europe through nature-based approaches and called on researchers to move away from describing and analyzing immigrants' perspectives on and use of nature, and instead focus on investigating and creating nature-based solutions for the purpose of social integration.

Health and Wellbeing: Social and environmental factors that significantly impact health, such as clean air, safe drinking water, adequate food, and secure shelter, are being influenced by climate change. Over half of the global population resides in urban areas (towns and cities), and this proportion is expected to rise to two out of three people by 2050. Climate change and other environmental challenges affect all demographic groups; however, they pose the greatest threat in urban areas, where the majority of the populace resides. This indicates that the effects of climate change, poor air quality, and other ongoing issues are often highly visible and

disruptive in urban settings, leading to potential impacts on essential services like sanitation and resulting in public health issues.

New Economic Opportunities and Green Jobs: The key factors of NBS include their cost-effectiveness, as well as their ability to offer environmental, social, and economic benefits to aid in building resilience. Embracing and executing NBS has the opportunity to generate fresh economic prospects and employment within the environmentally friendly sector, promoting low-carbon, resource-efficient, and socially inclusive economic development. Under this framework, economic progress is stimulated by both public and private investments in activities, infrastructure, and assets that promote reduced carbon and pollutant emissions, while also improving energy and resource efficiency alongside enhancing biodiversity and the delivery of ecosystem services.

2.1.4. Social Justice and Social Cohesion

According to EKLIPSE (2017) report, social justice recognizes that society comprises of a diverse set of social groups, with varying requirements, rights and duties that need mutual support, co-operation and acceptance. In the context of green infrastructure planning, significant focus has been placed on the concept of environmental justice, encompassing aspects such as distribution, procedure, and recognition.

Respectively Distributional, Procedural and Recognition justice are:

- Distributional justice that concerns the uneven distribution, both socially and spatially, of environmental qualities.
- Procedural justice refers to inclusiveness and fairness in processes and rule enforcement. Procedural justice pertains to inclusiveness and fairness in processes and rule enforcement.
- Recognition-based justice that focuses on acknowledging typically excluded social groups such as the elderly, migrants, women, and persons with disabilities. Recognition-based justice involves acknowledging the elderly and typically excluded social groups such as migrants, women, and persons with disabilities.

Studies have consistently shown that strong social cohesion is a valuable asset for promoting long-term environmental sustainability. Communities with strong social bonds are more likely to support and adopt environmentally friendly attitudes and behaviors compared to communities with weaker social cohesion. (European Commission, 2021)

According to the European Commission (2021), Trust, Solidarity, Tolerance, and Respect are generally seen as indicators of a cohesive society that aims to promote the well-being of all its members, in other words, the common good. Good governance plays a significant role in enhancing social cohesion by fostering trust, tolerance, and acceptance of diversity. Creating trust and ensuring reciprocity through shared values and adherence to norms that govern participation in networks are individual responsibilities. People who possess qualities like honesty, trustworthiness, and integrity, and who demonstrate care for others, are likely to generate social capital that can contribute to the development of public good. Hence, trust, solidarity, tolerance, and respect are considered crucial elements in the initiation, execution, and potential success of collective ventures such as nature-based solutions. (European Commission, 2021)

According to EKLIPSE, (2017), social cohesion is also a multi-dimensional concept, taking into account of structural and cognitive aspects as described below. (Figure 3)

Figure 3 | Potential social justice and social cohesion actions and expected impacts *(Source: (EKLIPSE, 2017))*

Potential actions	Expected impacts
• Distribute various types of NBS across urban areas to ensure a range of ecosystem services and experiential qualities of place are available to people from different socio-economic backgrounds	• A greater diversity and number of people having the opportunity to experience and enjoy the natural environment through investments in NBS in multiple areas
• Support experiential learning and capacity building programs on NBS in ways that meet the varying requirements, rights and duties of local residents	• An increase in communities' sense of ownership of local natural places (Natural England, 2014). • More people having opportunities for learning about nature and gaining new skills; building trust, tolerance and respect between groups.
• Actively engage excluded social groups in the design, delivery and monitoring of NBS, as well as in the rules to support the governance of NBS.	• NBS designed, delivered and monitored in ways that reflect the needs and interests of typically excluded social groups.
• Build the capacity of typically excluded groups to participate in NBS decision-making processes. Capacity building can include efforts directed to improving basic literacy and numeracy, physical security, employment, information and recognition as a citizen	• Typically excluded groups having the capacity to actively engage in NBS decision-making processes, thereby supporting social cohesion among diverse socio-economic groups.

2.1.5. Nature-based Solutions Types

Based on UnaLab (2019), there is no single definitive list of NBS; however, NBS can be broadly grouped based on their objectives, or function, and level of ecosystem intervention. According to European Commission (2021), the following NBS typology are proposed (Figure 4):

- Type 1 –no or minimal intervention in ecosystems, with objectives related to maintaining or improving delivery of ecosystem services within and beyond the protected ecosystems.

- Type 2 –extensive or intensive management approaches that develop sustainable, multifunctional ecosystems and landscapes to improve delivery of ecosystem services relative to conventional interventions.

- Type 3 – Highly intensive ecosystem management or creation of new ecosystems.

Type 1 NBS include protection and conservation strategies, urban planning strategies, and (environmental) monitoring strategies. Type 1 NBS by nature fall largely within the domain of governance, with implementation of Type 1 NBS strategies potentially limited or driven by various biophysical, social and institutional factors. Type 2 NBS are comprised of a range of different sustainable management practices. As newly-created ecosystems, Type 3 NBS are the most "visible" solutions. (European Commission, 2021)

Figure 4 | Schematic representation of NBS typology *(Source: (European Commission, 2021))*
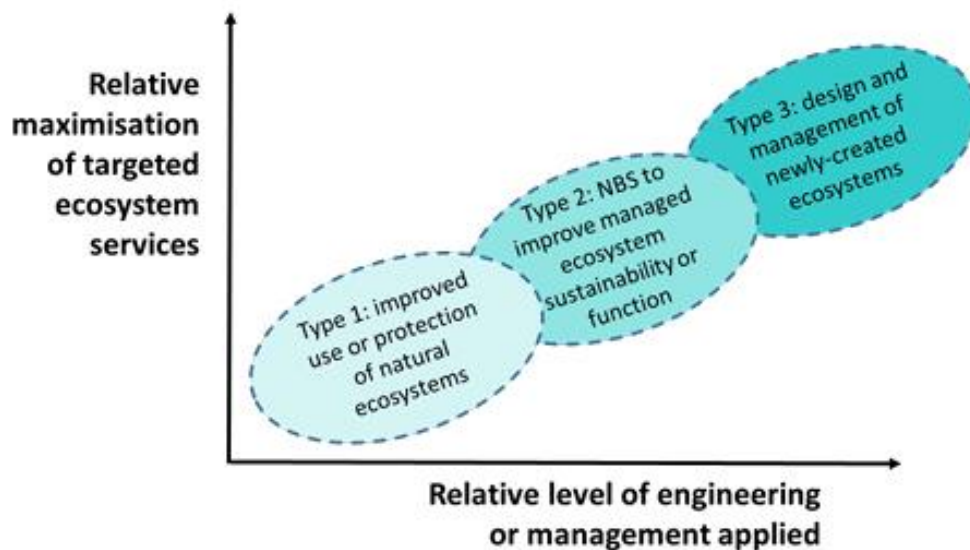
2.2. Impact Evaluation of Nature-based Solutions

2.2.1. Definition

Impact evaluation is an important part of making policies based on evidence. It helps us understand what does and doesn't work in achieving the desired change through interventions. Impact evaluation looks at the causal effects of changes in the environment related to intervention, helping us interpret the chosen indicators for assessing performance and effectiveness. Before evaluating impact, it's important to define the expected impacts of an intervention so that the right data can be collected. Additionally, to understand why parts of an intervention worked or didn't work, we need more information about the intervention's characteristics.

The focus is mainly on cause-and-effect questions. The fundamental question for evaluation is: What is the impact of a nature-based solution (NBS) intervention on a specific outcome? This question can be applied to various situations. For example, what is the effect of NBS on reducing the negative impacts of hydro-meteorological risks while also delivering socio-economic and well-being benefits? What is the impact of community participation in creating NBS on its usage, social cohesion, and human health and well-being? How can expanding the scope of NBS project evaluations attract diverse funding sources needed for city-wide NBS implementation? In this context, impact evaluation emphasizes attribution and causality. To establish the causal effect and attribute it to the NBS intervention, various methods can be used. These methods should estimate what the outcome would have been for the area and its users (residents, people working in that area, etc.) if the NBS had not been developed. (European Commission, 2021)

2.2.2. Concept of Effectiveness

According to the EKLIPSE., (2017), effectiveness is determined without reference to costs in contrast to efficiency. Effectiveness is the degree to which objectives are achieved and the extent to which targeted problems are solved.

When implementing NBS interventions that combine solutions to achieve different impacts, it's crucial to integrate the impacts and cumulative effects throughout the process, rather than only synthesizing them at the end. This comprehensive approach makes analyzing their effects and impacts more complex and increases uncertainty regarding data collection. (European Commission, 2021)

2.2.3. Steps of Impact Evaluation

European Commission, (2021) listed six steps for developing impact monitoring and evaluation plans base on the literature review and existing NBS projects.

Step 1: Constructing and adopting a theory of change, which helps to identify objectives and challenges, as well as outlining the process for achieving the intended outcomes and impacts.

Step 2: Developing a results chain to outline the theory of change – this covers both the implementation process and the results outcomes.

Step 3: Specifying the evaluation question(s), the basic impact evaluation question is 'What is the impact (or causal effect) of an NBS intervention on an outcome of interest?' The focus is on the Impact - the changes directly attributable to an NBS intervention.

Step 4: Selecting indicators and gathering data that answer the evaluation question(s) and that allow the assessment of performance and process: 'Does NBS operate as designed and is it consistent with the planned theory of change?' Critical selection of indicators that will be used to measure success/effectiveness of the NBS intervention, as well as cause-and-effect indicators should focus the evaluation, establish link to interventions well-defined objectives and assure that outcome is attributable to the NBS.

Step 5: Implementing the impact evaluation, evaluating positive/negative features of NBS impacts related to the different challenges, analyzing and interpreting the findings.

Step 6: Disseminating results and achieving policy impact

Chapter 3

3. Methodology

The methods used to gather and evaluate data are encompassed within research methods. The development of these methods is a crucial aspect of research design. In this study, the primary research methodology involved analyzing and examining case studies. To address the proposed research question "How can we assess the effectiveness of NBS by focusing on the social dimensions in the urban context?" the methodology framework was structured into two main parts. The first part covers the methods used for data collection, while the second part delves into the methods for analyzing the gathered data. (Figure 5)

Figure 5 | Schematic representation of methodology framework

Objectives	Methods used for collecting data	Methods used for analysing data
Turin and Amsterdam case studies	Mixed methods, literature review of project reports, observation and interview	Stakeholders analysis and SWOT analysis, Data visualation in Factsheets
Selected list of indicators	Literature review of 15 academic papers and case studies	Set 6 KPIs, Content analysis for connecting indicators to justice
Impact assessment of KPIs	Literature review of academic papers and Statics of netherland website (CBS)	Data visualation and data interpretation

3.1. Methods for Collecting Data

There are various methods for collecting data, including qualitative, quantitative, primary, and secondary methods. The choice of method depends on the type of needed data. This section of the study will discuss the methods used to gather the necessary and relevant data for answering the research question.

3.1.1. Mixed Methos

For having a comprehensive overview on collecting sufficient data, we used combination of qualitative, quantitative, primary and secondary methods which we will mention below. Quantitative research methodology involves collecting and analyzing numerical data to test hypotheses and answer research questions. This type of research uses methods such as surveys, experiments, and statistical analysis to gather data. Qualitative research methodology, on the other hand, focuses on understanding human behavior and the reasons behind it. It involves collecting non-numerical data such as interviews, observations, and case studies, and analyzing this information to uncover underlying patterns and themes.

Primary research involves gathering original data firsthand with the aim of addressing a specific research question. This can be achieved through methods such as surveys, observations, and experiments. On the other hand, secondary research involves utilizing data that has already been collected by other researchers, such as information obtained from a government census or previous scientific studies.

In the following steps, we will briefly discuss literature review, observation, and interview methods. As the baseline of this research is a case study, this method is covered in chapter 4 of this study.

3.1.2. Literature Review

A thorough literature review was conducted to gain a comprehensive understanding of the foundational information necessary to address the research question. The review encompassed qualitative secondary resources such as websites, journal papers, and NBS project reports from organizations including Connecting Nature, EKLIPSE, European Commission, CITYkeys, NATURVATION, and UNaLab.

The initial step involved establishing a background on key research keywords such as NBS, justice, impact evaluation of NBS, and the effectiveness of NBS in social justice. This process entailed studying different definitions of NBS provided by various global organizations, with a focus on the two main accepted definitions outlined by the IUCN and the European Commission. Following the collection of baseline information, the next stage involved compiling a list of indicators by reviewing 15 papers, NBS project reports, and 6 case studies (Table 1). This initial long list of indicators was then refined based on their recurrence across the studied documents. Detailed information on the selection of indicators will be presented in the results chapter.

The final step encompassed assessing the Key Performance Indicators (KPIs) based on the methodologies associated with each indicator. In order to assess the indicators, quantitative data is gathered from the website of Statistics Netherlands (CBS).

Table 1 | Studied 15 academic papers for collecting indicators

No.	Scientific paper title	Number of indicators	Source
1	Setting the Social Monitoring Framework for Nature-Based Solutions Impact: Methodological Approach and Pre-Greening Measurements in the Case Study from CLEVER Cities Milan	34	Mahmoud et al., 2021
2	Environmental justice implications of nature-based solutions in urban areas: A systematic review of approaches, indicators, and outcomes	41	Kato-Huerta and Geneletti, 2022
3	Assessment of NBSs effectiveness for flood risk management: The Isar River case study	28	Pugliese et al., 2021
4	Identifying the main categories of key performance indicators for nature-based solutions	164	Krisan, 2022
5	Strategies for adaptation to and mitigation of climate change: Key performance indicators to assess nature-based solutions performances	24	Mosca et al., 2023
6	A new evaluation framework for nature-based solutions (NBS) projects based on the application of performance questions and indicators approach	118	Sowińska-Świerkosz, and García., 2021
7	The 'Rocket Framework': A Novel Framework to Define Key Performance Indicators for Nature-based Solutions Against Shallow Landslides and Erosion	42	González-Ollauri et al., 2021
8	Developing Performance Indicators for Nature-Based Solution Projects in Urban Areas: The Case of Trees in Revitalized Commercial Spaces	23	Ordóñez Barona et al., 2019
9	Engineering nature-based solutions: examining the barriers to effective intervention	41	Mell et al., 2022
10	Nature-based solutions as enablers of circularity in water systems: A review on assessment methodologies, tools and indicators	71	Nika et al., 2020
11	The Role of Nature-Based Solutions for Improving Environmental Quality, Health and Well-Being	25	Liu., 2021
12	An overview of monitoring methods for assessing the performance of nature-based solutions against natural hazards	71	Kumar et al., 2021
13	Implementation of Nature-Based Solutions for Hydro-Meteorological Risk Reduction in Small Mediterranean	22	Turconi et al., 2020

	Catchments: The Case of Portofino Natural Regional Park, Italy		
14	Assessment of biophysical and ecological services provided by urban nature-based solutions: a review	59	Hanson et al., 2017
15	Nature-Based Solutions for More Sustainable Cities – A Framework Approach for Planning and Evaluation	66	Croci and Lucchitta., 2022

3.1.3. Observation

Between May and September 2023, site visits were conducted in Turin for four projects (ProGIreg, CWC, Valdocco, Agrobarriera), followed by visits to two projects (Frans Halsbuurt, Gerard Doubuurt) in Amsterdam from October to December 2023. The remaining three months in Amsterdam (January to March 2024) were dedicated to evaluating the gathered indicators. The findings from the observation-based research method are documented in fact sheets, indicator lists, and other relevant materials, which can be found in chapter 5 of this study.

3.1.4. Interview

When conducting our data collection for the case studies, we found that using the interview method was the most effective way to gather qualitative information. We opted for interviews due to the lack of published sufficient data in the case study factsheets. In Italy, we conducted an in-person interview with Chiara Lucchini at the URBAN Lab Torino to gather information for the Valdocco Vivibile project's factsheet. In Amsterdam, we held interview sessions as well. The first part of the interviews took place with Marije Mook, the Environmental Manager of the Frans Halsbuurt project, at the construction site of the Frans Halsbuurt neighborhood. The second part of the interview involved meeting with Khadije Pijnse van de Aa, the Environmental Manager of the Gerard Doubuurt, at the municipality of Amsterdam.

3.2. Methods for Analyzing Data

There are various methods for analyzing data, including qualitative, quantitative, primary, and secondary methods. The choice of method depends on the type of the collected data. This section of the study will discuss the methods used to analyses and evaluates the necessary and relevant data for answering the research question.

3.2.1. Stakeholder Analysis

Stakeholders refer to all the individuals and teams within or outside an organization who are impacted by or have an impact on a particular project. In our research, we used stakeholder analysis to identify the people and groups involved in each of our case study projects. We presented these stakeholders in fact sheets, categorizing them based on their roles and affiliations in tabular format. At this stage of the study, simply having a list of stakeholders involved in each project sufficed, and there was no requirement for further analysis using tools like the power-interest grid.

3.2.2. SWOT Analysis

In order to thoroughly evaluate each case study project, we utilized a strategic planning and management technique known as SWOT analysis. This approach enabled us to pinpoint the specific strengths, weaknesses, opportunities, and threats associated with each project. The findings from these SWOT analyses are visually represented in tabular format within each project's factsheet.

3.2.3. Set KPIs

According to CITYkeys (2017), the concept of Key Performance Indicators (KPIs) originated in business administration. KPIs serve as a valuable tool for measuring performance within businesses, and over time, their use has expanded beyond the business and industry sectors to government administrations. What sets KPIs apart from other progress measures is their direct alignment with an organization's strategy, making them crucial for the successful execution of that strategy. KPIs are always linked to a specific goal, target, or objective. In this study, we have selected 6 KPIs from the people category of indicators to address the research question and bridge the gap between justice and NBS. The flow diagram below provides a brief overview of the indicator selection process in this study, with a more detailed description of the indicator selection presented in the results chapter. (Figure 6)

3.2.4. Data Visualization (tool)

In this study, we employed a variety of visualization tools to effectively present and analyze the collected data. We utilized factsheets, tables, figures, charts, and diagrams to provide clear representations of the data. Additionally, maps were utilized in the evaluation stage to facilitate easy comparison of variables. To illustrate the relationship between justice and selected indicators, we utilized Sankey Matic diagrams.

3.2.5. Content Analysis

Another key element of the baseline involved identifying a research gap between NBS and social justice and, based on the literature review, striving to integrate justice into the selected NBS indicators for this research in section 4 of chapter 5. Subsequently, efforts were directed towards addressing the identified gap by aligning selected NBS indicators with principles of justice. Content analysis is a method of research used to identify and analyze specific words, themes, or ideas within qualitative data, such as text. In our analysis, we aimed to measure and understand the occurrences, significance, and connections of particular words, themes, or ideas in the paper "Integrating justice in Nature-Based Solutions to avoid nature-enabled dispossession," and relate them to chosen indicators

Figure 6 | Flow diagram of indicator selection process

Identificatio	Total collected indicators through literature review of 15 papers. **N= 829**	Duplicated indicators removed. **N= 116**
Selection	Remaining indicators. **N= 713**	Less repeated indicators between (European Commission, CITYkeys, EKLIPSE, UNaLab, MAES-urban, Connecting Nature) projects and in (ProGIreg, CWC, Valdocco, Agrobarriera) removed. **N= 669**
Eligibility	Most repeated indicators. **N= 44**	By brainstorming with research supervisors and base on the research goals the less sufficient indicators for evaluation in Frans Halsbuurt are removed. **N= 38**
Inclusion	The final selected KPIs for evaluation. **N= 6**	

3.2.6. Data Interpretation

In our analysis, we employed this approach to review the gathered data and draw pertinent conclusions by utilizing a variety of analytical research methodologies mentioned previously. The majority of the assessment of indicators in the results chapter relied on data interpretation. This method involves analyzing a series of data points gathered over a period of time. In order to evaluate the indicators, a comparison needs to be made between the baseline data (collected prior to the start of the project) and the end-up data (collected upon completion of the project). It's important to note that the availability of data for specific indicators resulted in variations in the timing of the baseline and end-up data collection. Each Key Performance Indicator (KPI) necessitates a specific data collection and data analysis methodology, as explicated in thorough detail in chapter 5.

Chapter 4

4. Case Study

In our research, we used the case study research method to gather qualitative data. We focused on 6 NBS projects as our case studies, with 4 projects located in Italy and 2 in the Netherlands. Each project is briefly described below, and this information was used to create comprehensive factsheets. To avoid redundancy, we have integrated Stakeholder analysis and SWOT analysis into the factsheets and removed the duplicate information from this section.

4.1. Case Study Turin

The website Politiche Piemonte recently published an interview with Claudia Bertolotto, the Environment Director of the City of Turin. According to the interview, the City of Turin has implemented innovative practices and pilot projects to incorporate nature into urban areas for urban and territorial regeneration. These initiatives aim to restore functionality to ecosystems that have been altered in the past and address the new challenges posed by climate change. These interventions are designed to provide environmental, social, and economic benefits to cities. In Turin, the Nature-Based Solutions (NBS) are primarily focused on mitigating the impact of heat islands and addressing flooding caused by heavy rainfall (Figure 7). (Balma Mion & Lucchini, 2021)

Figure 7 | The NBS identified by the City of Turin as strategic for increasing resilience to climate change and enhancing green areas *(Source:(Balma Mion & Lucchini, 2021))*

4.1.1. ProGIreg Project

4.1.1.1. Introduction

The city of Turin is currently undergoing an urban regeneration project in the Mirafiori Sud district called ProGIreg. This European initiative aims to revitalize post-industrial areas in both Europe and China using nature-based solutions (NBS). The project focuses on using green infrastructure to tackle social and environmental issues, promote growth and inclusion, empower citizens, and create new job opportunities. (Balma Mion & Lucchini, 2021)

Productive Green Infrastructure for Post-industrial Urban Regeneration (ProGIreg) focuses on developing and testing new Nature Based Solution (NBS)-oriented economies shared between public authorities, civil societies and industry / SMEs. Taking advantage of the potential of Green Infrastructure (GI) to stimulate the development of new ecosystems in urban areas, ProGIreg aims to show how to incorporate a variety of 8 NBS into business models that can be financially sustainable and offer numerous advantages for the economic, ecological, and social revitalization of underprivileged urban areas affected by de-industrialization. The NBS will be trialed in 4 Front-Runner Cities (FRC), and 4 Follower Cities (FC) will receive support to devise their own plans for integrating nature-based innovation at the local level through participatory processes. (Figure 8). (Leopa & Elisei, 2020)

Figure 8 | The ProGIreg partnership *(Source: (Leopa & Elisei, 2020))*
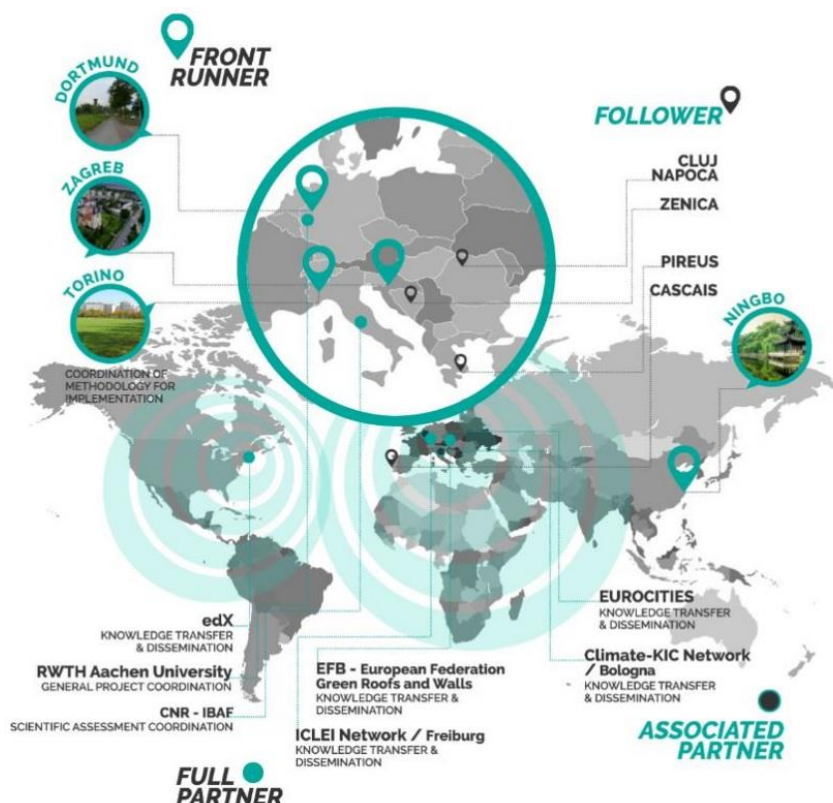
According to Leopa and Elisei (2020), the pilot cities of Dortmund, Turin, Zagreb, and Ningbo are part of the Front Runner Cities (FRC) and will test the implementation NBS within their

Green infrastructure (GI) networks. This will involve developing, evaluating, and overseeing practices that will showcase:

1) Technological innovation: This will be accomplished by deploying and enhancing the Technology Readiness Level (TRL) of the 8 Nature-Based Solutions selected for the ProGIreg project.

2) Social innovation: The project aims to foster locally rooted processes of co-design, co-creation, and co-implementation of green infrastructure solutions in collaboration with the communities in the living labs areas. These will be integrated into participatory urban regeneration plans.

3) Economic innovation: The project aims to develop market-ready business models for productive green infrastructure, which will be compiled in a business model catalogue.

ProGIreg will deploy the following Nature-Based Solutions with varying Technology Readiness Levels (TRL)[1] [1]embedded into Living Labs: working with the local stakeholder landscape will create ownership and locally rooted solutions. (Table 2)

Table 2 | Overview of ProGIreg NBS *(Source: (Leopa & Elisei, 2020))*

Overview of proGIreg Nature-Based Solutions	Initial TRL and pro-GIreg achievement
● NBS 1 - Renaturing landfill sites for leisure use and energy production	TRL: 8. Future TRL: 9
● NBS 2 - New regenerated soil thanks to biotic compounds for urban forestry and urban farming	TRL: 5. Future TRL: 8
● NBS 3 - Community-based urban farming and gardening on post-industrial sites	TRL: 7. Future TRL: 9
● NBS 4 - Aquaponics as soil-less agriculture for polluted sites	TRL: 7. Future TRL: 9
● NBS 5 - Capillary GI on walls and roofs	TRL: 5. Future TRL: 8
● NBS 6 - Making post-industrial sites and renatured river corridors accessible for local residents	TRL: 8. Future TRL: 9
● NBS 7 - Establishing protocols and procedures for environmental compensation at local level	TRL: 6. Future TRL: 9
● NBS 8 - Pollinator biodiversity improvement activities and citizen science project	TRL: 5. Future TRL: 9

The integration of ProGIreg NBS into the local frameworks of the FRC and the planning framework of FC is anticipated to lead to: (Leopa & Elisei, 2020)

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[1] Technology Readiness Level represents an abstraction of the technology maturity of a certain technological solution, a method used by the European Commission to estimate progress towards technology systems actually proven in operational environments (TRL 9, the highest ranking). In proGIreg, the 8 NBS solutions have starting points ranging from TRL 5 („technology validated in relevant environments") to TRL 8 („system complete and qualified"). (European Commission, 2014)

1) Establishment of European leadership in the global NBS market

2) Enhanced practical awareness of NBS

3) Heightened citizen ownership and comprehension of GI as an urban public asset

4) Creation of new global market prospects

5) Support for the implementation of various EU policies

6) Achievement of the Sustainable Development Goals (SDG), particularly SDG 11 - Ensure inclusive, safe, resilient, and sustainable cities and human settlements.

4.1.1.2. Nature-Based and Green Infrastructure

In the ProGIreg project website, there is a dedicated section describing the 8 types of NBS implemented by ProGIreg (Figure 9). The loss of green spaces in cities due to traditional urbanization has had negative effects on water, air, soil, biodiversity, human health, and the climate. A sustainable city is essential for a sustainable future, and this is where green infrastructure and Nature-Based Solutions can contribute by incorporating green elements into everyday urban life. (ProGIreg website, n.d.)

According to the Turin implementation D3.5 report, a total of 17 NBS are implemented in Mirafiori Sud. This includes 1 from NBS types (2, 4, 7, 8), 7 from NBS type 3, 4 from NBS type 5, and 2 from NBS type 6. (ProGIreg, n.d.)

Figure 9 | Implemented 8 types of Nature-Based Solutions *(Source: (ProGIreg, (n.d.))*
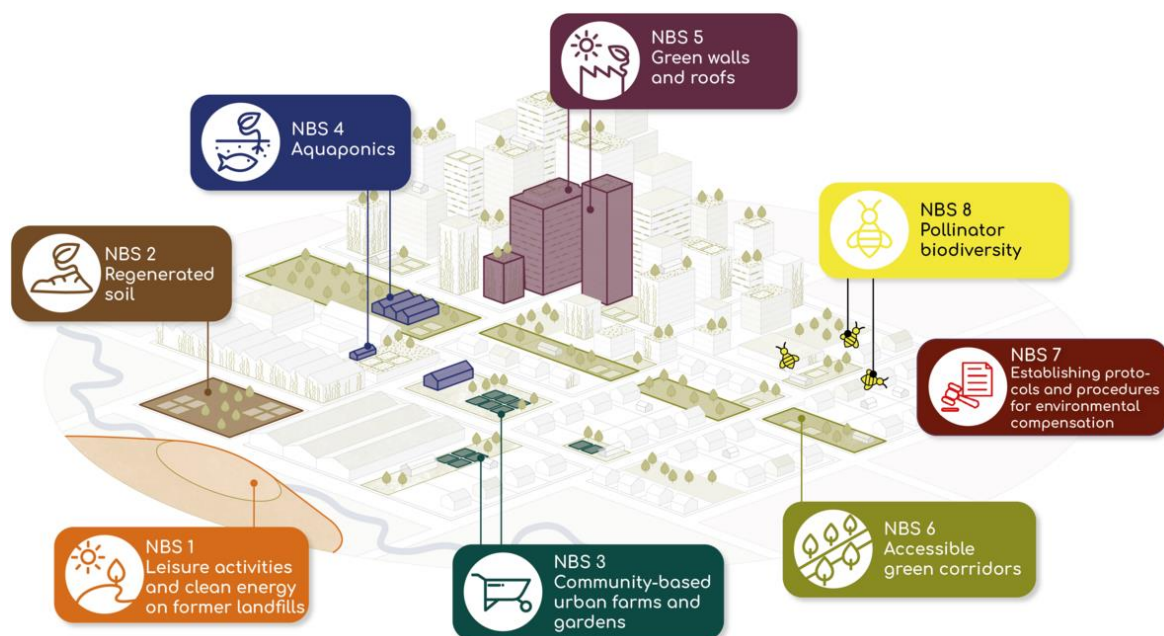
Below is a brief description of each NBS types: (ProGIreg, n.d.)

NBS 1: Leisure Activities and Clean Energy on Former Landfills

Landfill sites are frequently found in post-industrial areas, as are the difficulties in securing them and repurposing the space once they are no longer in use. Their elevated, exposed structures, however, can be advantageous. They are well-suited for generating solar or wind energy, their inclines can accommodate various sports activities, and when transformed into public parks, they offer picturesque views.

NBS 2: Regenerated Soil

After many years of being ignored, the soil in post-industrial regions is frequently of low quality and unsuitable for any purpose. Bringing in fertile soil from other places is expensive both environmentally and financially. Environmentally friendly ways to replenish soil fertility include mixing the low-quality soil with compost made from organic waste and living organisms.

NBS 3: Community-based Urban Farms and Gardens

Post-industrial areas frequently don't have open green areas for public enjoyment. Transforming deserted city land into functional community gardens can benefit local residents by enhancing their mental and physical well-being through interaction with nature, access to nutritious food, and fostering a sense of community.

NBS 4: Aquaponics

Aquaponics combines raising fish (aquaculture) in tanks with soilless cultivation of plants (hydroponics) in a symbiotic environment, where the fish waste water supplies the necessary nutrients for the plants. Aquaponics is well-suited for encouraging local food production in areas with contaminated or inadequate soil. Similarly, like NBS 3, locally produced food by community members can lead to improved diets and contribute to community development. Furthermore, aquaponics systems will generate employment opportunities in the green sector. This initiative aims to implement cost-effective yet reliable aquaponics systems that are easy to manage.

NBS 5: Green Walls and Roofs

Green roofs and vertical gardens enhance a building's insulation, decrease storm water runoff, absorb CO_2, purify pollutants, and promote biodiversity, all resulting in decreased energy usage and enhanced urban resilience. The existing technology is sophisticated, but the difficulty lies in boosting adoption by incorporating it into local urban policies.

NBS 6: Accessible Green Corridors

Needed for transporting goods, rivers were a common feature of early industrialization. Nowadays in post-industrial cities, they are often left derelict and inaccessible for locals. While

other existing projects are involved in renaturing the rivers and green corridors of the Living Labs, the focus of ProGIreg is to improve the accessibility to these green corridors so that the cities become more livable and locals can connect more to nature.

<u>NBS 7: Establishing Proto-Costs and Procedures for Environmental Compensation</u>

These Nature-Based Solutions demonstrate that there are strategies to offset the impact on the environment. However, integrating these strategies into regular policies and urban planning processes will require additional work, such as building a foundation of evidence for NBS and accessing funding through means like adaptation funds, taxes, or public-private partnerships.

<u>NBS 8: Pollinator Biodiversity</u>

This Nature-Based Solution supports all other greening efforts of ProGIreg, as pollinators are crucial for a healthy and functional ecosystem. To enhance urban areas for pollinators, cities can decrease the use of pesticides and enhance the size of green spaces as well as the diversity of plant species. Green networks and corridors play a role in preventing inbreeding of isolated populations, which can lead to the extinction of species. Monitoring the diversity and population levels of pollinators is an effective method for assessing a city's friendliness towards pollinators. ProGIreg's citizen science strategy involves engaging local residents in creating, monitoring, and raising awareness about pollinator-friendly spaces.

4.1.1.3. Indicators

The Spatial Analysis Methodology report offers a set of analysis subdomains and spatial datasets for each of the four key assessment domains of ProGIreg: socio-cultural inclusiveness, human health and wellbeing, ecological and environmental restoration, and economy and labor market, in order to evaluate NBS benefits in FRC against a baseline. The ProGIreg team, in collaboration with Work Packages, has created a matrix of descriptors and key reference sub-domains for the spatial statistical data requested to FRC and FC during the initial months of implementation.

This matrix includes indicators and statistical spatial data that partners have provided. A total of 71 spatial datasets, spanning the last 10 years (2008 – 2017), have been requested to analyze trends and dynamics at city and analysis area levels. The list of spatial datasets is available in the factsheets in the result chapter, with availability indicators separated for both city level and living lab level. (Leopa et al, 2020)

4.1.1.4. Local plan and policy frameworks

The planning and policy framework analysis sets the stage for Spatial Analysis and is the first step after checking spatial data availability. It provides information about the factors that shape

the context in each FRC and FC, and identifies provisions that encourage or discourage GI and NBS investments. It also helps in identifying potential obstacles and opportunities for progress. This part of the spatial analysis considers three criteria: governance level, instrument character, and policy domain. FRC and FC have recognized current local planning frameworks, programs, and activities for NBS development/implementation. Cities have also compiled a list of NBS-focused or relevant programs, activities, and projects, which will be further considered in the project. In the following table, only those plans which include requirements or provisions that are important for the implementation of NBS in Turin are presented (Table 3). (Leopa et al, 2020)

NBS planning and implementation in FRC Turin aligns with the Turin Metropolis 2025 Strategic Plan, especially focusing on Green Infrastructure, Urban Regeneration, Social Inclusion, and Environmental Sustainability. This plan serves as the basis for addressing various aspects such as socio-cultural inclusiveness, human health and wellbeing, ecological and environmental restoration, as well as economic and labor market benefits through the LL framework. Additionally, local regulatory plans (General Urban Plans) establish the necessary conditions for execution, while other strategies and urban programs help prioritize proGIreg NBS testing. (Leopa et al, 2020)

Table 3 | Local plan and Policy framework for Turin *(Source: (Leopa et al, 2020))*

Key Topics	Regional Level	Local Level	Local level and investments and actions
Green Infrastructure	**Torino Metropoli 2025 (The Metropolitan Torino 2025 Strategic Plan) - Environmental sustainability** The strategic plan for Turin 2025 underlines strategic trajectories in which future development should be conveyed. It recognizes the necessity of a diffuse dimension of sustainability and addresses it with a set of specific governance actions. One action, in particular, can be of use for this project: **Agenzia Metropolitana Corona Verde** defines the vision of the urban metropolitan green as a diffuse system with cultural, environmental and economic dimensions; accessible and opened to forms of cooperation between formal and informal actors. It is further developed in the Stakeholder Analysis. **POR FESR 2014/2020** (See "Asse VI": "Sviluppo Urbano Sostenibile" (in English: Sustainable Urban Development)	**Torino città d'acque – Turin, city of waters** Torino Città d'Acque is the project approved in 1993 by the City of Turin and currentl under implementation which provides for the recovery of the banks of rivers in a single river park of 70 km, with an area of 17 million square meters. The project links the four rivers of Turin (Po, Dora Riparia, Stura, Sangone) to create a continuous system of river parks connected by networks of pedestrian, cycling, naturalistic and educational routes. **(Museo Torino)** **Piano Gestione MAB Po Collina** Management Plan for the Man and Biosphere reserve of the territory of „CollinaPo". For the reserve, an Application Dossier was submitted to the UNESCO MaB Commission in 2015 **Progetto TOCC – Torino Città da Coltivare** (Torino, city to be cultivated) - represents a project approved in 2012 with the aims to promote the development of agriculture in the urban area: sustainable crops and	

Key Topics	Regional Level	Local Level	Local level and investments and actions
		addressed to the concept of "short chain", social agriculture, individual or collective horticulture, agritourism, urban forestation. **Piano strategico metropolitano 2018 - 2020 (cfr. P5: Una Città Sostenibile e Resiliente)** The Strategic Metropolitan Plan of Turin 2018-2020 (PSMTo), The PSMTo identifies a vision of unitary development for the entire territory of the medium to long term CMTo, and is divided into 5 project platforms, 20 strategies and 63 actions / projects; the PSMTo identifies the action priorities for the reference period and the dedicated resources within the Annual Operational Agenda. The GI component is addressed in **P5: A sustainable and resilient metropolitan city.**	
Urban Development and Urban Regeneration	**Torino Metropoli 2025: Urban Regeneration** The strategic plan looks at regeneration considering its diffuse dimension. Regeneration is considered in the form of innovative programs that need to coordinate new forms of social inclusion of the community and stakeholders to activate public and private resources. The basis of this form of regeneration is to be found in past Turinese experiences in urban regeneration which was able to mobilize the social dimension as well as the institutional one. Regeneration is seen as a multi-dimensional concept containing economic development, employment opportunities, services effectiveness, cultural and social regeneration, inclusion. This can be useful to recognize the resources that can be moved or activated on the field, and the possible actors that can help in rendering the project future proof and economically independent and sustainable.	**RG Torino (Plano Regolatore Generale, 1995) - Turin Urban General Plan**, which went through a general revision in order to be transformed into an urban instrument accessible with more simplicity and transparency - http://www.torinosiprogetta.it/ **AxTo - Azioni per le periferie torinesi** (Actions for the Suburbs of Turin) This project analyses and proposes area-based actions and urban acupuncture operations for the peripheral neighbourhoods in Turin, concerning housing, schools, infrastructure, GI, support of micro-enterprises, cultural production and social planning of the urban community. **Piano Strategico Metropolitano 2018-2020** (cfr. P3: Una Città Metropolitana innovativa e attrativa nei confronti di imprese e talenti) – Priority „An innovative and attractive metropolitan city for enterprises and talents".	**Programmi urbani complessi di Torino** ("Complex Urban Programmes") - tools for intervention in critical urban areas, with different purposes, but with similar characteristics **PRIU**-Programmi di Riqualificazione Urbana ("Urban Requalification Programmes") are complex urban projects traditionally of an infrastructure-focused nature, but being implemented in Torino under the provisions for an integrated and participatory approach similar to CLLD **Torino Metropoli 2025: "Quindici progetti pilota di qualità urbana".** The strategic plan has proposed 15 pilot projects for urban quality. These projects are aimed at places which are sparsely defined or have high urban development potential. These projects must follow a specific approach (placemaking) in order to resew the urban fabric with a mix of uses and to

Key Topics	Regional Level	Local Level	Local level and investments and actions
			promote the community to take in charge the management of these public spaces. It can be useful to analyse these projects in order to understand what the outcomes where.
Participation, social inclusion	**Torino Metropoli 2025: Social Inclusion dimensions.** The strategic plan makes of social inclusion a founding concept for its development. Point 5.3 - Strategy 2. Abilitating the socio-economic context, identifies horizontal "abilitating factors" for the development of the entire economic, territorial and social system. Social inclusion here is based on local economic base rehabilitation. The basic idea is to enable resources that are not only public to offer a set of new services that can improve quality of life in the city and thus actively involve the social dimension in the process. Social inclusion in the strategic plan is a broad term, and it involves many dimensions, from economics to transport, to sustainability. Point B.13 -"Social Innovation" points to the renewal of the welfare state system with the involvement of non-formal and non-public actors in the system. This interest and sensibility can be useful to the Progireg project, as it can help in sustaining projects of social innovation and renovation, mixing technology and territorial innovation, and using them to enable projects of social inclusion and participation.	**AxTo - Azione per le periferie torinesi** (see above); **Piano Strategico Metropolitano 2018-2020** (cfr. P4: Una Città Intelligente e Inclusiva) – Priority „An Intelligent and Incusive city	**AxTO Mirafiori Sud**, with currently three projects underway for the redevelopment of green areas (Emilio Pugno garden, Nino Farina gardens, Camilla Ravera) **UIA Co-City Project**

Key Topics	Regional Level	Local Level	Local level and investments and actions
Other connected topics of interest	**Torino Metropoli 2025: Environmental sustainability** A.5 "Manager for the Sustainable metropolitan city". This action has to do with the economical dimension of sustainability. It aims to reach opportunities offered by innovation through a more efficient use of resources creating socio-economic value with minimum impact on natural systems. This manager figure should promote coordinated actions on efficiency of use of natural resources, but also landscape restoring and rehabilitation and sustainable economy models. It has also to do with diffusion and experimentation of new action plans for the territory that concern environmental sustainability.		

4.1.1.5. Baseline assessment of local conditions

This part provides the background for the spatial analysis, establishing the initial evaluation of local conditions and the spatial data, while summarizing the key features of the FRC and FC / metropolitan areas involved in the project for comparison and dissemination at the local and project levels. ProGIreg will apply NBS with the goal of producing benefits for the entire urban area, particularly in terms of social and economic advantages. Putting these changes into context involves carrying out a preliminary spatial analysis at two different territorial scales:

a) The city/metropolitan analysis scale,

b) The LL analysis scale (for FRC), and the regeneration areas for which Urban Regeneration Plans will be designed (for FC)

The determination of the spatial analysis region for the city/metropolitan scale has been carried out taking into account the city's administrative boundary and/or the boundary of the metropolitan area or metropolitan association area, depending on the partner.

In the case of FRC Turin: The Mirafiori District covers an area of 11.49 km2 situated to the south of Turin. In Turin's case, the Analysis Area and the LL overlap. The following table provides definitions for FRC Turin's analysis area (Table 4): (Leopa et al, 2020)

Table 4 | Turin Identification Fiche *(Source: (Leopa et al, 2020))*

Turin Identification Fiche		
Localization of City	**Region (NUTS 2)**	*ITC1 (Piemonte)*
	Sub-region (NUTS 3)	*ITC11 (Torino)*
	Coordinates	*Latitude 45° 03' 00" Nord; Longitude 7° 40' 00" East*
Information about the city	**Population (2017)**	*884,733 inh.*
	Surface area	*129.99 km²*
	Density	*6,805.690 inh./ km²*
	Average elevation	*250 m*
	Climate	*Cfa – mild temperate climate (Köppen and Geiger classification)*
	Average temperature in winter	*1.4 °C*
	Average temperature in summer	*23.6 °C*
LL area	**Population**	*34,659 inh.*
	Surface area	*11,491 km²*
	Density	*3,016 inh./ km²*
Contact and Information from the Municipality	**Municipal website**	*http://www.comune.torino.it*
	Data sources	*http://geoportale.comune.torino.it/web/*
Description of context	**Specific objective for proGIreg implementation**	*- The LL methodology applied to NBS;* *- Education in schools;* *- Inclusion for disadvantaged social groups (social housing inhabitants; refugees;* *- Support to new entrepreneurship and new green jobs;* *- Common goods regulation to apply on NBS*
	Past intervention	*Living Labs on other topics, common goods regulation, educational environmental lab in school*

Context and description

The Municipality of Turin is the capital of the Piedmont region (North- West Italy). With 884,733 inhabitants, 130 km² territorial extension and a GDP of 55 billion euros (which is 4.5% of the national GDP) it is one of the most important cities in Italy. The administration, with about 9.000 civil servants, deals with the overall management of municipal assets and public services. Since the 1990's, Torino has been transformed from an industrial capital (predominantly in the automotive sector) into a center of innovation and culture.

In 2009, Turin officially kick-started its path to become a "Smart City" when the City Council decided to take part in the "Covenant of Mayor" initiative of the European Commission. As one of the first Italian cities, it developed an Action Plan for Energy in order to reduce its CO_2 emissions more than 20% by 2020. In 2016, the city won the second prize as "European Capital of Innovation" for open innovation models supporting social innovation start-ups and creating new market opportunities for urban innovations.

The Turin Living Lab (LL) will test and develop models for participatory urban regeneration whilst implementing the new municipal regulation on common goods. The LL area is the post-industrial "Mirafiori Sud" district (34,659 inhabitants on 11.5 km²) which is located along the river Sangone. The former working-class district is characterised by poor quality of the urban environment (green and grey infrastructure) accompanied by social segregation, poverty and security problems.

4.1.1.6. Spatial analysis levels and NBS to be implemented in the FRC of Turin

In ProGIreg, the following investigation levels for the city of Turin are used:

a) The City Level (129,99 km²) – Citta di Torino area, which is administratively divided into 8 districts (circoscrizioni)

b) The LL Analysis Area comprises the Mirafiori Sud district (1,149 ha), one of the largest districts in the city, and the area in which the Living Lab is going to be implemented. It is situated in the southernmost area of the Municipality.

Starting in the 1970s, the green spaces in the city expanded from 4 to 18.4 square kilometers, providing a standard of 19.05 square meters per resident, which ranks Turin as the leader in Italy. This growth was the outcome of a forward-thinking and environmentally friendly approach, guided by a series of urban surveys conducted since the late 1970s, which influenced the approval of the General Regulatory Plan in 1994. Presently, the city's urban green network includes:

- The "Green-Blue System" connecting four river corridors and the "Green Ring" (Anello Verde), a 45 km path system connecting hills and river banks

- The "System of the Cyclopists" along transport corridors and within the system of urban and peri-urban parks
- The "Spine System", green areas created following former railway lines and industrial areas of the semicentral urban area
- The "Urban Park Network", parks and gardens of the urban core area
- The "Urban Tree Network", the city 's woodland heritage network distributed across the city
- The "Network of small green neighbourhood areas" for which the city administration is seeking direct involvement of citizen groups.

The reason for implementing proGIreg in Turin is to tackle the challenges faced by the Mirafiori district, including infrastructure, inadequate urban conditions, social and economic problems, and safety issues, by implementing and experimenting with Nature-Based Solutions using the Living Lab methodology. The results are expected to make a positive contribution to: to: (Leopa et al, 2020)

- Education in schools;
- Inclusion for disadvantaged social groups (social housing inhabitants; refugees);
- Support to new entrepreneurship and new green jobs;
- Common goods regulation to apply on NBS.

In Turin, the following set of NBS realized: (Leopa et al, 2020)

Turin ProGIreg Nature-Based Solutions

- **NBS 2:** a 2 000 m² test area "New soil and plant species for urban forestry" in Parco Sangone
- **NBS 3:** an 8-ha development area for urban farming and gardening involving disadvantaged groups
- **NBS 4:** a small aquaponics testing installation
- **NBS 5:** small scale GI interventions
- **NBS 6:** a new greenway and cycling corridor along Sangone river which is connected to the overall Turin metropolitan cycling network and links ex-industrial private areas with public ones
- **NBS 7:** new environmental compensation instruments, connected with the environmental assessment and compensation of big events and the realization of a "green business network"
- **NBS 8:** Pollinator friendly green spaces

4.1.1.7. Stakeholder analysis in ProGIreg project

Every city has its own unique set of stakeholders and culture of engagement. Identifying these stakeholders is a crucial first step in ensuring that Nature-Based Solutions (NBS) and Urban Regeneration Plans are collaboratively developed at the local level and align with the expectations and needs of all relevant parties. ProGIreg utilizes a quadruple helix-approach to promote and maintain NBS innovations, with a focus on ensuring that the implemented

solutions are based on solid scientific research, comply with the legal frameworks of the FRC and broader governmental initiatives, achieve public acceptance and adoption, and are economically viable and sustainable.

In all stages of the project, four types of stakeholders are of interest to be engaged in the testing of NBS (FRC) and the development of Urban Regeneration Plans (FC):

Local government, Academia, Industry and the Civil society.

At the start of the project, it is important to identify the stakeholders to understand local priorities better and create solutions that are more closely connected to the local context, which will promote the long-term sustainability of the ProGIreg actions. The initial stage of this collaboration involves identifying the appropriate stakeholders from each of the four helix domains to assist FRC and FC in their participatory processes. (Leopa et al, 2020)

The internal stakeholders within ProGIreg consists of the collaboration between the municipality and the local universities (Università degli Studi Di Torino, Politecnico di Torino), citizen associations and NGOs already working in the area (MIRAFIORI, ORTIALTI), SMEs and industry (DUAL, ENVIPARK). FRC Turin represent civil society actors – associations of parents, NGOs protecting the interests of vulnerable groups (the homeless, Roma, Sinti, asylum seekers).

In Turin's Mirafiori district, the LL initiatives address the particular needs of the local residents, especially by creating green urban areas and utilizing nature-based solutions to improve social unity, inclusivity, and business development. This means that Turin can make use of existing well-established social NGOs and organizations that are already knowledgeable about the requirements of the broader local population who will benefit from these initiatives. (Leopa et al, 2020)

To avoid data repetition, we will present the stakeholder analysis of Turin at the living lab level in a factsheet in the results chapter.

4.1.1.8. SWOT analysis in ProGIreg project

In order to provide a useful, comprehensive, but condensed characterization of the local state of development in FRC and FC, the SWOT (Strengths, Weaknesses, Opportunities, Threats) instrument is used. The district of Mirafiori, once dominated by industry, is closely tied to the history of the FIAT Company, serving as a prime example of Italian city-factories. In its post-industrial state, the area experienced considerable physical, cultural, and social decline. However, FIAT has remained a significant force in revitalizing the area by prioritizing a robust CSR initiative that demonstrates the company's dedication to enhancing the cultural heritage of the post-industrial site. (Leopa et al, 2020)

The detailed SWOT analysis of Turin at the living lab level will be presented in the ProGIreg factsheet in the results chapter. Here we will mention the general points of the SWOT analysis at the Turin living lab level.

Socio-cultural inclusiveness

- Progressive depletion of industrial and residential buildings and reduced commercial activities

- Unemployment and sharp decline in population density of the district due to the loss of industrial activity
- High number of elderly people and a considerable number of empty social housing
- Concentration of people with a high incidence of social problems and a strong cultural mix physically isolated and socially separated from the surrounding areas

Human health and wellbeing

- Greenery present on the most important mobility corridors and public spaces
- Lack of accessibility from other parts of the district resulting from a lack of public transport connections with Mirafiori
- Emerging culture of community gardens, not all of them regulated by the city

Ecological and environmental restoration

- Presence of an important network of naturalistic pathways because of the natural assets of the area (green belt Corona Verde and Sangone River)

Economy and the labour market

- Necessity of stimulating social entrepreneurship
- Necessity to enrich the economic profile of the district

4.1.2. CWC Project

4.1.2.1. Introduction

The CWC-City Water Circles project is designed to assist cities in modernizing their urban water infrastructure systems by implementing a circular economy approach, providing numerous economic and environmental advantages. This is achieved by promoting a mindset of water preservation, incorporating unconventional water sources, and leading the way in integrating urban stormwater collection and utilization, as well as implementing city-wide gray water recovery initiatives. (CWC, 2022)

The partners collaborate to create a digital learning resource on urban circular water management, incorporating innovative nature-based technology solutions and smart governance tools for use across Central Europe. The project aims to promote water efficiency and reuse unconventional water resources to reduce water consumption and pressure on overexploited water resources in urban areas, while also mitigating the negative impact of intense weather events. The specific investment envisaged by the City of Turin is aimed at introducing a green roof technology to create an outdoor roof garden with aeroponic cultivation. The Municipality of Turin budget is 270,391.60 € (100% financed by the European Union). (CWC, 2022)

The City of Turin implements the following actions: (CWC, 2022)

- Activation of a working group aimed at analyzing the local situation relating to water management;
- Definition of a strategy based on the principles of the circular economy, in collaboration with local stakeholders and in synergy with the Italian technical partner Poliedra – Service and consultancy center of the Milan Polytechnic on environmental and territorial planning;
- Identification of good practices with particular reference to the implementation of "NBS solutions - nature based solutions";
- Design and construction of a green terrace and an aeroponic greenhouse at Open011 (Youth Mobility and Intercultural House) in Corso Venezia 11
- Communication and dissemination activities

4.1.2.2. CWC Stakeholders

The involvement process was successful, demonstrating substantial participation from both a qualitative and quantitative perspective. Regions play a significant role among the stakeholders, as they are responsible for creating urban regional regulations that impact provincial and municipal levels. Additionally, the Autorità di bacino are crucial stakeholders involved in the operation and management of the network supply. Stakeholders provided feedback for the FUA level action plan, which influenced the development of the plan and strategy and defined the desired interventions. The final version of the strategic documents is influenced by stakeholders. (CWC, 2022)

To prevent data duplication, we excluded the stakeholders of Turin in CWC project from this part. You can find more information in the CWC factsheet under the results chapter.

4.1.2.3. Baseline Assessment

The total area of FUA is approximately 1.701 square kilometers and encompasses 89 Municipalities. In 2018, the recorded population was 1,784,753. In 2018, 34.50% of the land was used, and the green area in the entire FUA covers about 1.320 square kilometers. The average annual precipitation is 927 mm. The assessment of water quality for rivers, canals, and lakes varies from very good to adequate. The water supply network is accessed by 100% of the population. All purification and treatment systems are managed by SMAT. Currently, 93 drinking water plants are operational, with some plants simultaneously eliminating multiple pollutants. (CWC, 2022)

The processes adopted by SMAT to guarantee the quality of the water supplied to users are the following: aeration, chemical oxidation with chlorine, chlorine dioxide or ozone, clarification and precipitation, filtration on sand or ion exchange resins, reverse osmosis, ultrafiltration, adsorption on activated carbon and other materials, disinfection with hypochlorite, chlorine dioxide and ultraviolet rays. The index of real losses in distribution is 24,97% in the City of Turin, and there is no dual water distribution system. (CWC, 2022)

The number of meters of sewerage network per person remained unchanged in 2018 compared to the previous year. To improve the treatment of wastewater, it is recommended to have two separate networks for black water and rainwater. This helps prevent the dilution of black water, which can make purification processes more expensive, and the contamination of rainwater, which is not very polluted and requires simpler treatments. In recent years, SMAT has been planning to separate the two types of networks for new sewer constructions and for the renovation of existing ones. (CWC, 2022)

SMAT administers 9,526 kilometers of municipal sewer networks, including separate systems for white and black water as well as mixed sewer systems, which equates to 4.2 meters per resident served. The majority of the water sourced from the environment comes from underground, such as from wells and springs (comprising approximately 82% overall). Only 17.7% is derived from surface sources like rivers, streams, and canals. (CWC, 2022)

- Water produced from wells: 71%
- Water produced from surface withdrawals: 17,7%
- Water produced from springs: 11,3%

I will store the following text: In 2018, SMAT supplied a total of 177.2 million cubic meters of water, with nearly 79.12% allocated for domestic use. With a population of 2,247,449 residents in the municipalities served by SMAT, the average daily drinking water consumption per person for domestic use was 171 liters in the Metropolitan city of Turin. Considering national data, the estimated annual water consumption in the Functional Urban Area (FUA) for 2018 was equivalent to 290.000.000 1.5-liter bottles (approximately 0.66 liters/day per capita). (CWC, 2022)

- Use of Potable Water Domestic use 79,12%

- Commercial and industrial use 13,61%
- Public use 5,83%
- Agricultural use and breeding 1,35%
- Other uses 0,09%

4.1.2.4. Vision

The vision of the stakeholders emerged during the first two stakeholders' meetings organized in spring and summer 2020. (CWC, 2022)

GENERAL OBJECTIVES:

- Quantitative and qualitative protection of the water resource
- Attention to the reality of climate change
- Develop an (eco) systemic approach to the strategy
- Generate a legal framework that facilitates water management
- Sharing of resources and knowledge
- Attention to data quality and solutions
- Involvement of entities, the population and dialogue between the parties
- Generate consciousness, awareness and education on the water resource
- Generate an action plan that can be extended and which can become practice, generate culture and influence at the political level
- Acting on the various levels and recognizing the different actors

OVERALL STRATEGIES:

- Education, training, information, awareness
- Collaboration, participation, co-creation and co-design │Between institutions / bodies with the territory
- Water: conscious use
- Urban green and ecosystem services
- Pilot projects
- Financing
- Data and indicators

During the third stakeholders meeting held in the fall of 2020, the vision ideas have been organized in the logical framework of the Strategic Plan.

4.1.2.5. Strategic Goals and Objectives

Several fundamental objectives were identified during the stakeholder meetings: (CWC, 2022)

1. Ensure the good quality of water bodies

2. Improve the hydrological response of the territory

3. improve the ecological conditions of watercourses

4. enhance the services offered by ecosystems and NBSs

5. improve the quality of the air and the microclimate

6. Generate consciousness, engagement and awareness, and improve governance

7. Minimize land use

Table 5 | Operational objectives and indicators of strategic goal 1 *(Source: (CWC, 2022))*

Operational objectives	Indicator
Reduction of network losses within values of ...	Percentage (%) or specific losses (l/d/km)
Provide rainwater collection and reuse systems ... buildings within the FUA	No. of buildings
Provide gray water reuse systems … buildings within the FUA	No. of buildings
Implement NBSs for the treatment of overflow water/runoff for an area of …	Total area of the implemented treatment NBSs

Table 6 | Operational objectives and indicators of strategic goal 2 *(Source: (CWC, 2022))*

Operational objectives	Indicator
Create infiltration SUDS to serve a waterproofed surface equal to …	Total area drained by SUDS
Create green roofs (lamination and evapotranspiration) for a total area of …	Total area of green roofs
Create diffuse lamination systems equal to …	Diffused lamination volume created

Table 7 | Operational objectives and indicators of strategic goal 3 *(Source: (CWC, 2022))*

Operational objectives	Indicator
Improve ecological conditions on … km of watercourses	Improvement of at least 1 IFF (= Fluvial Function Index) class in the affected waterways

Table 8 | Operational objectives and indicators of strategic goal 4 *(Source: (CWC, 2022))*

Operational objectives	Indicator
Implement NBSs for the treatment of overflow water/runoff for an area of …	Total area of the implemented treatment NBSs
Create infiltration SUDS to serve a waterproofed surface equal to …	Total area drained by SUDS

Create green roofs (lamination and evapotranspiration) for a total area of …	Total area of green roofs
Implement diffuse lamination systems equal to …	Diffused lamination volume created

Table 9 | Operational objectives and indicators of strategic goal 5 *(Source: (CWC, 2022))*

Operational objectives	Indicator
Create green roofs (lamination and evapotranspiration) for a total area of …	Total area of green roofs

Table 10 | Operational objectives and indicators of strategic goals 6 *(Source: (CWC, 2022))*

Operational objectives	Indicator
Involve citizens in information, education and awareness activities	Number of participants in activities / year
Involve key players in training activities	Number of participants in activities / year

4.1.2.6. Implementation

The execution involves carrying out planned actions. To implement the plans, various local government departments, institutions, and organizations must cooperate, even though private contractors may carry out the actual implementation activities. This section should establish the roles, responsibilities, relationships, and communication among these implementing bodies and stakeholders. (CWC, 2022)

Which organization is capable of successfully executing the strategy and ensuring that deadlines are met, results are of high quality, budgets are managed correctly, and stakeholders are provided with up-to-date information? From where will the resources for implementing the strategy be funded? Are there any specific financial, logistical, political, or social factors related to the local context that are crucial for the successful implementation of the strategy? This section should also address risk mitigation. Organizational, operational, financial, legislative, or attitude changes may be necessary to introduce and advance circular urban water management. The baseline assessment (e.g., identified gaps) and the analysis of national legislative and policy frameworks (D. T3.4.2, 3) are the sources of information about what obstacles prevent us from achieving the vision. (CWC, 2022)

The Strategic Plan includes both short-term (2030) and long-term (2050) goals. The Action Plan has a 4-year duration, with new Action Plans expected to be developed every 4 years. By initiating the first Action Plan in 2022, it is anticipated that the first two Action Plans will help achieve the 2030 objectives, and the subsequent 5 Action Plans will contribute to reaching the 2050 goals. (CWC, 2022)

The initial Action Program's activities described in the preceding paragraph contain the following elements: (CWC, 2022)

- a designated individual accountable for ensuring accurate implementation,
- an identification of any other potentially involved parties,
- a specified timeframe for completing the action,
- the anticipated outcomes,
- an approximation of the required financial resources (if internal resources of the executing entities are insufficient), as well as the potential funding source.

The individuals accountable for the initiatives outlined in the initial action program are some of the stakeholders who have been actively involved in the CWC project's activities: Turin Municipality, Metropolitan City of Turin, Polytechnic of Turin, and SMAT. Turin Municipality, with the assistance of the Metropolitan City of Turin, will be responsible for coordinating the execution of the Strategic Plan and the progressively implemented Action Plans. (CWC, 2022)

4.1.2.7. Monitoring and Evaluation

This paragraph serves to demonstrate the monitoring system of the Strategic Plan of the CWC project, a tool that establishes various strategic goals. Achieving these goals may not always be easily verifiable and depends not only on the actions planned in the current Plan, but also on other measures beyond the scope of the CWC project. As a result, some "operational goals" have been identified to be verifiable and measurable, relating exclusively to the "action plans" proposed by the CWC project. It is precisely these goals that the Plan's monitoring system focuses on, as the purpose of monitoring is to assess over time whether the actions implemented contribute to achieving the goals. (CWC, 2022)

The table in CWC factsheet in result chapter displays the operational goals, the quantification indicators, and the targets outlined in the Strategic Plan for two timeframes: 2030 and 2050. It also identifies the individual accountable for data collection and provision, as well as the frequency of data collection. (CWC, 2022)

For avoiding repetition of data, we didn't include the table again in this chapter.

4.1.3. CONEXUS (Valdocco Vivibile) Project

4.1.3.1. Introduction

CONEXUS is CO-producing NBS and restored Ecosystems – transdisciplinary nexus for Urban Sustainability. (Torino Eu Projects, n.d.)

CONEXUS receives funding from the EU Horizon 2020 program and is a research and innovation project spanning 4 years (2020-2024). The project involves 7 cities in Europe and South America: Barcelona, Bogotà, Buenos Aires, Lisbon, Santiago de Chile, São Paulo, and Turin as partners. CONEXUS focuses on creating knowledge, testing solutions, and involving stakeholders to combat climate change through the implementation of natural solutions (NBS) and the development of green infrastructures (GI). (Torino Vivibile, n.d.)

The CONEXUS project aims to offer relevant evidence concerning the impact and sustained feasibility of these methods. Conexus spans a four-year duration and is designed to offer readily available information on the restoration of natural ecosystems, enhancement of urban life quality, and promotion of cooperation between Latin America and Europe. (CONEXUS, n.d.)

4.1.3.2. CONEXUS Approach

CONEXUS aims to exhibit how nature-based solutions have the potential to counteract the negative impacts of urbanization by reviving and enhancing the functionality of urban and peri-urban ecosystems and the benefits they offer. The project will showcase the role of nature-based solutions in reconnecting people with nature, as well as their capacity to yield various advantages by testing creative approaches to integrating them into local environments. (CONEXUS, n.d.)

There key principles of the Conexus approach are: (CONEXUS, n.d.)

- <u>Nature-based thinking:</u> Nature-based solutions should be considered as integral parts of the environment, rather than as separate installations, in order to enhance their resilience and sustainability.

- <u>Place-based approach:</u> nature-based solutions are important for place-making (creating nature-based solutions), place-keeping (maintaining into the future) and place-prescribing (policies are programmes designed to engage people).

- <u>Co-production:</u> Involving project partners and communities in developing and implementing policies and nature-based solutions.

- <u>Mosaic governance models:</u> Forming adaptable teams across different sectors and levels to work together on specific issues and projects.

- <u>Nature-based solutions at multiple scales:</u> Establishing and assessing nature-based solutions on different scales: large (e.g. city-wide, strategic network); medium (e.g. restoration of river corridors, food production); and small (e.g. school grounds, communal spaces).

The objective of CONEXUS is to collaborate in producing, organizing, and facilitating access to collective and tailored knowledge required to assist cities and communities in jointly creating NBS and rejuvenating urban ecosystems, in order to catalyze a significant shift in urban policy and implementation in EU and CELAC (Community of Latin American and Caribbean States) nations. (Torino Eu Projects, n.d.)

The project takes on a planetary health approach: Preserving healthy landscapes and ecosystems is crucial for supporting human life, and it is imperative for humanity to rehabilitate, generate, and mend these landscapes and ecosystems through a reciprocal, continuous, and iterative relationship. This interdisciplinary initiative employs nature-based thinking (NBT) to unite community, private, public, and research collaborators in tackling this challenge, and it explores new co-production methods to introduce innovative NBS in "Life-Labs" and pilot projects. The primary idea of the project is to collaboratively develop contextually suitable NBS for restoring ecosystems and promoting sustainable urbanization in cities across CELAC and the EU, using a place-based approach (place-making, place-keeping, and place-prescribing), and resolving issues together with citizens. (Torino Eu Projects, n.d.)

4.1.3.3. CONEXUS Life Labs

Life-Labs provide an opportunity to collaborate and build partnerships with local communities of learning to support the development of NBS demonstrators, identifying opportunities and creating mechanisms to involve citizens, academics, public, private and third sectors, at different scales. This will enable the co-creation of ecological restoration programmes by developing new ways of working in an integrated way across institutions and organizations in all cities. Key actors in the city partnerships will trial NBT methods, building on the 'mosaic governance ' concept, helping to further understanding of how each NBS intervention fits within its own unique institutional and governance context. (CONEXUS, n.d.)

4.1.3.4. Turin Living Lab (Valdocco)

The Turin Life-Lab aims to apply nature-based solutions for climate adaptation at both small and large scales. Its efforts will include small-scale initiatives in the northern and southern parts of Turin. Additionally, it will collaborate closely with private sector investors at a larger scale to create new financial models. The project will identify opportunities to enhance biodiversity and promote human health and well-being. It will also investigate possibilities for renovating neglected spaces and repurposing public areas. The pilot will be evaluating the newest design methods while tackling the unique obstacles of Turin. The nature-inspired solutions in place must adhere to the historically significant street layouts and conform to the stringent architectural preservation rules. Meanwhile, Turin is dealing with growing climate-related risks, placing emphasis on lessening the impact of flooding through stormwater management, creating sustainable urban drainage systems, and establishing versatile green networks. (CONEXUS, n.d.)

4.1.3.5. Location of Turin Living Lab (Valdocco)

The project involves the area called Valdocco, a historic district of the city of Turin which is part of the Aurora district and is included in District 7. The boundaries of the redevelopment are between Strada del Fortino to the north, corso Regina Margherita to the south, corso Principe Oddone to the west and via Cirio – via San Pietro in Vincoli to the east. The project is divided into two lots and the first lot, limited to the south by via Sassari and via Robassomero, will be completed by the end of 2022. (Torino Vivibile, n.d.)

4.1.3.6. Aims of Turin Living Lab (Valdocco)

The project's goal is to redefine how urban space is used. Currently, the focus is solely on the road network, but there is a need for solutions that create more areas for pedestrians. This includes spaces for walking and, importantly, high-quality places for people to stop, meet, interact, and enjoy. The project began with changing the waste collection system in the area. By removing public bins from the roads, it opened up an opportunity to enhance the space without sacrificing parking. The project aims to introduce various green and permeable infrastructure solutions that will revitalize the area and support the development of a "climate-proof neighborhood." (Torino Vivibile, n.d.)

4.1.3.7. Objectives of Turin Living Lab (Valdocco)

The experimentation objective is to test out various solutions to reduce the heat island effect and manage rainwater, all with the aim of creating a more habitable urban environment. This approach will enable the development of a set of intervention modules that can be easily duplicated in other urban areas with a similar fabric to adjust to changing climate conditions. At present, the area lacks greenery, and 90% of the public space is occupied by roads with lanes for vehicles, open areas, and traffic barriers that are not in proportion to the local area's needs, which encourages high-speed driving. There is also heavy traffic and excessive parking, as the area provides access to the city center's restricted traffic zone without requiring payment. Addressed issues, strategies and benefits are briefly illustrated in the following figure. (Figure 10)

The main interventions concern: (Torino Vivibile, n.d.)

- The modification of certain major intersections involves creating significant curves that direct vehicles into the appropriate lanes while also expanding the sidewalks to provide resting spots for pedestrians, complete with green and permeable areas. These same spaces are designed to collect rainwater from the streets, reducing the volume of water runoff during heavy rainfall.

- The design of bump-outs at smaller street crossings for installing pedestrian walkways along with green spaces, which also serve to slow down the flow of rainwater.

- Expanding the walkways outside the school buildings to establish secure drop-off zones for students and parents;

- Converting tarmac areas into green infrastructure for shading and cooling by removing the sealant.

- Encouraging opportunities for relaxation and social interaction in inviting and verdant surroundings through the installation of various types of urban green furniture.

- Creating shaded walkways to encourage easy movement and connect pedestrians with different parts of the city;

- Utilization of materials with the ability to reflect solar radiation, thereby decreasing the heat island effect;

- Implementation of public transport shelters with green roofs designed to withstand climate changes.

Figure 10 | Addressed issues, strategies and benefits of Valdocco project *(Source: (CONEXUS, (2023))*
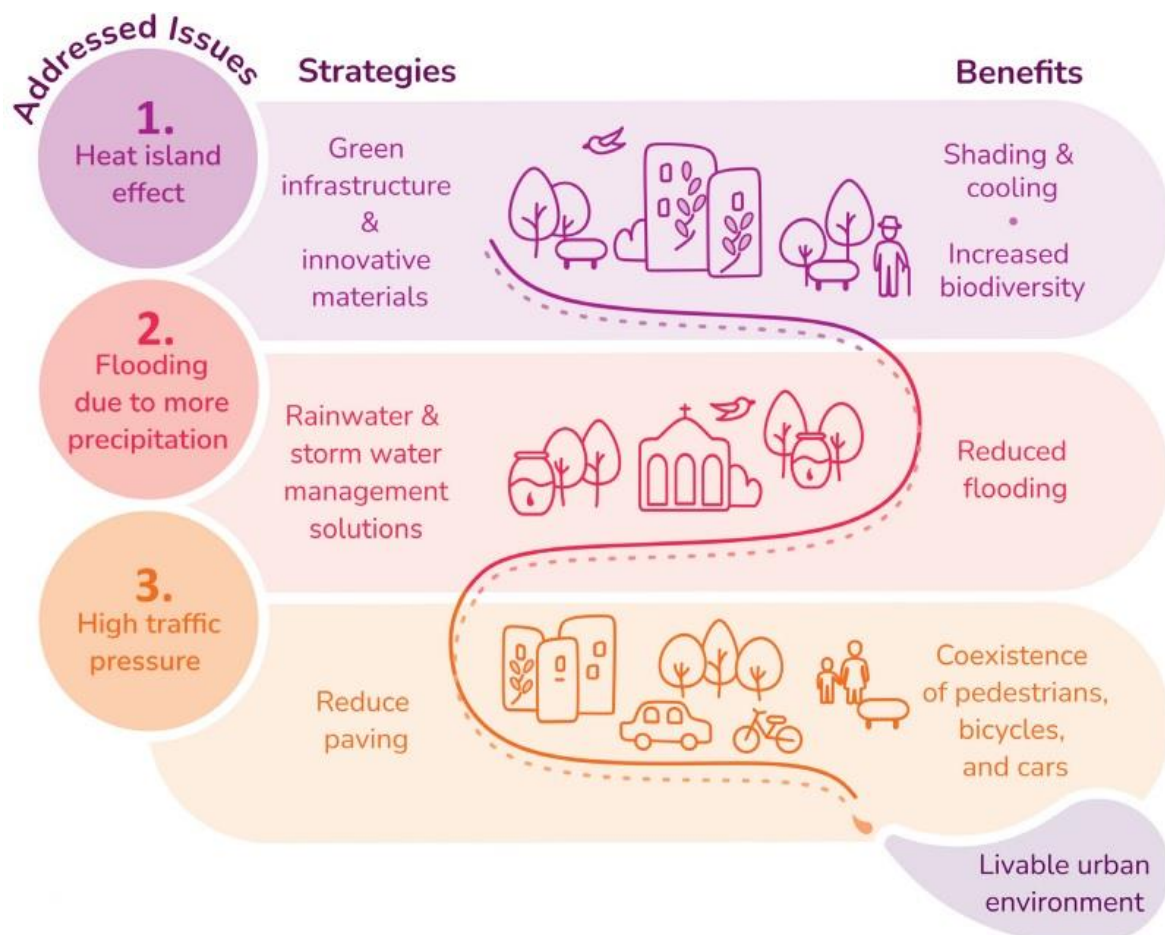
4.1.4. Agrobarrier Project

4.1.4.1. Introduction

The green system's redevelopment project also included improving the former "Boschetto" area by transforming it into a space for urban horticulture. This area, spanning 1,900 square meters between via Petrella and the schools in via Leoncavallo, has been unused since the urbanization of the 1960s and 1970s. Over time, it has become overgrown with brambles, weeds, and shrubs, giving it a "wild" appearance and forming a true "grove." The cleaning and safety efforts began in March 2014. The stability of the area's fence wall was first examined, and then the undergrowth vegetation was cleared. Experts conducted a thorough assessment of the tree specimens and determined it was essential to remove plants that did not ensure sufficient stability and safety. The ground analyses results allowed for the identification of the former "Boschetto" as a nature corner and communal space dedicated to urban gardening and the promotion of eco-friendly farming practices. The plan included subdividing the area into several vegetable plots: two larger ones for communal gardening activities and 20 individual 20-square meter plots. Additionally, the site would feature a storage area for equipment, two shade canopies, and restroom facilities. (Comune, 2015)

4.1.4.2. Announcement of Project

Organizations such as associations, cooperatives, and foundations are the target of this announcement. They are invited to propose a project for managing the area that fulfills specific objectives. These objectives include actively engaging citizens and residents of the neighborhood, creating social gathering opportunities, and organizing educational programs and workshops on environmental sustainability. The selected applicant will sign a five-year agreement with District 6 and can receive a maximum grant of 10,000 euros. The entire zone is under the management of a single organization, designated through the initiative "Coltiva Barriera!", which was launched by the Urban Committee and District 6 in the initial months of 2015. According to the announcement, this entity is not only responsible for maintaining and supervising the area, but also for arranging recreational, educational, and social events to transform the "Boschetto" into a place for gatherings and meetings, fostering participation, solidarity, and awareness of environmental issues. (Comune, 2015)

The RE.TE. NGO, in collaboration with several experienced partners including the Parco del Nobile Association, the Il Gelso Paziente Social Cooperative, Volontarinrete, and the Scholé Futuro Onlus Institute for the Environment and Education, won the tender with their "Agrobarriera" project. The project involves organizing seminars, meetings, workshops, and other events to enhance the Barriera area. (Comune, 2015)

4.1.4.3. Aim of Project

The aim of the AgroBarriera project is, in fact, to adopt horticulture as a tool for transforming the Boschetto into a meeting place for the inhabitants and citizens of Barriera di Milano: a space for the community to promote and disseminate values such as participation, solidarity, and attention to environmental issues and sustainable behavior. (Comune, 2016)

The goal of the program is to promote social farming as a tool for community development, working on four themes in particular: (RE. TE. ONG, n.d.)

- Psychophysical well-being of the population
- Social inclusion
- Raising awareness of a sustainable lifestyle
- Contrast to the different forms of poverty, especially the educational one

The announcement is aimed at all citizens of District 6 who have reached the age of majority, with particular attention to residents in the areas closest to the Boschetto di via Petrella and to the weakest categories, in order to guarantee the widest social mix.

The assignees will each be able to use a 20 square meter vegetable garden for two years by paying an annual fee of 120 euros. The cultivation should comply with environmental sustainability, and all the necessary equipment for cultivation will be provided. In addition to tending to the vegetable garden, the greengrocers will participate in other activities. They will join the "management committee" of the space and must dedicate at least 2 hours per week to volunteer activities. These activities will include maintaining shared spaces and organizing events to liven up the Boschetto area. (Comune, 2015)

4.1.4.4. Series of Activities

The actions to achieve these objectives mainly consist of didactic horticulture activities, in which agriculture becomes a pretext and a context in which to address issues such as respect for nature, the protection of biodiversity, responsible production and consumption, the fight against discrimination, and health. Among the actions we can mention the collective gardens, formed by heterogeneous groups and having team building as their primary objective, and the formation of strong ties to strengthen the social fabric, the school gardens, in which a group of students is accompanied in the care and management of its own vegetable garden, and training workshops, in which techniques and practices of synergistic agriculture and permaculture are explored and implemented.

Each action implemented in the program is designed with a view to achieving the Sustainable Development Goals contained in the 2030 Agenda. Among those most touched upon during the activities, there are certainly goal 10 - reduce inequalities, 11 - sustainable cities and communities, and 12 - responsible consumption and production. (RE. TE. ONG, n.d.)

It has launched a series of activities since spring 2016: (Comune, 2016)

Individual vegetable gardens:

Through a public tender, the twenty individual vegetable gardens have been given in concession to as many "gardeners". Together with the operators of RE.TE. ONG, the group of gardeners has organized itself by defining regulations for the use of equipment and spaces. Since April 2016, the gardeners have started their activities with the sowing and planting of the first vegetables.

<u>Agro Afterschool Project</u>:

The project, created by RE.TE. ONG in collaboration with the Parco del Nobile association, the Institute for Education and the Environment Scholè Futuro Onlus, and financed by the Compagnia di San Paolo, involved for the 2015/2016 school year the pupils of the schools "Salvo D'Acquisto," "Grazia Deledda," "Giuseppe Perotti," and the lower secondary school "Benedetto Croce." The activities, proposed with the aim of supporting students with more learning difficulties (6-14 years) in their study programs, envisaged after-school cycles divided into workshops on Global Citizenship and Environmental Education, which took place at the schools involved during the winter months and in the collective gardens of the grove during the spring months. A total of 60 pupils were involved.

<u>Collective vegetable garden:</u>

From September 2016, the collective vegetable garden care activities had started thanks to a series of workshops held with the support of Vol.To - Centro Servizi per il Volontariato.

4.2. Case Study Amsterdam

According to the Amsterdam city council, climate change is occurring in the Netherlands, as in other countries. Climate change in Amsterdam is resulting in an increase in extreme precipitation, heat stress, drought, and sea level rise. The adverse effects of extreme weather on Amsterdam residents, particularly those with limited resources to protect themselves, are significant. The impact of climate change includes increased inequality of opportunity and segregation, social unrest, decreased confidence in the government, and health issues for less prosperous people. These include heat-related problems due to inadequate housing and reduced work and learning performance.

Flooding causes serious issues and high costs for the community. It damages social facilities like hospitals, healthcare centers, and schools and hinders the city's development. Major floods can also lead to financial instability and significant casualties.

Drought and subsidence contribute to pile rot under homes, widening the inequality between prosperous and less prosperous homeowners. Affluent individuals can finance a new foundation more easily, while less prosperous groups rely on government support. Additionally, there may be an increase in diseases, such as tropical diseases spreading to Amsterdam.

The Amsterdam city council focuses on preventing climate change and safeguarding the city and its residents from extreme weather. They integrate climate risks into city planning by developing new standards and guidelines. Using stress maps, they identify risk factors and take necessary measures to address potential problems from extreme weather conditions. Their goal is to prepare the city for the changing climate by 2050. They are implementing a Climate Adaptation Strategy and a Climate Adaptation Implementation Agenda, with a focus on creating a green ecological structure with high biodiversity and a natural green-blue network in every new neighborhood design. As part of the ' Amsterdam Rainproof ' neighborhood approach, they also organize neighborhood actions in collaboration with housing associations, local organizations, and residents to jointly green gardens and other public spaces. (Amsterdam City Council, n.d.)

Figure 11 | The City of 2026 *(Source: (Amsterdam City Council, n.d.))*

4.2.1. Frans Halsbuurt Re-Development Project

4.2.1.1. Introduction

All the information about the Frans Halsbuurt project has been gathered from the reports and documents presented on the Municipality of Amsterdam's project website (Gemeente Amsterdam, n.d.) and (Frans Halsbuurt, 2022). The Frans Halsbuurt is an attractive and popular area with new restaurants, cafes, and galleries. With the opening of the North/South line, there is increased pressure on public space. To address this, the district plans to create more street space by relocating parking spaces to the Albert Cuyp garage. Additionally, the opening of the North/South line will impact traffic flows in the area, potentially increasing visitors walking through the Frans Halsbuurt to the Museum Quarter.

The Frans Halsbuurt is situated in the South district of the Municipality of Amsterdam and is a part of De Pijp. The neighborhood is located in the northwest corner of the Oude Pijp. De Oude Pijp is a highly urban area with a delicate balance between living, working, and leisure. It is one of the most densely populated parts of Amsterdam. The Albert Cuyp market, the Ferdinand Bolstraat, and the Van Woustraat with their shops are the district's main attractions. The population is diverse but feels connected and respects each other's lifestyles.

The Frans Halsbuurt was constructed in the latter half of the 19th century in accordance with Van Niftrik's urban expansion plan. As a result, the streets are wider on average compared to the rest of De Pijp, where Kalff's plan was implemented. In the 1990s, urban renewal took place, resulting in the implementation of a residential area structure with various curved streets to accommodate staggered parking spaces.

The preparation for a renovated public space in the Frans Halsbuurt has a long history. Variant studies were already carried out in 2008, combined with idea workshops for residents. In 2014, a memorandum of principles for the Frans Halsbuurt was established, and a design was drawn up. The project experienced changes in 2018 due to a motion, leading to a complete shift in project principles. After an intensive participation process, a new memorandum of principles was implemented.

4.2.1.2. Goal

The ultimate objective of the project is to redesign the public space in a way that meets all requirements. The council aims to involve residents and entrepreneurs in the design process through intensive participation. Participation from the neighborhood is a policy priority. The neighborhood will design its own public space, and the key changes include:

- Eliminating 600 parking spaces
- Designing bicycle parking spaces
- Adding 16 waste collection containers
- Removing clutter in consultation with the neighborhood

4.2.1.3. Relationship with current developments

The redesign of public space in the Frans Halsbuurt is linked to a number of developments. They are listed point by point below:

<u>1. Coalition agreement</u>

The Coalition agreement is started from the 2018 and developing an 'Amsterdam Car-Free Agenda' and for this reason they are examining five directions in conjunction:

- Parking-free Canal Belt;
- Inner city (city center) as car-free as possible;
- Parking-free residential streets;
- Cuts in plus/main network car.

Their goal is to eliminate 7,000 to 10,000 parking spaces by 2025. A feasibility study into this is part of the 'Agenda Amsterdam Car-free'.

<u>2. Area Agenda</u>

De Pijp and Rivierenbuurt area agenda 2016 – 2019 as established by the municipal council.

<u>3. Opening of the North-South line</u>

The opening of the North-South line has marked a significant change in the city's public transport system. The metro station 'De Pijp' is located next to the Frans Halsbuurt (Albert Cuyp exit). This location is expected to generate increased pedestrian and bicycle traffic. It remains to be seen, but it is assumed that a major walking route will be established between this location and Museumplein.

<u>4. Albert Cuyp garage</u>

With the opening of the Albert Cuyp garage, they can now reduce the number of parking spaces in the FHB. The specific details of the new parking regulations are still undecided. This will depend on factors such as the impact of removing a large number of parking spaces in the short term.

<u>5. Improvement of air quality</u>

The council aims to improve air quality in the city. They plan to reduce CO_2 emissions from cars by encouraging electric/hybrid driving and restricting entry to high-emission vehicles. More charging stations will be installed around the city, including in the De Pijp area. This may require expanding the number of charging points in the Albert Cuyp garage.

OAIS and three worm hotels will be installed in the project area in consultation with the OAIS team to align with the final use of the public space.

The Frans Halsbuurt Redevelopment project has no interface with Ring Oud Zuid.

4.2.1.4. Policy and Frameworks

A summary of the most important policy frameworks is given below.

- Public Space Planning Manual (HIOR): hior.amsterdam.nl including:

- The Public Space Vision
- The Water Vision
- The Lighting Policy Framework
- The Urban Framework for Outdoor Advertising
- The Amsterdam Movement Logic
- The Standard for the Amsterdam Streetscape (Puccini Method)

- CVC Guidelines
- Structural vision 2010-2030 (February 2011)
- North/South Line environment program (2011) and work plan North/South Line environment program (2013)
- South Terrace Policy 2013, Fewer rules, clear enforcement (Zuid district, April 17, 2013)
- Main tree structure (HBS) from Amsterdam Structural Vision 2040 (February 2011) and Tree Policy South 2012, Zuid District (2012)
- Catering Policy South 2011, South District (December 21, 2011)
- Doing business in South (South district, August 2012)
- Research into bicycle parking in Frans Halsbuurt, March 2019
- Parking bill (November 2012)
- Mobility Approach Amsterdam 2025, Municipal Council (June 13, 2013)
- Welstandsnota, The beauty of Amsterdam 2013

4.2.1.5. Participation

The design of public space is influenced by the neighborhood, which is made up of approximately 2,500 residents with different ideas. A process-based approach is being used to achieve a widely supported design in multiple steps. It's important to realize that there are established legal frameworks for public space design and that it involves analysis and decision-making.

It was decided to first inform the neighborhood about the established frameworks and then start a process linking creativity to decision-making. The legal frameworks and points of interest were presented during meetings on March 6, 7, 26, and 28.

The initial meetings primarily centered on legal frameworks, which are standard and applicable to all those involved in public space design. These frameworks are rooted in national legislation and municipal regulations, along with established policies. For instance, emergency services necessitate a minimum free passage of 3.5 meters. Points of interest are more open to municipal preferences but are still open to discussion and potential changes. During the second series of meetings on March 26 and 28, the focus was on the neighborhood frameworks. The neighborhood frameworks are created based on statements by the neighborhood, mood boards, and discussions among local residents, expressing the neighborhood's wishes. After the meetings, the neighborhood had until April 19 to complete the Mentimeter online, and the output is included in the Memorandum of Principles.

4.2.1.6. Legal Frameworks and Principles

Frameworks are fixed and not open to discussion:

- Current legislation and regulations apply, as well as the established policy of the municipality of Amsterdam. This also includes local regulations and the motion already indicated.
- In principle, the roadway will remain in its current location. The desired route procedure must be completed once again, requiring utility companies to coordinate their routes for the cables and pipelines.
- The terrace plan has been established and will not be changed. This means that existing terraces may not be expanded and that no permission will be given for new terraces.
- The requirements of rainproof will be met.
- The Stadhouderskade (including parking spaces) does not make any part of the project. This concerns the part of the Stadhouderskade between the Ruysdaelkade and the Ferdinand Bolsstraat.
- Realize underground waste collection (OAIS). There are already places administratively determined. However, additional containers must be provided for plastic and glass.
- All trees survive. There are opportunities for more greenery, e.g. facade plants or planters to tackle heat stress and take rainproof measures.

Points of attention that unlike the frameworks, they are open to discussion:

- Charging stations in the Frans Halsbuurt itself can be reused for mobility hubs or moved.
- The newly constructed parking strip on the Ruysdaalkade will in principle be maintained. However, there will be no parking spaces again. This is done in consultation with the neighborhood.
- In the long term, natural gas will be replaced as an energy carrier. However, a definitive choice for a replacement medium is now too burdensome for the project. Residents and entrepreneurs must agree. Becomes future developments have been taken into account, for example by reserving any pipeline routes (after research).
- Traffic circulation and the connection with surrounding neighborhoods.

These frameworks and principles are available to the public online prior to the first meeting and were presented in detail during the first meeting. Moreover, two substantively identical evenings were organized for the plenary meetings, so that residents and entrepreneurs could choose which evening was best for them.

4.2.1.7. Outcomes

1. Greening

One of the most important desires of the neighborhood is to increase the greenery. This request has been expressed in both a previous survey and in community meetings.

2. Street Profile on one Level

It has been noted that the majority of residents in the neighborhood prefer a single-level street profile for the residential area. The speed limit for vehicles should be reduced to a maximum of 20 km/h to ensure safety. Cars should be considered as guests in this area.

3. Gray Facilities

The "grey facilities," such as bicycle racks and the underground waste collection system, should be surrounded by green plants. These can be hedges, but other shapes are also possible. The neighborhood should work with public space designers to further develop this idea.

4. Loading and Unloading Facilities

People generally find the distance to the current loading and unloading facilities, averaging between twenty and thirty meters, satisfactory.

5. Bicycle Parking

The current bicycle parking situation could be improved. While there are plenty of facilities available, they are not evenly distributed across the area. Residents in Frans Halsstraat and Ferdinand Bolstraat have expressed a shortage of bicycle parking spaces. Most residents would prefer to have the distance from their front door to the nearest bicycle parking spot to be less than 15 meters. This would be less of an inconvenience for visitors as well.

6. Street Lighting

The neighborhood attaches great importance to the fact that the lampposts in Daniël Stalpertstraat (Ritter mast) are placed everywhere.

7. Play Facilities

A slight majority of people feel that there are enough play options available for children in the neighborhood. It would be great if we could designate play areas on each street if possible. It is preferred to integrate play areas with green spaces. The neighborhood doesn't place much importance on sports and recreational activities for adults.

8. Ruysdaelkade

When designing the Ruysdaelkade waterfront, seating and greenery are essential for enhancing its allure.

9. Biodiversity

Biodiversity is enhanced by planting plants and trees to attract birds and beneficial insects to the area. A significant number of respondents express interest in adopting a plant plot.

10. Art

A large majority agrees that there should be more space for art. However, this still needs to be further developed in consultation with the neighborhood.

4.2.2. Gerard Doubuurt Re-Development Project

4.2.2.1. Introduction

All the information about the Gerard Doubuurt project has been gathered from the reports and documents presented on the Municipality of Amsterdam's project website (Gemeente Amsterdam, n.d.) and (Gerard Doubuurt, 2021). The Gerard Doubuurt is undergoing major maintenance that will lead to the redesign of Eerste van der Helststraat, Gerard Doustraat, Daniel Stalpertstraat, and Tweede Jacob van Campenstraat. A participatory public space plan started in April 2020 to involve the neighborhood in the redevelopment process. The area faces challenges due to its urban character, with limited public space and increasing visitor numbers. The focus is on making clear choices to balance the neighborhood's traffic and infrastructural needs with the growing demand for accommodation and greenery.

In the Gerard Doubuurt, there is a conflict between quality of life and economic interests due to limited public space. The area faces visitor pressure throughout the day from shops, cafés, and the Albert Cuyp market, impacting the functionality of public space. The streets in this part are somewhat wider and more regular in width compared to the rest of the Noordelijke Pijp. The plan for the Gerard Doustraat, drawn up in 1877, resulted in narrower streets than originally intended, creating striking triangular squares. The Marie Heinekenplein, constructed in the 1990s, is not part of this.

The Gerard Doubuurt is part of the Oude Pijp in South Amsterdam, located between Stadhouderskade (north), Ferdinand Bolstraat (west), Van Woustraat (east), and the Albert Cuypmarket (south). The neighborhood was created based on expansion plans by J.G van Niftrik (1866) and completed by J. Kalff (1875). Permission was granted in 1876 to halve the blocks projected east-west for profitability, so Quellijnstraat could be added later. By 1884, the Gerard Doubuurt was almost entirely built up.

The Gerard Doubuurt is a unique example of a neighborhood built for all sections of the population through private entrepreneurship. The grid structure of closed building blocks with small bends in the walls gives the area its distinctive character, creating a strong separation between public and private space. The only consciously designed square is the Marie Heinekenplein (1997).

The Gerard Doubuurt is characterized by high building density, with an average of 19,350 homes per square kilometer. It is one of the most densely built neighborhoods in Amsterdam and has a special architectural quality integrated with the Frans Halsbuurt.

4.2.2.2. Purpose

The Public Space Plan aims to work with the neighborhood to create a shared vision for the future design of public spaces, with the goal of improving quality of life and making clear choices for the new design. This includes:

> 1. Making broad choices for the redesign: establishing the foundational elements for the redesign.

2. Developing temporary measures and actions for the redevelopment aimed at enhancing quality of life. This will involve the participation of residents, entrepreneurs, and organizations from the neighborhood, along with South district and municipal departments.

3. The plan involves engaging in dialogues with the neighborhood to determine necessary choices and measures based on the desire for everyone to contribute to improving quality of life.

The plan addresses not only the design of public space, but also focuses on themes that significantly impact the quality of life in the neighborhood. These include accessibility, space, waste management, and greenery. For instance, it's crucial to consider the logistics of supplying shops and food establishments. The concept behind this is to emphasize the importance of discussing the use of public space before making any physical changes. This allows for a collaborative determination of the neighborhood's needs. Another essential aspect of engaging with the neighborhood involves exploring what residents and business owners can do to enhance the livability of the neighborhood.

Different urban frameworks apply to the Gerard Doubuurt Public Space Plan and the planned redevelopment. These frameworks mostly arise from policy and vision documents drafted by the municipality of Amsterdam and the South district.

4.2.2.3. Participation

The Public Space Plan's participation approach aims to engage with the community to determine what they consider important for redevelopment and which issues they want to tackle. The South District is committed to actively involving the neighborhood in creating a Public Space Plan. To achieve this, a process advisory group has been established, consisting of residents and civil servants, to jointly shape the participation process. This approach differs from the usual process controlled solely by the municipality.

Process Advisory Group:

The process advisory group members were carefully selected by the research and participation agency that oversaw the process. It was important for the group to be representative of residents and entrepreneurs from the neighborhood, with a diverse range of ages and backgrounds. The process advisory group played a key role in shaping the process for developing the Public Space Plan from May 2020 to January 2021. Their main objective was to involve as many people from the neighborhood as possible in the process. The group's responsibilities included:

- Coming to a consensus on the process and method for neighborhood surveys to understand what is happening in the neighborhood and to gather suggestions for improvements.

- Providing advice on how to engage the neighborhood in creating a shared vision for the future use and design of public space.

There have been 5 online meetings with the members of the process advisory group. All reports from the process advisory group are public and can be found on amsterdam.nl/gerarddoubuurt.

The group has decided to conduct two neighborhood investigations and has also provided advice on how these investigations should take place. This includes using an online interactive map and conducting street conversations online.

4.2.2.4. Participation Outcomes

It is essential to involve residents and entrepreneurs from the Gerard Doubuurt in the Public Space Plan. After all, who knows the neighborhood better than the people who live and work there? Three neighborhood surveys have been conducted, including interactive maps, online street conversations, and neighborhood consultations. The results of these surveys have been integrated into the Public Space Plan.

Interactive map (August-September 2020)

On the online interactive map of the Gerard Doubuurt, residents, visitors, and entrepreneurs can indicate what is good and what needs improvement. There are 87 points of interest with suggestions for improvement on the map. Many of these entries have received responses from others in the form of comments or likes. Some themes have garnered more responses than others, indicating their importance to residents. In summary, the points for improvement indicated by residents are:

- Overcrowding and busyness

- Increasing noise pollution

- Limited sidewalk space

- Traffic leading to insecurity

- Few wastes disposal areas

- Need for a greener appearance

Online street conservation (December 2020)

In addition to the interactive map, the street conversations will be available online in December 2020. The purpose of these conversations was to further explore the points of interest that play a role in the Gerard Doubuurt. A total of 29 residents and entrepreneurs took part in these conversations per street, always in groups of 4-6 people. The most important points from these conversations are as follows:

- Accessibility for cyclists, pedestrians, and cars

- Quality of life in the neighborhood, with a focus on waste, greenery, lighting, and community interaction

The outcome of the street conversations shows that it is important to find the right balance in public space, including identifying the necessary facilities and amenities and addressing the wishes of both entrepreneurs and residents.

Neighborhood discussions and survey by Gerard Doubuurt Association (March/April 2021)

The Gerard Doubuurt Association conducted a written survey in the neighborhood, in addition to the previous participation rounds. The survey asked for solutions to identified problems and also inquired whether residents and entrepreneurs saw a role for themselves in addressing these issues, or if this should be done by the municipality or other parties. A total of 45 residents and 5 entrepreneurs participated in the study. The proposed solutions covered various themes, including accessibility, car parking, bicycle parking, traffic circulation and logistics, green initiatives, climate adaptation, waste management, and space for recreational activities.

In addition, 14 street conversations were held with 14 residents and 4 entrepreneurs. These conversations showed that the neighborhood desires peace, cleanliness, regularity, conviviality, and co-creation with the municipality and other relevant parties. This means:

- Peace and quiet: reduced traffic, fewer crowds on the streets due to regular cleaning of rubbish and obstacles, more spaces for bicycle parking, less for car parking, and fewer social crowds due to shorter stays, students, and tourists.

- Cleanliness: emptying waste containers more often or providing larger containers; better enforcement of waste disposal rules; taking action against rats.

- Regularity: established cleaning schedules, regular patrols through the neighborhood-by-neighborhood concierge/police officer, designated telephone number/app group for notifications, and planned activities for and by residents.

- Conviviality: residents in contact with each other (through neighborhood association, notice board), participating in joint activities to improve the neighborhood and street scene, taking care of each other, and sharing stories.

- Co-creation: a municipality that seriously connects residents and entrepreneurs, is easily accessible, and engages in continuous dialogue with openness, equality, respect, and takes responsibility where it should lie.

Chapter 5

5. Results

In this chapter, the research presents the culmination of its findings based on a comprehensive review of literature, primary and secondary research studies, and case studies gathered in preceding chapters. Each of the study's objectives is thoroughly addressed in this section, correlating with the progression of the research. Furthermore, the chapter endeavors to address the research question posited in the initial chapter.

The results section commences with detailed factsheets of four case studies in Turin, Italy, and two case studies in Amsterdam, the Netherlands. Subsequently, it proceeds with an inventory of indicators derived from the literature review and the examined case studies' projects, and proceeds to analyze these indicators through the lens of justice.

Finally, the section outlines the selection of 6 KPI from the inventory of indicators, based on the project goals of the Amsterdam case studies. It also independently assesses the effectiveness of the NBS project of Frans Halsbuurt in relation to selected KPIs.

5.1. Factsheets of Turin

A factsheet is a concise, single-page or multi-page document that contains essential information pertaining to a product, substance, service, or other topics. It serves to provide relevant information to end users, consumers, or the general public in a clear and straightforward manner. Factsheets often utilize components such as lists, tables, and diagrams to effectively and efficiently convey information.

In this research, we have created fact sheets for the case studies we've examined to concisely outline and highlight key aspects of each project. These fact sheets include project descriptions, objectives, types of nature-based solutions (NBS), stakeholders and partners, budget information, a list of indicators, and SWOT analysis. The aim is to provide readers with a quick and easy way to grasp the important details of the projects and gain an overview in a short amount of time.

Factsheet of Turin case studies are arranged in this section by starting with ProGIreg then continued with CWC, Valdocco and Agrobarriera projects. Prior to delving into the Turin factsheets, it is advisable to gain an overview of the city of Turin.

ProGIreg Project Factsheet

Description:

ProGIreg was funded by the European Commission under the Horizon 2020 programme and its name stands for "Productive Green Infrastructure for post-industrial urban Regeneration". It aims to demonstrate the benefits of nature-based solutions (NBS) applied into business models in post-industrial cities. The cooperation of public actors, civil societies, academies and industry/SMEs is fundamental to build shared practices and ensure continuity over time. [1]

Turin is characterized by typical features of a post-industrial city that has turned from an (almost) exclusively industrial centre to an innovative city based on culture and services. Deindustrialization of the core of the local industrial manufacturing sites has resulted in areas being emptied, disused or abandoned. The Living Lab in Turin is located in Mirafiori Sud, a post-industrial district that witnessed remarkable growth during the 50s-60s thanks to the car industry especially FCA (Fiat Chrysler Automobiles).

The industrial crisis in the 80s-90s led to the progressive population decline and ageing in Mirafiori Sud district, and the entire city of Turin. Mirafiori Sud is a suburb with poor quality urban environments (neglected green and grey infrastructures) and social issues such as social segregation, poverty and safety problems. The Mirafiori district has weaknesses and great opportunities that can play a pivotal role in transforming the area with successful implementations of several NBS. [2]
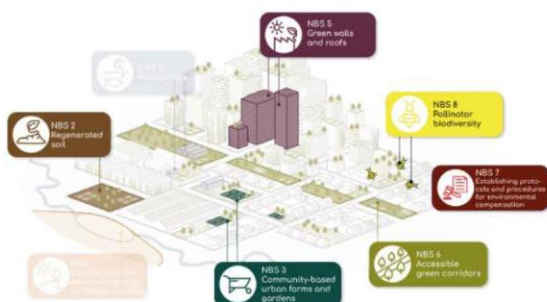
Timeline:

Started in 2018 – Complemented in 2023[3]

Location:

Below map shows the Turin's Living Lab of this project which is the district of Mirafiori Sud. Located on the river Sangone, it is a former working-class area with 40,000 inhabitants and various social groups. [4]

Aim and goals:

The NBS implementations in the Living Lab of the proGIreg research project pursue the goal of addressing social, economic and urban problems. The Living Lab approach entails testing specific NBS in real life conditions by involving diverse stakeholders including citizens at an early stage in co-design and co-implementation processes, aimed at boosting collaborative and long-lasting engagement including vulnerable and marginalized groups. ProGIreg uses nature for renewal for regenerating green infrastructure and land accessibility by:

- Creating green corridors by connecting already existing cycle paths,
- Turning empty buildings into green infrastructures, i.e. green roofs and walls
- Transforming brownfields into community gardens,
- Using regenerated soil, to give new life to poor and non-fertile land;
- Experimenting with collective farming practices as a tool for urban regeneration and social inclusion
- Involving educational institutions and residents to experiment with horticultural practices,
- Designing, managing and maintaining green areas (green infrastructure) shared with local businesses, associations and citizens

The long-term objective is to disseminate and replicate these solutions and practices in other areas of Turin, national and international cities, identifying business models and transversal planning tools whose added value lies in the integrated and shared management of green infrastructure systems. [5]

NBS Types:

Below table shows the 7 different NBS types that are used in Turin Living Lab and overall, 17 NBS are implemented. [6]

NBS Type	NBS Title	Budget
Regenerating soil	New soil production in Sangone Park	278.000 €
Community-based urban farms and gardening on	Mirafiori Castel's ruins recovery and new planting	16.000 €
	Gardens in Cascina Piemonte (Orti Generali)	324.100 €
	Pollinator friendly garden at WOW	7.500 €
	Didactic gardens in schools	81.000 €
	Micro vegetable gardens (OrtoMobile)	25.000 €
	Community school gardens	15.000 €
	Gardens around the houses	34.800 €
Aquaponics	Aquaponic test system	20.000 €
Green on walls and roofs	New green roof at Casa nel Parco	29.316,97 €
	Green indoor wall in a school	40.000 €
	Green wall outdoor on a homeless dormitory	40.000 €
	New green roof at WOW	53.500 €
Accessible green corridors	Green corridor	60.000,00 €
	Local natural heritage enhancement in green corridor	22.000 €
Local environmental compensation processes	Strategic public-private partnership for greening the city	30.000 €
Pollinator biodiversity	Butterfly garden for disadvantaged people	59.244 €

Budget:

€ 896.500,00 to the City of Torino [7]

Partners:

Partners of this project are mentioned below: [6]
- Comune di Torino (COTO)
- Politecnico di Torino (POLITO)
- Università degli studi di Torino (UNITO)
- Fondazione Mirafiori (MIRAFIORI)
- Orti Alti (OA)
- Parco scientifico e tecnologico per l'ambiente – Environment Park SPA (ENVIPARK)
- Dual s.r.l. (DUAL)

Stakeholders:

Overview of primary stakeholders [8]

Role	Type	Name
Users/ Beneficiaries	**Civil Society**	social housing residents
	Education	Istituto Comprensivo Cairoli (Comprehensive School "A. Cairoli")
		Istituto Comprensivo Salvemini (Comprehensive School "Salvemini")
	Civil Society	Associazione genitori Cairoli (Parents association)
		Associazione Genitori Castello di Mirafiori (Parents association)
		Association for homeless men - Coop. Stranidea / Serivizio Adulti in difficoltà, Comune di Torino
		Association for homeless women - Coop. Animazione Valdocco / Serivizio Adulti in difficoltà, Comune di Torino
		Association for migrants - Coop. Progetto Tenda on the behalf of Consorzio Kairos / Ufficio Stranieri Comune di Torino
		Associazione CEPIM – Torino (Center for persons with Down Syndrome)
Governance	**Local Organizations**	Comitato Borgata Mirafiori (Township committee)
	District Government	Circoscrizione 2 (2nd Neighbourhood)
		Città di Torino - Servizio Verde pubblico (Green spaces public service)

	City Administration and Agencies	Città di Torino - Servizio Grandi Opere del Verde (Large green infrastructure public service)
		The Metropolitan Green Agency - future unique reference point for institutions, citizens and visitors in relation to the green dimension.
	Environmental protection	ARPA Piemonte (Regional Environmental Protection Agency)
	Local health authority	ASL Città di Torino (Local Health Authority)
Providers	Social Housing agency	ATC (Territorial Agency for Housing)
Influencers	Network of associations	Mirafiori Social Green
	Enterprises and industry	TNE, FCA
	Non-profit projects	Essere anziani a Mirafiori Sud (NGO "Being elderly in Mirafiori Sud")"), Casa Farinelli

Overview of secondary stakeholders [8]

Role	Type	Name
Governance	Local administration	servizi sociali ex circoscrizione 10 (10th Circumscription Social Services)
	Metropolitan area administration	Città Metropolitana di Torino
	Regional administration	Regione Piemonte
Secondary / benficiaries	Local health provider	Asl Città di Torino – Neuropsichiatria (Local Health Authority – Neuropsychiatric)
		Asl Città di Torino - Servizio dipendenze (Local Health Authority – dependencies service)
	Education	IIS Primo Lev
		ENGIM San Luca
	Civil society organisation	"+1 nel mondo"
		Benvenuti in Italia
		Casa del Mondo

Role	Type	Name
	Civil society	Daycare Centers for Elderly: Centro Anziani Via Candiolo, Centro Anziani Via Morandi
	Civil society: shop owners' associations	UNIONE MIRAFLORES
		VIA PLAVA e VIE LIMITROFE
		A.MI.CO. 10
		A.COM.ART
Providers (Services and Data)	Cleansing department	Amiat
	Integrated water services	SMAT
	Research institution	Inrim – Istituto Nazionale di Ricerca Metrologica
Potential secondary influencers	Non-profit organizations and trade associations	OrMe - Orti Metropolitani Torinesi
		Associazione Italiana Persone Senza Dimora / homeless people Italian Association
		Coldiretti
		I passi
		cpg strada delle cacce
		Mirafleming
	Church communities	Santi Apostoli, San Luca, Beati Parroci, San Barnaba

SWOT Analysis:

Turin Living Lab SWOT analysis is categorized in 4 key scientific assessment domains: [8]

1.Socio-cultural inclusiveness

2. Human health and well-being

3.Ecological and environmental restoration

4.Economic and labor market

SWOT Analysis Turin – Living Lab Level				
	Strengths	**Weaknesses**	**Opportunities**	**Threats**
Socio-cultural inclusion	- Presence of community foundations and city networks have helped to avoid degradation at local level, in spite of the socio-economic decline in the district. - The district attracted new young residents with the project ALLOGGIAMI - Presence of sports activities related to green areas (CUS) - Good availability of social assistance services	- Abandoned industrial areas that prevent communications and internal connections within the neighbourhood - Loneliness, relational isolation, growth of mono-parental families - Downward population dynamics (albeit not that accentuated), with a 3.59% migration rate and an overall - 0.86% population growth rate for 2017) - Decrease of generalized participation to social, religious and otherwise community events and gatherings - Closure of public services - Fragmentation of the social fabric and of the support network (third sector) - Lack of social control of public and green spaces - Absence of pedestrian areas, areas of safe access to the school and areas with limited traffic - High concentration of public housing (social housing) - Absence of public libraries - In spite of Mirafiori being a district with many residents, its density is relatively low – under half of that of Turin (3,086 inh/km² vs. 6,805). The low population density does not favour interaction: poor interaction between inhabitants and users (Polito students /	- Empty industrial spaces: potential social spaces to be filled - Presence of the seat of the Politecnico design office, with the relative number of young people (2000 students) and teachers - Action to involve the CUS on the Colonnetti Park - Construction of a common identity in the neighbourhood – a "Mirafiori brand" with which inhabitants can identify - Refurbishment of farmhouses on the golf course area	- Absence of a public policy that puts local projects in place at city level - Economic crisis: participation becomes a luxury if you do not have a job and you are in layoffs - Confidence crisis towards intermediate subjects (representation crisis) - Thousands of square meters of empty / vacant spaces that can further enhance degradation at local level (lack of attractiveness for development, "broken windows theory")

SWOT Analysis Turin – Living Lab Level				
	Strengths	**Weaknesses**	**Opportunities**	**Threats**
		teachers, FCA workers, CUS users, etc.)		
Human health and wellbeing	- Presence of numerous green areas equipped for outdoor sports and of urban gardens - Wide availability of accessible public green – considerably higher surfaces of green space per capita compared to the city (91 vs. 55 m² / inhabitant) - Presence of cycle path along the Sangone river	- Higher incidence of cardio and respiratory diseases, allergic diseases, chronic stress, mental health diseases and NCDs compared to data at city level. Relevant presence of alone elderly with psychic discomfort - Insecurity perceived in the green area along the Sangone river - Presence of dangerous infrastructures such as unsecured electric pylons within equipped green areas - Low permeability between the various parts of the district - Continuous use of the private vehicle, a serious shortage of cycle paths and difficulties in expanding the infrastructure (e.g. the via Plava bike path has been financed but the construction does not start) - Shortage of park areas accessible to the West	- CSR companies to involve the employees of companies based in Mirafiori South in the care of the green - Presence of Eco design and chemistry faculty in the territory - opportunities for activities of education and sensitivity to environmental issues	- Extra-urban vehicular traffic at high distance which potentially threatens the health of the inhabitants through air pollution

SWOT Analysis Turin – Living Lab Level				
	Strengths	**Weaknesses**	**Opportunities**	**Threats**
Ecological and environmental situation	- District with good presence of green areas, especially available for residential building areas - Parks extended to the south with good ecological potential - Large spaces that help to avoid traffic congestion with the associated peaks of air pollution - Low temperature, reduction of heat island effect due good connectivity to green areas and building density - The presence of a strong third sector which is already oriented toward increasing socialization, social cohesion and environmental issues is pivotal for the success of this project as well. Some of the association and networks that are providing us support are OrtiAlti, Mirafiori Chlorophyll Project and Mirafiori Social Green Project. - Presence of active associations in terms of environmental sustainability - Higher percentage of "green per capita" than the rest of the urban area - Presence of vast areas dedicated to community gardens - Presence of cycle paths that connect the district to the city centre	- Urban soils with high levels of pollutants from industrial pollution and fuels used in past years - High levels of atmospheric pollution - Abandoned industrial areas - Presence of abusive gardens as degraded and often polluted areas - Poor availability of cycle paths for local use, which connect the various areas of the neighbourhood	- Possible connection and enhancement of the peripheral parks within the Corona Verde program and the ongoing process to redevelop the shores of the Sangone river - Processes of social activism that allow the involvement of citizens in the care of green spaces (Co-City / Regulation of common goods) - Presence of flat roofs and residual urban spaces as potential green roofs of greening - Eco design and faculty of chemistry, education and sensitivity to environmental issues - Industrial brownfields as potential for new green spaces	- Significant pollution due to the presence and use of the waste incinerator - Little local public transport, can limit the transition to more sustainable transport models - Possible conflicts between anthropic uses of green areas and their ecological value and ecosystem services

SWOT Analysis Turin – Living Lab Level				
	Strengths	**Weaknesses**	**Opportunities**	**Threats**
Economy and labour market	- Presence of large multinational enterprises - High number of employees in the service sector - Low real estate values in the area, compared to the urban average - Wide availability of empty accommodation - Good solutions for temporary residents, at low cost	- Work activities are increasingly individual within the district - Youth unemployment over 50% in the LL Analysis Area – District Mirafiori - Average completed year of studies for Mirafiori citizens is the third year, indicating a generally low education level. - Few local shops compared to city average - Low number of local businesses - Declining outdoor market activity - Lower number of employees in the construction sector (due to the crisis)	- TNE (Torino Nuova Economia) development plans and the former Mirafiori factory (example, Competence Center) - Presence of innovative companies in the Ex-Iveco area - FCA CSR policies	- Low interaction between the development plans of the TNE area, the former Mirafiori factory and the local community - Crisis in the construction sector and in the industrial sector

Indicators for Evaluation: [8]

proGIreg reference domains	Spatial analysis subdomains	Spatial Data	Availability in Turin City	Availability in Turin Living Lab
1. Socio-cultural inclusiveness	1.1 Demographics	1.1.1. Total population	✓	✓
		1.1.2. Population density	✓	✓
		1.1.3. Population growth rate	✓	✓
		1.1.4. Migration rate	✓	✓
	1.2 Social and cultural inclusiveness	1.2.1. Material deprivation rate	✓	✓
		1.2.2. Work intensity	✓	Not requested
		1.2.3. Diversity statics	✓	✓
	1.3 Education and access to social and cultural services and amenities	1.3.1. Educational attainment	✓	✓
		1.3.2. Recreational or cultural facilities	✓	–
		1.3.3. Accessibility of public urban green spaces	–	–
	1.4 Hosing	1.4.1. Housing quality	–	–
		1.4.2. Public housing	–	–
		1.4.3. Housing affordability	–	–
		1.4.4. Density of the built environment	✓	–
2. Human health and wellbeing	2.1. Health	2.1.1 Incidence of cardio and respiratory disease	✓	✓
		2.1.2 Incidence of allergic diseases	✓	✓

proGIreg reference domains	Spatial analysis subdomains	Spatial Data	Availability in Turin City	Availability in Turin Living Lab
		2.1.3 Incidence of chronic stress/ mental diseases	✓	✓
		2.1.4. Obesity rate	✓	–
		2.1.5. Life expectancy at birth	✓	Not requested
	2.2. Wellbeing	2.2.1. Green space per capita	✓	–
		2.2.2. Urban safety - Crime	✓	–
		2.2.3 Urban safety – accidents	–	✓
3. Ecological and environmental restoration	3.1 land use and Vegetation	3.1.1. % of green spaces	✓	–
		3.1.2. Structure of green spaces (trees)	✓	–
		3.1.3. Structure of green spaces (shrubs)	✓	–
		3.1.4. Structure of green spaces (meadows)	–	–
		3.1.5. % Surface of brownfields	✓	–
		3.1.6. % Surface of polluted brownfields	–	–
		3.1.7. Canopy cover	–	–
		3.1.8. Leaf Area Index	–	–
		3.1.9. NDVI	–	–
	3.2 Climate/ Meteorological data	3.2.1 Precipitation	✓	✓
		3.2.2 Relative humidity	✓	✓
		3.2.3 Air temperature	✓	✓
		3.2.4 Wind strength	✓	✓
		3.2.5 Wind direction	✓	✓

proGIreg reference domains	Spatial analysis subdomains	Spatial Data	Availability in Turin City	Availability in Turin Living Lab
	3.3 Air Quality	3.3.1 Ozone concentration	✓	✓
		3.3.2 NOx concentration	✓	✓
		3.3.3 PM 2.5 concentration	✓	✓
		3.3.4 PM 10 concentration	✓	✓
		3.3.5. VOC Concentration	–	–
		3.3.6. GHG inventory	✓	–
	3.4 Soil	3.4.1. Soil quality	✓	–
	3.5 Water	3.5.1. Water quality	Not requested	–
	3.6 Urban environment	3.6.1. Heat island effect	–	–
4. Economic labour market benefit	4.1 Market labor and economy indicators	4.1.1. GPD per capita	✓	–
		4.1.2. Businesses in the area – Industrial	–	–
		4.1.3. Businesses in the area – commercial	–	✓
		4.1.4. Businesses in the area – Offices	–	–
		4.1.5. Public jobs	–	–
		4.1.6. Private jobs	–	–
		4.1.7. Public green jobs	–	–
		4.1.8. Private green jobs	–	–
		4.1.9. Qualified jobs	–	–
		4.1.10. Non – qualified jobs	–	–

proGIreg reference domains	Spatial analysis subdomains	Spatial Data	Availability in Turin City	Availability in Turin Living Lab
		4.1.11. Turnover in the green sector	–	–
	4.2 Gentrification indicators	4.2.1 Employment rate	✓	✓
		4.2.2 Un employment rate	✓	✓
		4.2.3. Revenues by household	–	–
		4.2.4 a Sale value for residential use	–	✓
		4.2.4 b Rental value for residential use	–	✓
		4.2.5 a value for commercial/ industrial/ office rate	–	✓
		4.2.5 b Rental value for commercial/ industrial/ office use	–	✓
		4.2.6. Free services	✓	–
		4.2.7. Basic utilities	–	Not requested
	4.3. Tourism and attractiveness indicators	4.3.1. Current number of tourists	✓	–
		4.3.2. Number of temporary events	–	–
		4.3.3. No. of foreign students	✓	Not requested
		4.3.4. Local expenses	–	–
	4.4. Taxes, Investment & Financing	4.4.1. Local taxes	✓	–
		4.4.2. Green investment programs / funds	–	–

Sources:

1. https://progireg.eu/fileadmin/user_upload/Deliverables/D3.2_FRC_implementation_Plan_OFFICIAL.pdf

2. https://progireg.eu/fileadmin/user_upload/Turin/ProGIreg-Living_Lab-Turin.pdf

3. https://progireg.eu/fileadmin/user_upload/Deliverables/D.3.3_Implementation_monitoring_report_1_OFFICIAL.pdf

4. https://progireg.eu/turin/

5. https://progireg.eu/fileadmin/user_upload/Turin/ProGIreg-Living_Lab-Turin.pdf

6. https://progireg.eu/fileadmin/user_upload/Deliverables/D3.4_and_annexes.pdf

7. https://www.torinoeuprojects.it/en/progireg-2/

8. https://progireg.eu/fileadmin/user_upload/Deliverables/D.2.2_proGIreg_SpatialAnalysis_2020-07-28.pdf

Description:

Water is both a resource and a hazard for cities. The supply of good-quality water is crucial for the well-being of residents. The access to water is also critical for many economic activities. Freshwater is a limited resource and its availability is threatened by overexploitation, pollution and a changing climate. An excess and a scarcity of water are two extreme urban threats resulting from climate change. In the project CWC (City Water Circles): Urban Cooperation Models for enhancing water efficiency and reuse in Central European functional urban areas with an integrated circular economy approach. CWC proposed adaptation solutions increasing the city's resilience towards decentralized water and wastewater systems, rainwater harvesting systems and the recycling and reuse of greywater.

The pilot action of rainwater recovery rooftop garden and aeroponic greenhouse in Turin is being implemented at "Open 011", a youth hostel built for the 2006 Winter Olympics in Turin in a former 1940's factory. The building is EU ECOLABEL which is certified and already employs ICT devices to monitor the building's environmental performance: a temperature monitoring system and a weather station. The pilot action applies different nature-based solutions (NBSs) to deal with rainwater: an intensive green roof with garden and greenhouse on its big south terrace, rain garden near the building. [1]

The challenge for the city is to think about new ways to recover and use water. The pilot helped Turin and other public authorities to define innovative "Green & blue infrastructure strategies" to feed the future "Local Environmental Adaptation Plan" in line with the "Mayors Adapt"

initiative. Moreover, the pilot follows the sustainable water management principles with a rainwater harvesting scheme, aimed to reuse harvested rainwater for green roof and aeroponic irrigation, as well as for pluvial flood mitigation and managed aquifer recharge in urban context. [2]

The pilot design includes the following components:
- An intensive green roof of approx.180 m²;
- An aeroponic greenhouse for food cultivation;
- A rain garden with a surface area of 21 m² and a storage volume of 10 m³ (corresponding to a rain event of about 20 mm with a return period of 5-10 years) to collect and slowly infiltrate the rainwater overflow.
Rainwater harvested from approx. 230 m² of roof surface will be collected in an underground cistern with a 13 m³ capacity and used to irrigate the green roof. Rainwater from approx. 100 m² of roof surface will be harvested and separately collected in a small rainwater tank (350 l) placed on the terrace to be used for aeroponic irrigation in the greenhouse. Rainwater from the green roof (180 m²) and the overflow of the rainwater storage tank

will be fed into the rain garden for infiltration, thus closing the water cycle. [3]

The City of Turin implemented the following actions: [4]

- Activation of a working group aimed at analyzing the local situation relating to water management;

- Definition of a strategy based on the principles of the circular economy, in collaboration with local stakeholders and in synergy with the Italian technical partner Poliedra – Service and consultancy center of the Milan Polytechnic on environmental and territorial planning;

- Identification of good practices with particular reference to the implementation of "NBS solutions - nature based solutions";

- Design and construction of a green terrace and an aeroponic greenhouse at Open011 (Youth Mobility and Intercultural House) in Corso Venezia 11

- Communication and dissemination activities

Timeline:

The Open 011 pilot action was started with Design process in May 2020 and complemented with monitoring in March 2022. [2]

Budget:

57,160 € for "Open 011" pilot action. [1]

Municipality of Turin budget: 270,391.60 € (100% financed by the European Union) [4]

NBS Type:

Blue and Green Infrastructure

- Green Roof
- Rain Garden

Location:

Open011, Corso Venezia, Turin, Metropolitan City of Turin, Italy (Open 011 Youth Hostel) [2]

Boundary of Turin

Open 011 – Youth Hostel

Aim and goal:

The objective of the project is to introduce and promote water efficiency measures and the reuse of unconventional local water resources, such as rainwater and gray water, for public and domestic purposes in and around public and residential buildings, in order to reduce water consumption and relieve pressure on overexploited water resources of functional urban areas. At the same time, the reuse of rainwater will reduce the negative impact of intense weather events. The specific investment envisaged by the City of Turin is aimed at introducing a green roof technology to create an outdoor roof garden with aeroponic cultivation. [4]

Partners: [5]

- Responsible Organization: Citta di Torino
- Turin Municipality (COTO)
- Poliedra (Service and consultancy centre at Politecnico di Milano on environmental and territorial planning)
- Iridra
- SMAT Torino

Stakeholders: [6]

Stakeholder involvement of CWC project		
Category	**Institution**	**Description**
Water management	SMAT	Single manager of the Integrated Water Service
	STET SPA	East Trentino Territorial Services
	IREN	-
Urban Planning	Metropolitan City of Turin	Local authority
	Piemonte Region-Strategic Planning and Green	Local authority
	Economy Sector	-
	Municipality of Collegno	Local authority
	Municipality of Venaria	Local authority
	Municipality of Rivoli	Local authority
Citizens	Freelancer	-
Sectoral Agency	ENVIRONMENT PARK	Science and technology park for the environment
	ARPA Piemonte	Regional Agency for Environmental Protection
	ENEA	National Agency for new Technologies, Energy and Sustainable Economic Development

Other- Public authority	ANCI	-
	ATC	-
Associations and NGOs	HYDROAID	Non-profit association
	Associazione Mercato Circolare (Circular Market Association)	Srl Benefit Company
	D.O.C.s.c.s.	Cooperative and social enterprise
	IL TUO PARCO (Your Park)	-
	PRONATURA	-
Higher educaton and research	Polytechnic of Turin - DIATI	Department of environmental engineering of the territory and infrastructures
	University of Turin	Green office
SMEs	HYDRODATA SPA	Engineering services, studies and research in the hydrological – hydraulic - environmental field, technical - economic and organizational consultancy.
	Orti Alti (High Gardens)	-
Large enterprises	FCA	-

SWOT Analysis:

SWOT Analysis of Turin CWC project			
Strengths	**Weakness**	**Opportunity**	**Threat**
- Strong support of Iridra and the constant and active participation of the Stakeholders. - Development of a strategic plan with short- and long-term horizons (2030 and 2050) - The proGIreg (productive Green Infrastructure for post-industrial urban regeneration) was cross fertilized with the concepts delivered by CWC. [7] - Stakeholders by participating in the process increased their	- Only 4 municipalities including Turin, out of the 89 composing the FUA (Functional Urban Areas), were active in the Stakeholder group. - Strategies and Action Plan received the official endorsement only from Turin municipality. - Municipalities are very different in terms of urbanization and green areas, as some of them are mountain municipalities and others are urbanized cities. [7]	- The contacts created during the stakeholder group meeting permitted to start a Master Thesis with the Politecnico di Torino. The thesis will regard the hydraulic modelling of the CWC pilot (green roof, rain garden, rainwater harvesting) - Turin Municipality will be involved in the recently H2020 funded project NICE (Innovative and enhanced nature-based solutions for sustainable urban water cycle), related on NBS for	- Existence of significant problems in adopting laws, regulations, and policies on water management and creating a real governance system, because there is no administrative body corresponding to the FUA (Functional Urban Areas). [7] - Lack of material in the post Covid-19 period, in addition to the significant increase in material costs. [10]

knowledge and understanding among themselves. [7] - City of Turin was already in touch with all the stakeholders for other projects and initiatives. This made it easier to reach them and ask for their participation in the CWC project. [8] - The strong link between CWC and NICE is quite straightforward, making the NICE project a perfect spin-off to continue the activities developed within the CWC project. [7] - The DLRs (Digital Learning Resources) in Italian are free access resources available on CWC website. -The process of stakeholder engagement which had the DLRs as its core is giving good results in Torino FUA (Functional Urban Areas), leading to well-structured Strategies and a feasible Action Plan. [9] - In baseline assessment the water quality assessment for rivers, canals and lakes ranges from very good to adequate. - The percentage of population with access to the water supply network is 100%. [6]	- A long procurement phase due to bureaucratic hurdles, in addition to the long time required to check and approve the financial soundness of the contracted company. [10] - Unforeseen retrofit works in the building. Since the building was built in 1940 some technical, aesthetic, and infrastructural barriers had to be solved, which required modifications in the original design concept. [10] - The index of real losses in distribution is 24,97% in the City of Turin, and there is no dual water distribution system. - In 2018, the extension of the sewerage network per inhabitant served (meters per inhabitant) remained stable compared to the previous year. [6] - Presence of bureaucratic barriers which prevent significant changes in the allocated budget for construction costs during the implementation phase. [2]	sustainable water management. [7] - The greenhouse created under the CWC project will also be an opportunity for training and dissemination on the issues of urban agriculture and food. [7] - It is worth mentioning as a fallout of CWC, that a water service provider company (Acqua Novara VCO) got inspired by the stakeholder engagement CWC methodology for the development of its Sustainability Plan, which also led to the development of a currently ongoing thesis project. [8]	

Indicators for Evaluation:

This paragraph has the purpose of illustrating the monitoring system of the Strategic Plan of the CWC project, a tool that sets itself various strategic objectives whose achievement is not always easily verifiable and depends not only on the implementation of the actions envisaged by the present Plan, but also from other measures that go beyond the possibilities of the CWC project. For this reason, some "operational objectives" have been defined, conceived precisely to be verifiable and quantifiable and exclusively concerning the "lines of action" proposed by the CWC project: it is precisely on these objectives that the attention of the Plan's monitoring system, as the monitoring has the purpose of verifying over time whether the actions

implemented allow the achievement of the objectives. The following table shows all the operational objectives, the indicators used for quantification and the targets identified on the two-time horizons of the Strategic Plan: 2030 and 2050. The responsible person for collecting and providing the data and the frequency of detection is also identified. [6]

Operational Objectives		Indicator	Target 2030	Target 2050	Entity responsible for providing the data	Monitoring frequency
Reduce network losses		Specific losses (m3/Km/day)	18	13	SMAT	Annual
Reduce Civilian Consumption		Per capita consumption (liters/person/day)	155	140	SMAT	Annual
	Increase the use of rainwater	Annual volumes used to replace drinking water (m3/year)	59.000	590.000	Municipalities of the FUA	Quadrennial (at the end of each Action Plan)
	Increase the use of treated greywater	Annual volumes used to replace drinking water (m3/year)	10.000	100.000	Municipalities of the FUA	Quadrennial (at the end of each Action Plan)
Cut the urban expansion forecasts of the municipalities of the FUA		Extension of new urbanized land (m2/year)	Not yet defined	Not yet defined	Municipality of Turin on ISPRA data	Quadrennial (at the end of each Action Plan)
Promote NBS and SUDS in urban contexts		Waterproofed area served by SUDS (hectares)	100	1000	Municipalities of the FUA	Quadrennial (at the end of each Action Plan)
		Green roofs (m2)		50.000	Municipalities of the FUA	Quadrennial (at the end of each Action Plan)
Promote both urban and rural forestry		New trees planted	680.000	1.700.000	Municipalities of the FUA	Quadrennial (at the end of each Action Plan)
Involve key players in training activities		Number of people involved in the activities	Not yet defined	Not yet defined	Municipalities of the FUA	Quadrennial (at the end of each Action Plan)
Involve citizens in information, education and awareness activities		Number of people involved in the activities	53.400	178.000	Municipalities of the FUA	Quadrennial (at the end of each Action Plan)

Sources:

1. https://programme2014-20.interreg-central.eu/Content.Node/summary-1-en-final.pdf

2.https://programme2014-20.interreg-central.eu/Content.Node/D.T2.7.1-Final-pilot-self-evaluation-report-Turin-FINAL-v2.pdf

3.Green roof and pubic space in Turin - Interreg (interreg-central.eu)

4.https://www.torinoeuprojects.it/cwc-city-water-circles/

5.https://programme2014-20.interreg-central.eu/Content.Node/DC3.2-FactSheets-Torino.pdf)

6.https://programme2014-20.interreg-central.eu/Content.Node/D.T3.3.4-Turin.pdf

7.https://programme2014-20.interreg-central.eu/Content.Node/CWC-O.T3.1.1-Integrated-urban-strategy-Torino-final-1.pdf

8.https://programme2014-20.interreg-central.eu/Content.Node/DT117-Summary-report-STH-involvement-final.pdf

9.https://programme2014-20.interreg-central.eu/Content.Node/CWC-O.T1.2-DLR-Output-Factsheet-Torino-IT-FINAL.pdf)

10.https://programme2014-20.interreg-central.eu/Content.Node/CWC-Transnational-on-line-handbook-with-pilot-project-s-less.pdf

CONEXUS (Valdocco Vivibile) Project Factsheet

Description:

The goal of CONEXUS was to co-produce, structure, and promote access to the shared and contextualized knowledge needed to support cities and communities to co-create NBS and restore urban ecosystems to help drive the necessary step change in urban policy and practice in EU and CELAC (Community of Latin American and Caribbean States) countries. The project adopts a planetary health perspective: healthy landscapes and ecosystems are vital to sustain human life, and humanity must restore, create and heal these landscapes and ecosystems in reciprocal, continuous and iterative relationship. This transdisciplinary project uses Nature-Based Thinking (NBT) to bring together community, private public and research partners to address this challenge, and experiments with new co-production methods to deliver innovative NBS in "Life-Labs" and pilot projects. The central concept of the project was to co-create context-appropriate NBS for ecosystem restoration and sustainable urbanization in CELAC and EU cities, using a place-based approach (place-making, place-keeping and place-prescribing), and solving problems together with citizens. [1]

The Turin Life-Lab (Valdocco) will be working at the micro and macro levels to implement nature-based solutions for climate adaptation. The pilot will find new opportunities for increasing biodiversity whilst also improving human health and well-being. It will also explore opportunities to retrofit forgotten spaces and repurposing areas of the public right of way. The nature-based solutions implemented will need to respect the historically-defined streetscapes and adapt to the strict architectural preservation regulations. [2]

Timeline:

The project duration is 48 months. Start date (September 2020) – End date (August 2024) [3]

The project is divided into two lots and the first lot, limited to the south by Via Sassari and Via Robassomro, completed in 2022. [4]

Aim and goal:

The interventions were designed to have high replicability and multifunctional benefits, both in functional terms and in relation with production of ecosystem services. Innovation in design, materials, vegetation and new mobility patterns are specific elements of the project. At city scale the Valdocco Life Lab worked in order to spread, share abd value the strategies and policies defined in the Climate Resilience Plan and the Green Infrastructure Plan and approved by the City of Torino (after a consultation phase). Both documents are at the same time technical and policy addressed plans and constitute the benchmarks aimed at exchange practices and strategies NBS and NBT oriented.

Given the specific role of "test site" conferred by the Public Authority to Valdocco Vivibile, the delivery of the Life Lab acquires a significant role in the implementation of the new environmental policies of the City. The main aim is then to provide the Life Lab a dissemination/public communication strategy, establishing a community of learning that collectively builds and share information, ideas experience and expertise linked to the Nature-Based Solutions implemented in the neighborhood. In particular, the schools of Valdocco will be involved in the development of a public communication

campaign promoting new awareness and familiarity with climate change mitigation and adaptation actions and sustainability related issues. [3]

Location:

The project involves the area called Valdocco, a historic district of the city of Turin which is part of the Aurora district and is included in District 7. [4]

Boundary of Turin

Boundary of Valdocco – District 7

Budget:

Turin City Council for (Valdocco Vivibile) budget is 175,287.50 €. [1]

Rainwater management in the Valdocco Vivibile Project with time scale by 2022 is one of the infrastructure pilot actions of CWC project which the Environmental compensation funds (approximately 1,200,000 €) is from TRM S.p.A. And another phase by 2023 is supported financially around 3,500,000 € by PON Metro - integration with REACT-EUR funds. [6]

NBS Type: [3]

- Green and Blue Infrastructure
- Rain gardens
- Permeable pavement

Partners: [3]
- Urban Lab
- City of Turin
- EU

Stakeholders: [3]

Stakeholder involvement of Valdocco project		
Role	**Type**	**Name**
Governance	Public Institutions	Comune di Torino
Users/Beneficiaries	Education (Academia/University)	Politecnico di Torino
		Universita degli Studi di Torino
		Malmo University
	Museum/Research Centre	Parco Arte Vivente
	Academia/Public/Private Institution	IAAD/IIS Galileo Ferraris/Forwardto
Providers	Organization	Urban Lab
Influencers	Professional Company	Seacoop
	Private Foundation	LINKS Foundation
		Fondazione CRT, Sviluppo e Crescita

CONEXUS Indicator List:

#	NBS Indicator	Turin
Challenge area 1: Climate resilience		✓
1	Total carbon storage and sequestration in soil per unit area per unit time	✓
2	Total carbon storage and sequestration in vegetation per unit area per unit time	✓
3	Avoided greenhouse gas emissions from reduced building energy consumption	
4	Monthly mean value of daily maximum temperature (TX)	
5	Monthly mean value of daily minimum temperature (TN)	
6	Heatwave incidence	
Challenge area 2: Water management		✓
7	Surface runoff in relation to precipitation quantity	✓
8	Water quality: general urban	
9	Total Suspended Solids content	
10	Nitrogen and phosphorus concentration or load	
11	Metal concentration or load	
12	Total faecal coliform bacteria	
Challenge area 3: Natural & Climate Hazards		
13	Disaster resilience	
14	Disaster-risk informed development	
15	Mean annual direct and indirect losses due to natural and climate hazards	
16	Mean number of people adversely affected by natural disasters each year	
17	Risk to critical urban infrastructure	
18	Multi-hazard early warning	
Challenge area 4: Green Space Management		✓
19	Green space accessibility	✓
20	Total green space within a defined area: Share of green urban areas	✓
21	Soil organic carbon	✓
22	Soil organic matter index	✓
Challenge area 5: Biodiversity Enhancement		✓
23	Structural and functional connectivity of green infrastructure	
24	Number of native species	
25	Number of non-native species introduced	
26	Number of invasive alien species	
27	Shannon Diversity Index: Species diversity within defined area	✓
28	Shannon Evenness Index: Number of species within defined area	✓
Challenge area 6: Air Quality		
29	Number of days during which air quality parameters exceed threshold values	
30	Proportion of population exposed to ambient air pollution	
31	European Air Quality Index	
Challenge area 7: Place Regeneration		
32	Derelict land reclaimed for NBS	✓
33	Quantity of blue-green space ratio to built form	✓
34	Perceived quality of urban green, blue and blue-green spaces	
35	Place attachment (sense of place): Place identity	
36	Recreational value of public green space	✓
37	Incorporation of environmental design in buildings	
38	Preservation of cultural heritage	
Challenge area 8: Knowledge and Social Capacity Building for Sustainable Urban Transformation		✓
39	Citizen involvement in environmental education activities	✓
40	Social learning regarding ecosystems and their functions / services	
41	Pro-environmental identity	
42	Pro-environmental behaviour	
Challenge area 9: Participatory Planning and Governance		✓

43	Openness of participatory processes	✓
44	Openness of participatory processes: proportion of citizens involved	
45	Sense of empowerment: perceived control and influence over decision-making	
46	Public – private partnerships activated	
47	Policy learning for mainstreaming NBS	
48	Trust in decision – making procedures and decision makers	
Challenge area 10: Social justice and Social Cohesion		✓
49	Bridging social capital – quality of interactions between social groups	
50	Bonding social capital – quality of interactions within social groups	
51	Inclusion of different social groups in NBS projects	
52	Trust within the community	
53	Solidarity among neighbours	
54	Tolerance and respect	
55	Availability and equitable distribution of blue-green space	✓
Challenge area 11: Health and Wellbeing		✓
56	Level of outdoor physical activity	
57	Level of chronic stress (Perceived stress)	
58	General wellbeing and happiness	✓
59	Self-reported mental health & well-being	
60	Cardiovascular diseases (Prevalence, Incidence, Morbidity & Mortality)	
Challenge area 12: New Economic opportunities and Green Jobs		
61	Value of NBS calculated using GI-Val	
62	Value of NBS calculated using Economic Value of Urban Nature Index	
63	Mean land and/or property value in proximity to green space	
64	Changes in mean house prices/ rental markets	
65	Average land productivity and profitability	
66	Property betterment and visual amenity enhancement	
67	Number of new jobs created	
68	Retail and commercial activity in proximity to greenspace	
69	Number of new businesses created and gross value added to local economy	
70	Recreational monetary value	
71	Overall economic, social and health wellbeing	

SWOT Analysis:

SWOT Analysis of Turin Valdocco project			
Strengths	**Weakness**	**Opportunity**	**Threat**
- Large availability of space for implementation of NBS designs. - Existence of pedestrian connections within the site. - Using the slope of area to lead rain water to rain gardens. - Presence of park and green areas in site. - Presence of cycle path along the Dora River.	- Citizen's disagreement with removing car parking areas and implementing pedestrian area or rain gardens. - Preserving Historical areas rules ignoring to plant trees in front of cathedral because of view access. - Parks with less well-furnished play grounds for children. - Existence of cables underground cause to limitation in planting trees. - Lack of disable accessibility infrastructure.	- Possibility to expand the outreach of the project to other parts of the city. - Possible connections to existing city parks. - Opportunities for initiatives that foster community integration. - Synergy with CWC project in Rainwater management.	- Less financial support for removing asphalt areas. - Existence of Cimici insects because of specific types of trees.

Sources:

1. https://www.torinoeuprojects.it/en/conexus-2/

2. https://www.conexusnbs.com/life-labs/turin

3. https://urbanlabtorino.it/projects/conexus/?lang=en

4. https://www.torinovivibile.it/aree-tematiche/valdocco-vivibile/#

5. https://www.torinoeuprojects.it/en/conexus-2/

6. https://programme2014-20.interreg-central.eu/Content.Node/D.T3.3.4-Turin.pdf

Agrobarriera Project Factsheet

Description:

The redevelopment project of the green areas also involved the enhancement of the former "Boschetto" area, through its transformation into a space used for urban horticulture. The area, which extends over 1,900 square meters between via Petrella and the schools in via Leoncavallo, has remained unused since the urbanization of the 1960s and 1970s, becoming prey to the growth of brambles, weeds and shrubs which over time have given it a "wild" aspect giving rise to a real "grove". [1]

"Boschetto" area is one of the areas which the Redevelopment of Green areas project's interventions is placed. [2]

The entire area is managed by a single entity, identified through the tender "Coltiva Barriera!", promoted by the Urban Committee and District 6 in the first months of 2015. As per the notice, this subject is entrusted not only with the care and management of the area, but also with the organization of recreational, educational and social activities, in order to make the "Boschetto" a meeting and gathering place, of participation, solidarity and awareness of environmental issues. [1]

The Agrobarriera known by all as the "Boschetto", has become a space for urban horticulture, socialization, the culture of sustainability. The project is carried out by the **RE.TE. ONG**, winner of the "Coltiva Barriera" tender, promoted by the Urban Committee and District 6 to identify the manager of this 2000 square meter green space, transformed through the intervention of the Public Green Service of the City of Turin in an area dedicated to urban horticulture, divided into different zones intended to house around 20 individual gardens, a collective garden and an area designed for laboratory and social activities. [3]

In 2023 June 30 RE.TE. ONGs and Agrobarriera presented "Lombrico Amico", a worm-growing project that produced humus using garden clippings, organic residue from local markets, from Caat (Centro agroalimentare di Torino) and from urban farmers at the parco dell'Arrivore di Torino with a final aperitif. The project closes the cycle with respect to the theme of food surpluses, those in the rotting phase become new nourishment for Turin's urban gardens. At the end of the presentation, an aperitif with food recovered from the unsold goods of the Porta Palazzo market by Ecomori, a food-saving sentinel project.

The project is carried out by the RE.TE ONG Network together with Eco Dalle Città with the contribution of the District 6 City of Turin. [4]

Timeline:

The project is started with 5 years duration in 2015 by signing the agreement between District 6 and the RE.TE ONG. The agreement is not automatically renewable. [5] In 2021 the renewal, for another 5 years, starting from the date of execution of this deed. [6] Total duration of Agrobarriera project was for 10 years.

Budget:

The Agrobarrier fund is 10.000,00 € for starting the project. This amount was the reward of announcement in 2015. [7]

There is no any further information about renewal of this fund annually or not.

NBS type:

Urban gardens

LombriCulture

Location:

Via Errico Petrella 28, 10154 Turin TO

Boundary of Turin

Milan Barrier – district 6

Agrobarriera plan

Aim and goal:

In fact, the aim of the AgroBarriera project was in fact to adopt horticulture as a tool for transforming the Boschetto into a meeting place for the inhabitants and citizens of Barriera di Milano: a space for the community to promote and disseminate values such as participation, solidarity and attention to environmental issues and sustainable behavior.

A series of activities:

- *Individual Vegetable gardens:* through a public tender , the twenty individual vegetable gardens have been given in concession to as many "gardeners".

- *Agro After school Project:* The activities, proposed with the aim of supporting students with more learning difficulties (6-14 years) in their study programmes, envisaged after-school cycles divided into workshops on Global Citizenship and Environmental Education, which took place at the schools involved during the winter months and in the collective gardens of the grove during the spring months. A total of 60 pupils were involved. [3]

Other goals:

- Support forms of social aggregation and participatory management of public space.

- Enhance the experiences of collective gardens and urban gardens managed by third sector subjects by citizens.

- Enhance the territory of Barriera di Milano thanks to the use by the community of spaces that have not been used up to now.

- Promote forms of knowledge and dissemination of eco-sustainable

methods and practices within the urban context (separate waste collection, rational water management, green waste management, management of energy consumption).

- Improve awareness towards natural or organic agriculture. [8]
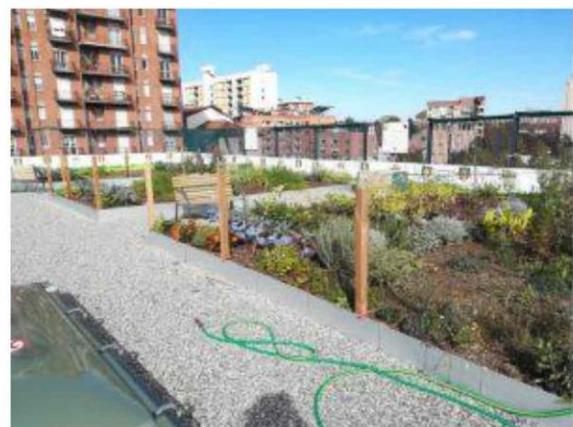
Partners: [3][9]

1. RE.TE. ONG

2. Associations Parco del Nobile

3. Institute for Environment and Education Scholè Futuro Onlus

4. Volontarinrete

5. Il Gelso Paziente Social Cooperative

6. EU

Stakeholders: [3][9]

Stakeholder involvement of Agrobarrier project	
Category	**Institution**
Government	Agency of Urban Development for the redevelopment of a Barriera di Milano area
	BARRIERA BENE COMUNE
	Citta di Torino – 6 Circoscrizione
	EU
Education	Institute for Environment and Education Scholè Futuro Onlus
	Salvo D 'Acquisto school
	Grazia Deledda school
	Giuseppe Perotti
	lower secondary school "Benedetto Croce"
Associations and NGOs	RE.TE. ONG
	Associations Parco del Nobile
	Volontarinrete
	Il Gelso Paziente Social Cooperative
	AGRO BARRIER
	Urban Barrier

SWOT Analysis:

SWOT Analysis of Turin Agrobarriera project			
Strengths	**Weakness**	**Opportunity**	**Threat**
- The safety works of area initially started by applying the fence wall. - The cleaning works of area started by removing undergrowth vegetation. - After a careful evaluation by the experts regarding the tree specimens, it was necessary to cut down the plants present, which did not guarantee adequate conditions of stability and safety. - Based on the results of the analyzes carried out on the ground, it was possible to define the destination of the former "Boschetto" as a corner of nature and sharing dedicated to urban horticulture and the promotion of agro-ecological practices. - Provision of guidance on environmental sustainability and necessary equipment for all residents assigned to the vegetable gardens - Contrast to the different forms of poverty, especially the educational one - The area is equipped with a space for storing equipment, two shade canopies and toilets.	- Milan Barrier with poor social classes is the location of Agrobarrier project.	- Cleaning the unused area and changing that area to Agrobarrier Project. - The greengrocers will also be involved in other activities: they will become part of the "management committee" of the space and they will be required to commit at least 2 hours a week to volunteer activities, which will range from taking care of the shared spaces to organizing initiatives to animate the Boschetto area. - School gardens, in which a group of students is accompanied in the care and management of its own vegetable garden, training workshops, in which techniques and practices of synergistic agriculture and permaculture are explored and implemented. - The collective gardens, formed by heterogeneous groups and having team building as their primary objective and the formation of strong ties to strengthen the social fabric. - Psychophysical well-being of the population - Raising awareness of a sustainable lifestyle	- The area has remained unused since the urbanization of the 1960s and 1970s, becoming prey to the growth of brambles, weeds and shrubs which over time have given it a "wild" aspect giving rise to a real "grove". - Milan Barrier with poor social classes is the location of Agrobarrier project. - Lack of connection (public transport, cycling lanes) to the rest of the city - Traffic - Competition with other purposes for the use of the vacant land - Lack of sustained long-term budget

Sources:

1.http://www.comune.torino.it/urbanbarriera/migliora/riqualificazione-area-ex-boschetto.shtml#.Vzw17EDKF8E

2. http://www.comune.torino.it/urbanbarriera/migliora/riqualificazione-sistema-verde.shtml

3. (http://www.comune.torino.it/urbanbarriera/news/progetto-agrobarriera.shtml)

4.http://www.vivoin.it/events/lombricoamico-presentazione-del-progetto-di-lombrichicoltura-al-parco-dellarrivore/)

5. (https://www.ortiurbanitorino.it/atlante/Agrobarriera_file/2021_3600038agrobarriera.pdf)

6.(http://www.comune.torino.it/urbanbarriera/news/al-via-il-bando-per-lassegnazione-degli-orti.shtml#.ViDyhVKdeSo)

7. (https://www.ortiurbanitorino.it/atlante/Agrobarriera.htm)

8. (http://www.comune.torino.it/urbanbarriera/bm~doc/bando-coltiva-barriera-2.pdf)

9. https://www.reteong.org/categorie/item/3-agrobarriera.html)

5.2. Factsheets of Amsterdam

A factsheet is a concise document, typically one or a few pages long, that provides vital information about a product, substance, service, or other relevant topics. These documents are frequently utilized to deliver key information in a clear and straightforward manner to end users, consumers, or the general public. Factsheets often utilize elements such as lists, tables, and diagrams to effectively and efficiently convey information.

In this study, we have developed concise fact sheets for the case studies under review, aimed at succinctly highlighting the key aspects of each project, such as project description, objectives, types of Nature-Based Solutions (NBS), stakeholders and partners involved, budget, and SWOT analysis. Regrettably, the NBS projects in Amsterdam that were analyzed did not have an available list of indicators. The fact sheets are designed to provide readers with quick access to essential project information, allowing for a brief yet comprehensive understanding of each project.

The Amsterdam case studies are arranged in this section, starting with the Frans Halsbuurt neighborhood, and then continuing with the Gerard Doubuurt neighborhood. Before delving into the factsheets of Amsterdam, it is better to have an overview of the city of Amsterdam.

Frans Halsbuurt Neighborhood Factsheet

Description:

De Oude Pijp is a highly urban area, with a fragile balance between living, working and staying. It is one of the most densely populated parts of Amsterdam. To cope with the growing influx of pedestrians and cyclists in the area, the streets in the Frans Halsbuurt redesigned. The Frans Halsbuurt in De Pijp area is an important residential and traffic transit area in Amsterdam that characterized by narrow streets.

To gain insight into the use of space in this neighborhood, a surface analysis was made and the result was: Building (46.3%), Inside of building blocks (21%), Sidewalk (18%) Away (7.5%), Car parking (7.1%) which the public space covers 33% of the neighborhood.

The municipality of Amsterdam is carrying out the major maintenance and redesigning of the Frans Halsbuurt. With this project, Frans Halsbuurt will be a car-free and climate-proof residential area with plenty of space for pedestrians, cyclists, greenery and play opportunities for children. The Frans Halsbuurt will be a low-traffic residential area, where cars are guests. There are parking spaces nearby including Albert Cuyp underground garage which can compensate the eliminated parking lots of Frans Halsbuurt neighborhood.

The final design for the Frans Halsbuurt was preceded by an intensive participation process and was adopted by the municipal council on June 2, 2022.

Residents and entrepreneurs actively contributed ideas and discussions which has a major influence on the design of public space. In fact; the intention is for the neighborhood to design its own public space. However, the neighborhood consists of approximately 2,500 residents who all have their own ideas about the use of public area.

The redesign of public space in the Frans Halsbuurt is linked to a number of developments. Listed below:

1. Coalition agreement "Amsterdam Car-Free Agenda"
2. Area Agenda
3. Opening of the North-South line
4. Albert Cuyp garage
5. Improvement of Air quality
6. Underground Waste Collection System (OAIS)
7. South bicycle parking and multi-year bicycle plan
8. Amsterdam Rainproof

Timeline:

Started in 2018 – will Complement in 2025

- 3rd and 4th quarter 2022: Phase 1
- 3rd quarter 2022 to 2nd quarter 2023: Phase 2A and 2B
- 1st quarter 2023 to 4th quarter 2023: Phase 3 and 4
- 3rd quarter 2023 to 2nd quarter 2024: Phase 5, 6A and 6B
- 1st quarter 2024 to 4th quarter 2024: Phase 7, 8A, 8B and 9
- 3rd quarter 2024 to 4th quarter 2025: Phase 10 to 16

Location:

The neighborhood is located in the northwest corner of the Oude Pijp. The Frans Halsbuurt is the area between Stadhouderskade, Ferdinand Bolstraat, Albert Cuypstraat and Boerenwetering.

- *Map of Amsterdam city*
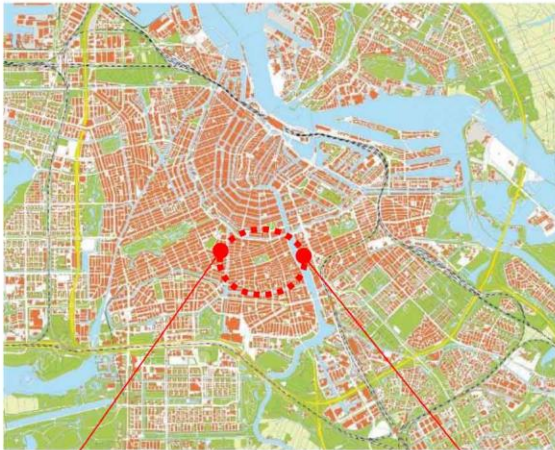
- *Map of Pijp area*
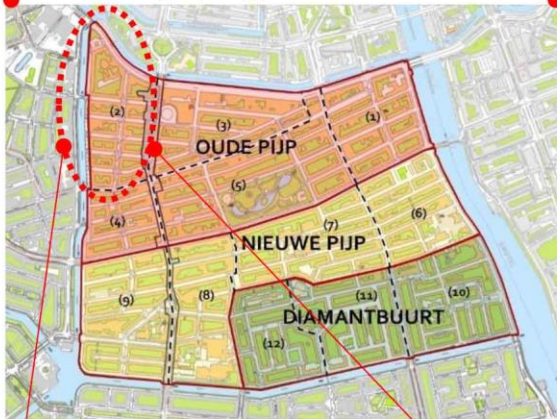
- *Map of Frans Halsbuurt*
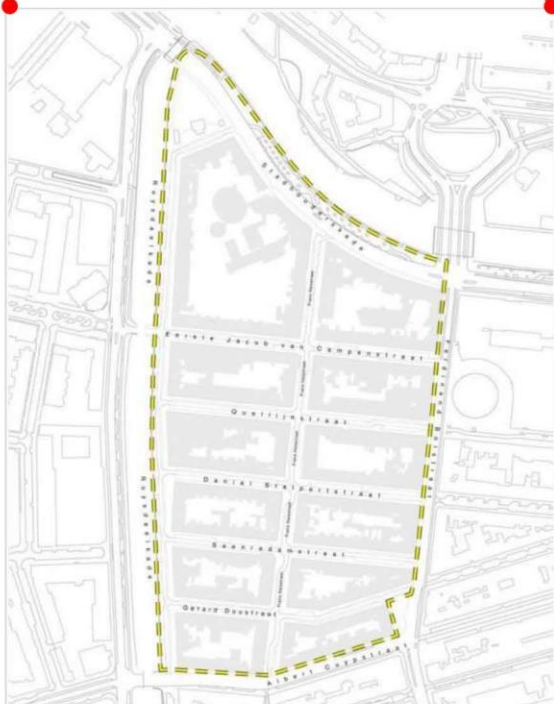
Aims and Goals:

The ultimate objective of the project is a redesign of the public space that fully meets all the requirements imposed on the project area. The principles noted in Frans Halsbuurt redevelopment project:

- Greening √

As much as possible planting in larger areas.

- Street profile on one level √

Ground level on one level, but color difference between sidewalk and roadway.

- Gray facilities √ / x

'Green around Gray' becomes the 'Om en Om' principle. Everyone has a view of green, but their view of grey is minimized. Larger green areas: more growing space for plants and nature.

- Loading and unloading facilities √

In coordination during participation, evenly distributed over the street sections according to needs and experience of the past 2 years.

- Bicycle parking √

Sufficient, optimally distributed, 15m waking distance.

- Street lighting, everywhere Rittermast x

This proved to be unfeasible and not included in this plan.

- Play facilities √

More safe and free space on the sidewalk, Car-free streets and spread of 5 playgrounds in the neighborhood in accordance with urban policy and participation.

- Ruysdaelkade √

When it comes to the design of the waterfront of the Ruysdaelkade, seating is often mentioned. In addition, people here also attach importance to adding greenery, which gives more allure to waterfront.

- Biodiversity √

Larger green areas: larger biotope, where flora and fauna can grow and flourish. Biodiversity is promoted by planting plants

and trees that ensure the birds and useful insects return to neighborhood.

– Art

A large majority agrees with the statement that there should be more space for art. This still needs to be further developed in consultation with the neighborhood.

– Rainproof

To make the neighborhood rainproof when there is a heavy rain.

The only things that can be mentioned in this redevelopment project were the followings:

- *Elimination of 600 parking spaces in Frans Halsbuurt and replacing them in Albert Cuyp underground parking.*
- *Keeping few parking lots for disabilities.*
- *Designing bicycle parking spaces*
- *Adding 16 containers for underground waste collection (realization from the Underground Waste Collection System (OAIS) project in close consultation)*
- *Removing 'clutter': stray bicycles, walls (in consultation with the neighborhood)*
- *Adding green spaces and rain gardens*
- *Reprofiling of current pavement*
- *Replacing sewerage and installing drainage (rainwater drainage)*
- *Replacing drinking water, gas pipes*
- *Removing and relocating cables*
- *Decrease of the neighborhood streets speed from 30km/h to 20/15km/h by signs and speed bumpers*

Stakeholders:

- Municipality of Amsterdam
- South District Committee
- Department of Spatial Planning & Sustainability
- Department of Traffic & Public Space
- Albert Cuyp underground parking
- Underground Waste Collection System (OAIS)
- Terra Nostra
- European Tree Technician (ETT) or European Tree Worker (ETW)
- Waternet (Water and Sewerage pipes)
- Liander (Electrical cables and Gas pipes)
- Qirion (High-Voltage cables)
- KPN (Telecom company)
- Local authority
- Rainproof program
- VRA
- Bicycle parking
- Public Space Management
- Enforcement and supervision
- Department of Finance
- V & OR lighting
- CORA, Coordination System for Working on the City
- Residents of neighborhood
- Entrepreneurs of Frans Halsbuurt
- Buurtvereniging Frans Halsbuurt
- BIZ Frans Halsbuurt
- 'nood- en hulpdiensten' (police, ambulance and the fire department)
- Bomenstichting
- Buurtregisseur Politie

NBS Types:

- Rain gardens
- Ground and Facade gardens
- Accessible green pedestrian pathway
- Car-Free zone
- Permeable pavement

Budget:

The total budget of this project is 7,315,000 €:

- The available coverage of 4,797,737 € for the implementation of the Paving project comes from the following budgets:
    - 3,645,737 € SMF
    - 207,000 € VRA
    - 300,000 € Rainproof
    - 500,000 € Urban Preservation Reserve
    - 145,000 € BLVC contribution to K&L parties' costs

- The available coverage of 2,514,648 € for the implementation of the Green project comes from the following budgets:
    - 1,843,648 € SMF
    - 500,000 € Rainproof
    - 171,000 € Growth site improvement Trees

The estimates have been carried out based on the SSK system and tested internally.

- 59,385 € expected costs of management, maintenance and operation of the Paving and Green projects of Frans Halsbuurt redevelopment.

	Kasritme	2022	2023	2024	2025	2026	Totaal
Lasten							
Project1	Verhardingen	€ 500.000	€ 1.600.000	€ 1.600.000	€ 1.097.737		€ 4.797.737
Project2	Groen	€ 200.000	€ 600.000	€ 600.000	€ 1.000.000	€ 117.263	€ 2.517.263
	totaal	€ 700.000	€ 2.200.000	€ 2.200.000	€ 2.097.737	€ 117.263	€ 7.315.000
Baten	SMF	€ 700.000	€ 1.750.000	€ 1.450.000	€ 1.592.000		€ 5.492.000
	VRA				€ 207.000		€ 207.000
	Rainproof		€ 200.000	€ 500.000	€ 100.000		€ 800.000
	R stadsbehoud		€ 250.000	€ 250.000			€ 500.000
	Groeiplaatsverbetering Bomen				€ 171.000		€ 171.000
	K&L bijdragen				€ 27.737	€ 117.263	€ 145.000
	totaal	€ 700.000	€ 2.200.000	€ 2.200.000	€ 2.097.737	€ 117.263	€ 7.315.000

SWOT Analysis:

SWOT Analysis of Frans Halsbuurt			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
- The design task is up to the neighborhood. - Attractive and varied residential area. - The update of the De Pijp 2005 zoning plan is only mandatory before mid-2018, but the district intends to bring this date forward and aim for adoption of the updated plan in 2016. - Streets in this Frans Halsbuurt are on average wider than the rest of De Pijp. - A great diversity of functions can be discovered in the plinths of the old residential blocks. - The Public Space covers 33% of area. - There are floating gardens in the Boerenwetering, called "floatlands". - Before starting participation process decided to first make the neighborhood aware of the established frameworks based on national legislation and frameworks based on municipal regulations and established policy. - The roadway will remain where it is now/ about pipelines and cables. - Charging stations in the Frans Halsbuurt itself can be reused for mobility hubs or moved.	- Densely populated residential neighborhood - Occupancy of public spaces with 600 car parking lots in neighborhood - Existence of less bicycle parking spaces - There are no Underground Waste Collection System (OAIS) containers for plastic and glass. - No Underground Waste containers have been fitted into the two dead-end streets which the placement decision of containers was based on the old design from 2016. - The distribution of Waste containers equally. There are very few Wase containers in Ruysdaelkade. - The De Pijp 2005 zoning plan currently applies to the Frans Halsbuurt. - Long timeline of project. - The number of play facilities in the area is limited. - The limited number of benches are placed (7) by municipality and (11) by residents. - The lighting in Frans Halsbuurt is very diverse. - Level difference of street in Frans Halsbuurt.	- Opening of the North/South line and the developments around Museumplein give a boost to area. - Openning of underground Albert Cuyp garage in reduce the parking pressure and improve the quality of the living environment in the Oude Pijp and specifically the Frans Halsbuurt. - The redesign of public space in the Frans Halsbuurt is linked to a number of developments: 1. Coalition agreement 2. Area agenda 3. Opening of the North-South line 4. Albert Cuyp garage 5. Improvement of Air quality 6. Underground waste collection system (OAIS) 7. South bicycle parking program and multi-year bicycle plan - Neighborhood is well served by various main networks: car, bicycle and public transport. - There are opportunities for more greenery, façade plants or planters to tackle heat stress and take rainproof measures.	- The pressure on public space is high, and it is expected to increase in coming years. - The neighborhood consists of approximately 2,500 residents who all have their own ideas about the use of the public space in participation process. - The total cost will be higher than for a comparable projected. - Due to legal regulations, all streets are officially part of a 30 km zone. The neighborhood streets are therefore part of the 30 km zone. Zones of 20 km are not regulated by law. - Trashes are collected around the Waste containers and cause to become a gathering place for rates. - The crowded and noisy nightlife which cause to increase of nuisance regarding noise and urination in this area. - Indication of fluctuations in the groundwater. This leads to degradation of the wooden pole structures of homes/buildings. - Redesigning of project can affect the trees negatively: 1. The cables and pipes lie within the sphere of influence of the trees' root.

SWOT Analysis of Frans Halsbuurt			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
- The residents are jointly both client and designer. - More than 90% of the space under the green areas is free of cables and pipes. This is because of a sustainable growing area where water can infiltrate. - Design of this project base on the residents' view and comment changes to meet their needs. - Using the ground-penetrating radar in this project to do analysis regarding root, soil and groundwater conditions. - There are 120 trees in neighborhood that are in different ages and species, mainly elms and acacias, just 114 trees are alive. - In current situation without redesign project more than 80 trees can live for 15 years and more, less than 10 trees can live for 5 years and less.	- Less space for pedestrians (Walking sides). The entire sidewalk is occupied around Café areas and terraces. - Existence of too many trees especially tall ones make the neighborhood dark and gloomy. - The small gardens in front of houses which made by residents will be eliminated in design of project. And residents disagree to lose their money and energy which spent on gardens. - The view of multiple bicycles in front of the basement window of houses is discomfort situation for residents of this neighborhood. - In some part of neighborhood to much light entering to houses and cause light pollution. - A large number of cables and pipes are located under the sidewalks. - Most of the trees are planted on hard surfaces, often in cramped planting areas. - There root imprint on the sidewalks and with large trees often in the roadways. (Broken paving due to roots). - The trees are mainly planted as an avenue structure. - From 120 trees of project area, 6 of them are remain as only stumps.	- In the long term, natural gas will be replaced as an energy carrier. - Any additional coverage costs come from subsidies from the Rainproof program and VRA. - Collaboration of Municipality of Amsterdam and Pakhuis de Zwijger for organizing a series of meetings in which residents are involved in the future of their neighborhood. - Given the opportunity to residents to create a mood board in participation process. - Redesigning of project can affect the trees positively: 1. Enlarging and raising the existing tree levels and thus increasing the open tree levels. 2. Improving the existing tree growing through soil exchange or improvement. 3. Realizing facilities for 'Climate Adaptive', in particular the extensive and elevated tree levels. - The plan area is located at a distance of 6.5 km from the Natura 2000 areas 'Markemeer & Ijmeer' and 8 km from 'Ilperveld, Varkensland, Oostzanerveld & Twiske'.	(Creation of free space for swerve system.) 2. The adjustment and artificial regulation of the groundwater level. 3. The activities and design measures for Climate Adaptive. (Expanding the drainage system, underground water storage and replacing water lines.) 4. Redesign of the current street scene. (Realizing loading and unloading places and underground waste containers.) 5. Re-profiling and changing the pavements including taking-up and hardening. - The root loss of between 5% to 40% as a result of the redevelopment which cause to decrease in absorption capacity and as well as a decrease in stability. - The reserch shows that 12 trees out of 114 will disappear. - After redevelopment project only 34 trees will live for 15 years, 38 trees for 10-15 years, 29 trees for 5-10 years and 13 for less than 5 years.

SWOT Analysis of Frans Halsbuurt			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
	- No tree within the project area is registered as a monumental or valuable tree.	- The plan area is located at a distance of 4 km from the nearest Nature Network Netherlands (NNN) area Amsterdamse Bos. - The tree technical supervisor has a guiding and advisory role during the work and checks at random times whether tree protection measures are being complied with. - Municipality wants to keep trees and do the construction in away to hurt less trees. - Terra Nostra has carried out a Tree Effect Analysis (BEA) for project area trees. - 3 trees can transplant successfully base on (BEA) analysis. -	- The work may have a negative effect on the bat habitats. (In construction work, lighting is sometimes used for security at night which the presence of bright lighting can have a negative effect on quality of the foraging area of the common bats.

Source:

Municipality of Amsterdam Website

https://www.amsterdam.nl/projecten/franshalsbuurt/#h87dfa3a0-3b3e-4193-85c9-fc3f72f64a83

https://amsterdam.raadsinformatie.nl/vergadering/986601#ai_6795019

Gerard Doubuurt Neighborhood Factsheet

Description:

To keep the Gerard Doubuurt area livable, it was a time for improvements in the busy public space of this neighborhood. The Gerard Doubuurt must be and remain a nice area to live, work and visit.

The Gerard Doubuurt like the rest of De Noord-Pijp, is distinguished by its highly urban character. In addition to being a residential area, also it is an attractive due to the large number of craft shops, cafes, restaurants and Albert Cuyp market. The Gerard Doubuurt is one of the most densely built neighborhood in Amsterdam with 19,350 inhabitants per square kilometer.

Public space is limited, so it should be made choices for playgrounds, greenery, parking for bicycles or cars. To get an idea of what is already good and what needs to be changed, the municipality of Amsterdam entered into discussions with the neighborhood. Through neighborhood surveys, street conversations and meetings, the possibilities to improve the quality of life in the neighborhood are mapped out.

Municipality is jointly developing the Short and Long-term measures to improve the neighborhood within the De Oude Pijp Area Program. Some temporary measures have already been taken: Including eliminating 120 car-parking spaces from 313 and locating extra bicycle parking spaces, green areas and extra loading and unloading areas.Municipality carry out major maintenance in several phases. Now municipality is working on the basic principles for all major maintenance. Implementation for the first phase is now scheduled for 2024.

Timeline:

Started in 2020 – 1 phase will Complement in 2026

- 2020:
  Neighborhood inventories.

- 2021:
  Neighborhood conversations with Gerard Doubuurt Association, Analysis of neighborhood. Elimination of 50 car-parking spaces.

- 2022:
  Completing draft memorandum of principles and preferred design by participation process of neighborhood.

- 2023:
  Taken decisions and development of phase 1 design. Start to eliminate 70 additional car-parking spaces.

- 2024:
  Decisions, tender, implementation of phase 1.

- 2025:
  120 Car-parking spaces have already removed.

- 2026:
  Completion of phase 1 work

Location:

The Gerard Doubuurt is part of the Oude Pijp and is located south of the Amsterdam city center which is between the Stadhouderskade (noord), Ferdinand Bolstraat (west), Van Woustraat (oost) en de Albert Cuypmarkt (zuid). The entire neighborhood, as part of De Pijp, was created based on expansion by J.G. van Niftrik (1866) which was completed by r J. Kalff (1875).

- *Map of Amsterdam city*

- *Map of De Pijp area*
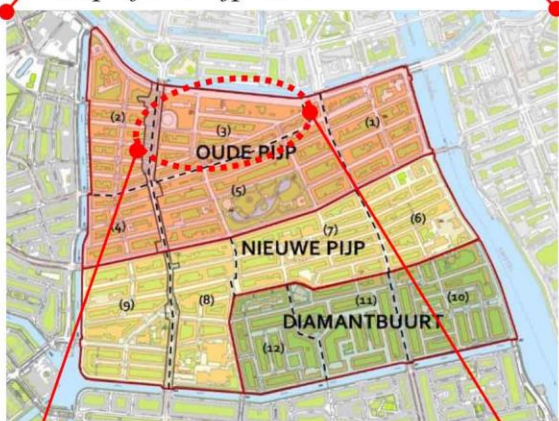
- *Map of Gerard Doubuurt area*

Aims and Goals:

The aim of the Public Space Plan was to develop a joint version of the future together with the participation of neighborhood for the design of public space and improving the quality of life and to make clear choices for the new design.

Developing the joint version of the future is not an open plan process. The frameworks of project fixed by municipality: Including in the areas of low-traffic, climate adaptation and the Puccini method. The agenda and process of this project will be determined in consultation with the Process Advisory Group (PAG).

The analyzes of participation and the Urban development situation show that the Gerard Doubuurt has a number of general challenges. These assignments are divided into:

A. Character
B. Livability
C. Accessibility
D. Facilities

Involving residents and entrepreneurs from the Gerard Doubuurt is important for this Public Space Plan. Three neighborhood surveys have been conducted: Interactive map, Online Street conversations and neighborhood conversation. The results of these neighborhood surveys have been incorporated into this Public Space Plan.

In summary, these were the points for improvement indicated by residents:

- Too full and too busy
    - The area is too full and too busy
    - Too few bicycles parking spaces
    - Lack of car parking spaces
    - Parked cars dominate the street scene
    - Aggressive homeless people
- Increasing noise pollution
    - Noise pollution due to traffic jams
    - Noise pollution from catering establishments
    - Noise pollution due to loading and unloading
    - Concern about increasing noise pollution

- Limited space on the sidewalk
  - Limited sidewalk space because of parked bicycles and large terraces
  - Full terraces restrict passage
  - Sidewalk exits blocked
  - Limited space for children to play on the sidewalk
  - Nuisance caused by carelessly parked bicycle
- A lot of traffic brings unsafety
  - Unclear intersection
  - Tight bend for trucks
  - Visibility is taken away by loading and unloading location
- Few wastes spot
  - Overflowing garbage containers
  - Overfull of containers in catering part
  - Waste on the streets and porches
- Need for greener appearance
  - No optimal use of the square
  - Neglected façade gardens
  - Taller trees for protection
  - Horizontal greenery is often seen as an obstacle
  - More green zones by replacing the stone pavements
  - Electra house disfigures the street

NBS Types:

- Rain gardens (Infiltration of rainwater into groundwater
- Ground and Facade gardens

- Accessible green pedestrian pathway
- Permeable pavement

Budget:

There is no published available data for budget.

Stakeholders:

- Municipality of Amsterdam
- South District Committee
- Process Advise Group (PAG)
- Project team STBY
- Residents & Entrepreneurs
- Zuid District
- Gerard Doubuurt Association
- Department of Spatial Planning & Sustainability
- Department of Traffic & Public Space
- Public Space Management

SWOT Analysis:

SWOT Analysis of Frans Halsbuurt			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
- Public participation Announced via letter, posters, postcards and social media to residents. - Using the Interactive map and online platforms for collecting residents' opinion. - Tall trees protect the area from heat waves and also collect dust and block noise. - Positive points of the neighborhood are its liveliness and conviviality according to participants.	- Nuisance caused by carelessly parked bicycles. - Too few bicycle parking spaces indoor and outdoor. - Overflowing garbage containers especially in catering establishments. - Wastes are on the street and in porches. - The area is too messy and busy. - Noise pollution due to catering, traffic jams, loading and unloading.	- The possibility of creating more green spaces by removing car parking spaces. - There were different opportunities to participate in the meetings via online meetings or interviewing by telephone. - Opportunity of using car parking spaces for greenery. - Opportunity of using green facades and green roofs against noise pollution.	- Loading and unloading area blocks the view of turning traffic which creates dangerous situation. - Due to the Covid-19 situation, it was not possible to have street conversations in the neighborhood through personal meetings which cause to change of action plan from a physical to online approach to involve the neighborhood.

SWOT Analysis of Frans Halsbuurt			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
- As much transparency as possible in communication. - The neighborhood has a strong mix of functions in the plinth. - Most of the buildings are 3-4 stories high with sloping roofs. - Pedestrian connections between Albert Cuypstraat and Gerard Doustraat are important routes to and from the Albert Cuyp Market. - In a participatory approach, various stakeholders work together that ensures richness and diversity in expectations and interpretations. -	- Overdue maintenance of façade gardens creates a neglected appearance. - Many permanent parking spaces cause to not use the street as a public playground and meeting places. - Limited space for children to play on the sidewalks. - Unclear intersections of area can make a dangerous traffic situation. - Tight bend for trucks. - Horizontal greenery is often seen as an obstacle. - A large concrete electrical house disfigures the street. - Trees push up the paving stones in the street with their roots. - Trees block light and make homes darker and cooler. - Feeling unsafe due to poor lighting of neighborhood. - Dark side of full and busy Gerard Doubuurt is to experience real nuisance from this crowd. - There is a limited street furniture's (benches) and play facilities and less public greenery in this area. - Lack of parking spaces. - Not optimal use of squares. - Nuisance caused by traffic.	- The Albert Cuyp market creates a lot of liveliness in the area. - Outside the opening hours of the market, the Albert Cuypstraat offers potential space for bicycle parking. - By using the same design principles as the Frans Halsbuurt in designing the Public Space of the Gerard Doubuurt, these neighborhoods become a coherent as whole.	- Creating more meeting places means to have more noise pollution. - Tension between neighborhood-specific and metropolitan policy (Occasionally the conversations became somewhat stuck between neighborhood-related problems and metropolitan problems. - Heat stress is a problem in the Gerard Doubuurt. - The Albert Cuyp market causes a lot of inconvenience due to loading and unloading, wastes, crowds. Etc. - There are homeless people in the area who are aggressive towards passers-by and residents and leaving a lot of litter behind. - Side effects of the unsafe traffic situation cause to air pollution.

SWOT Analysis of Frans Halsbuurt			
Strengths	**Weaknesses**	**Opportunities**	**Threats**
	- At the start of the project, the South District indicated that developing a Public Space Plan for the Gerard Doubuurt would not be an open pan process. - In a participatory approach, various stakeholders work together that ensures differences in expectations and interpretation. - The numerous storage and distribution spaces in the area are striking, resulting in a lot of loading and unloading movements. - Construction of taller buildings at the intersection of Ferdinand Bolstraat with Stadhouderdkade (around Marie Heinekenplein). - The courtyards are largely built-up, meaning that the building blocks have hardly any open spaces (up to 97% of the plot areas per block are built-up). - The streets are predominantly one-way. It is difficult to get out from the area. - Less young people involved in Process Advise Group (PAG). - Car parking spaces take up a lot of space. - The neighborhood has little free square space. - Limited space on the sidewalk due to parked bicycles and large terraces. - Green roofs are virtually absent in the neighborhood.		

Overview of suggestions that arose in multiple sessions

Pedestrians
- Remove obstacles from the sidewalk for more space

Bicycle parking
- Create more bicycle parking spaces
- Specify car parking spaces for bicycle parking
- Construction of (underground) bicycle parking garage
- Use car garages that are not full for bicycle parking
- Priority bicycle parking facilities for residents
- Make alternative bicycle parking facilities more attractive
- Flexible spaces for bicycle parking with clear time slots
- Remove obstacles from the sidewalk
- Stricter enforcement on illegally parked bicycles

Car parking and through traffic
- Sacrifice parking spaces for more space for pedestrians, greenery and bicycle parking
- Adjust existing parking spaces
- Provide alternative car parking spaces
- Neighborhood only accessible to local traffic and residents with a car

Waste
- Collect waste more often
- Reintroduce a fixed bulky waste day
- Bring back the two permanent neighborhood cleaners
- Central point for waste containers for the catering industry
- Better communication about how to deal with waste
- Strict enforcement on waste and fines
- Mark where bulky waste is allowed to be placed on the street

Green facility
- Create more facade gardens one paving stone wide
- Use car parking spaces for landscaping
- Better and more beautiful street lighting in **Tweede Jacob van Campenstraat**
- Place more trees in Gerard Doubuurt

Meeting each other in the neighborhood
- Investigate how the space can be organized efficiently
- Take the entrepreneur into account
- Benches not a good idea on second thought

55

Source:

Municipality of Amsterdam website

https://www.amsterdam.nl/projecten/gerard-doubuurt/

5.3. Indicators list

The NBS impact evaluation relies strongly on the adoption of quantitative and qualitative impact markers – the performance and impact indicators. These serve as means for assessing the progress of an adopted pathway targeted at achieving specific objectives, including those of various temporal and spatial scales. Selection of indicators can occur at any time during the cycle of adaptive management of NBS.

In this research, we collected suitable NBS (Nature-Based Solutions) indicators by studying numerous scientific papers. Out of these, we selected 15 papers that closely aligned with our topic and contained NBS indicators. We then conducted a detailed study of these selected papers and utilized their indicated indicators. In Chapter 3, (Figure 6) briefly illustrates the indicator selection process. In chapter 3, (Table 1) collect these 15 scientific papers in one table to see how many indicators are collected from each paper. Based on the literature review of 15 papers plus the indicators which used in NBS projects' case studies, overall, 829 indicators collected for the empirical analysis of the economic, environmental, circular and social efficiency of NBS. These 829 indicators include all 12 societal challenge areas which mention above.

(Figure 12) shows the collected 15 independent indicator lists from 15 scientific papers that are separated by rectangle border from each other in excel file. The different colors in (Figure 12) illustrate the various societal challenge areas. For managing these many of indicators and distinguishing them easily, each societal challenge area heighted by one color.

Figure 12 | 15 independent indicator lists base on the 15 scientific papers in excel
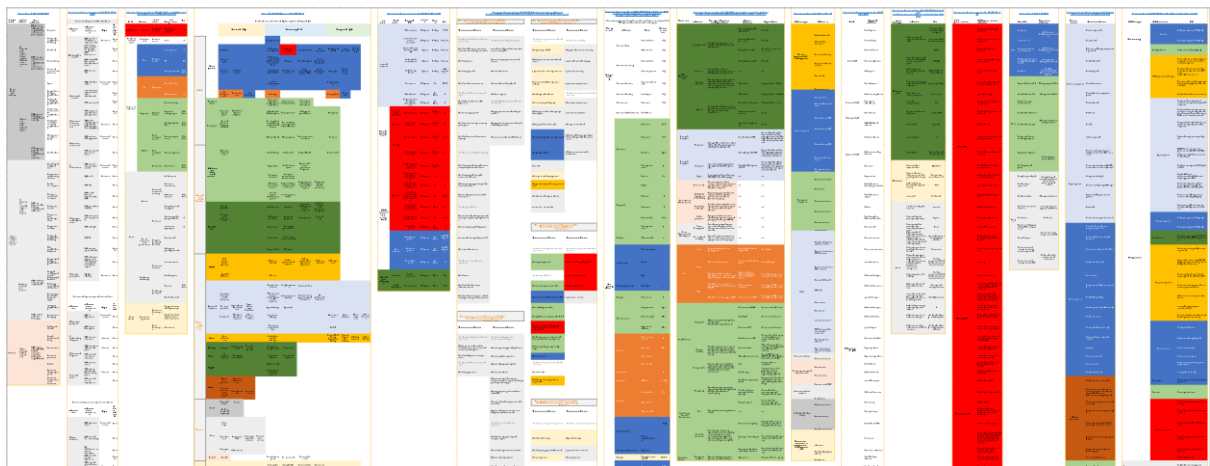
After eliminating repeated indicators, the last 713 indicators are selected to check the presence of them in (European Commission, CITYkeys, EKLIPSE, UNaLab, MAES-urban, Connecting Nature) projects and in (ProGIreg, CWC, Valdocco, Agrobarriera) case studies. Existence of each indicator in mentioned projects highlighted by color. (Figure 13)

Figure 13 | Checking the presence of each indicator by highlighting in mentioned projects and case studies

After steps mentioned above, indicators are selected for final list base on the most repeated indicators between projects. The 44 indicators are selected for final list which appeared at least 3 times in the mentioned projects. By these methodological steps, indicators decreased from 77 to 44. (Table 11) shows the final list of indicators briefly with repetition number of each indicator which the complete table with units and metrics of each indicator is illustrated in (Annex 1). The paper No. mentioned in below table is based on (Table 1) in chapter 3.

Table 11 | Final collected list of indicators with number of repetitions between studies sources

No.	Sustainable Development	Societal challenges	Indicators	No. Repetition	Sources
01			Population Density	4	Paper No. 04 1. CITYkeys 2. MAES-urban 3. ProGIreg 4. Connecting Nature
02	People	Place Regeneration	Urban Sprawl	4	Paper No. 04 1. EKLIPSE 2. MAES-urban 3. UNaLab 4. Connecting Nature
03			Recreational value of blue-green space	3	Paper No. 04 1. European Commission 2. Valdocco 3. Connecting Nature
04			Access to public amenities	3	Paper No. 04 1. European Commission 2. CITYkeys 3. Connecting Nature

05			Land devoted to roads	3	Paper No. 04 1. European Commission 2. EKLIPSE 3. Connecting Nature
06			Place identity and sense of belonging	3	Paper No. 01 1. European Commission 2. valdocco
07			Reclamation of contaminated land: percentage of contaminated area reclaimed	4	Paper No. 01 Paper No. 15 1. EKLIPSE 2. UNaLab 3. Connecting Nature
08		Knowledge & Social capacity Building	Cultural Value	5	Paper No. 15 1. European Commission 2. EKLIPSE 3. ProGIreg 4. CWC
09		Participatory Planning & Governance	Openness of participatory process	3	Paper No. 12 1. European Commission 2. EKLIPSE 3. Valdocco
10			Impact on social learning	3	Paper No. 06 Paper No. 12 1. EKLIPSE 2. Valdocco
11			Safety (e.g., criminal reports in the area) or perceptions of safety	3	Paper No. 02 1. European Commission 2. ProGIreg
12			Access to housing	3	Paper No. 15 1. CITYkeys 2. EKLIPSE 3. ProGIreg
13		Social Justice & Social Cohesion	Cognitive aspects: indicators of trust, attachment to neighborhood, practical help, tolerance, and respect	3	Paper No. 15 1. European Commission 2. MAES-urban 3. Valdocco
14			Citizen access to public transport	3	Paper No. 04 1. CITYkeys 2. EKLIPSE 3. Connecting Nature
15		Health and Wellbeing	Stress reduction	4	Paper No. 11 Paper No. 15 1. EKLIPSE 2. ProGIreg 3. Valdocco

16			Cardiovascular diseases	3	Paper No. 11 1. European Commission 2. EKLIPSE 3. Valdocco
17			Carbon storage and sequestration in vegetation and soil	5	Paper No. 04 Paper No. 11 1. European Commission 2. EKLIPSE 3. MAES-urban 4. Valdocco 5. Connecting Nature
18			Leaf area index	4	Paper No. 07 1. European Commission 2. MAES-urban 3. ProGIreg
19			Air temperature	4	Paper No. 04 Paper No. 06 Paper No. 14 1. ProGIreg 2. Connecting Nature
20	Planet	Climate Resilience	Nonspatial indicators of shares: share of emissions (air pollutants) captured/ sequestered by vegetation	3	Paper No. 15 1. EKLIPSE 2. Connecting Nature
21			Energy Savings	3	Paper No. 04 Paper No. 06 Paper No. 12 1. Connecting Nature
22			Reduced energy demand for heating and cooling	3	Paper No. 11 1. CITYkeys 2. EKLIPSE
23			Annual amount of pollutants captured and removed by vegetation	3	Paper No. 04 Paper No. 11 1. EKLIPSE 2. Connecting Nature
24		Water Management	Flood peak reduction	6	Paper No. 04 Paper No. 06 Paper No. 12 Paper No. 15 1. European Commission 2. EKLIPSE 3. Connecting Nature

25			Water quality	4	Paper No. 04 1. European Commission 2. ProGIreg 3. Valdocco 4. Connecting Nature
26			Ground water quality	4	Paper No. 06 1. EKLIPSE 2. UNaLab 3. Connecting Nature
27			Water exploitation index	3	Paper No. 07 1. European Commission 2. CITYkeys 3. Connecting Nature
28			Water consumption	3	Paper No. 04 Paper No. 07 1. CITYkeys 2. Connecting Nature
29			Green space accessibility	7	Paper No. 09 Paper No. 14 Paper No. 11 1. European Commission 2. CITYkeys 3. Valdocco 4. Connecting Nature
30			Recreational (number of visitors, number of recreational activities)	6	Paper No. 15 1. European Commission 2. EKLIPSE 3.ProGIreg 4. CWC
31		Green Space Management	Community garden area/child capita and in a defined distance	4	Paper No. 04 1. European Commission 2. MAES-urban 3. Connecting Nature
32			Distribution of public green spaces	4	Paper No. 06 1. European Commission 2. UNaLab 3. Connecting Nature
33			Area of green space	4	Paper No. 06 1. CITYkey 2. Valdocco 3. Connecting Nature
34			Land-use intensity	3	Paper No. 04 1. MAES-urban 2. UNaLab 3. Connecting Nature

35			Local food production	3	Paper No. 04 Paper No. 06 1. CITYkeys 2. Connecting Nature
36		Biodiversity	Connectivity of urban green and blue spaces (struct. And funct.)	3	Paper No. 04 1. European Commission 2. Valdocco 3. Connecting Nature
37			Species diversity	3	Paper No. 04 1. European Commission 2. MAES-urban 3. Connecting Nature
38			% of protected areas (ecologically and/or culturally sensitive)	3	Paper No. 04 1. European Commission 2. MAES-urban 3. Connecting Nature
39			Ecological connectivity (eco. Connectivity index)	3	Paper No. 04 1. EKLIPSE 2. Connecting Nature
40		Air quality	Air quality index	4	Paper No. 04 Paper No. 14 1. CITYkeys 2. Valdocco 3. Connecting Nature
41			Value of air pollution reduction	3	Paper No. 04 Paper No. 09 1. EKLIPSE 2. Connecting Nature
42	Prosperity	Natural & Climate Hazards	Areas (ha) and population exposed to flooding	4	Paper No. 15 1. European Commission 2. MAES-urban
43			Inundation risk for critical urban infrastructures (probability - economic)	4	Paper No. 04 1. European Commission 2.EKLIPSE 3.Valdocco 4. Connecting Nature

44		New Economic Opportunity & Green Jobs	Number of jobs created; gross value added	5	Paper No. 15 1. European Commission 2. EKLIPSE 3. Valdocco

5.4. Connecting Indicators to Justice

In this part of our research, we tried to analyze indicators from a justice standpoint by referring to the paper "Integrating justice in Nature-Based Solutions to avoid nature-enabled dispossession." In the mentioned paper, Anguelovski and Corbera (2023) cautioned against making NBS a nature-enabled dispossession for the most vulnerable residents and communities and asked: Under which principles and conditions can NBS, as a policy tool, deliver justice benefits across rural and urban areas?

They proposed a step-by-step approach to integrating and mainstreaming justice in NBS policy stages. To avoid the types of socio-environmental dispossessions reviewed and to guarantee that NBS do not (re)create nature-for-elite profit and greenwashing by repackaging post, harmful, nature-conservation and restoration, and adaptation programs, Anguelovski and Corbera suggest the eight justice-centered principles that should govern the present and future of NBS.

They articulate and dissect these principles in ways that can support decisions for more just NBS-related policy options, as well as for the design, implementation, and evaluation phases of a more justice-centered NBS policy or project. In this study, we expand on this topic and connect justice to indicators, and analyze it in the indicator selection phase. (Table 12)

The eight justice-centered principles are: (Anguelovski and Corbera, 2023)

1. NBS need to be accompanied by thorough evaluations of their benefits before implementation. Additionally, the use of NBS should aim to maximize both mitigation and adaptation co-benefits, as numerous cities and regions have already pledged to do so. (Meli et al., 2017; Honey-Rose's et al., 2018)

2. NBS must also ensure the establishment of renewable and sustainable economic routes and address unsustainable land utilization practices. These encompass a wide range of activities, including extensive agricultural practices, biofuel manufacturing, mining, and other resource extraction in rural areas, as well as extensive real estate expansion through densification and urban expansion, financial developments, and tourism-driven economies in urban areas.

3. NBS also needs to find ways to prevent the taking over and enclosing of land for the purpose of creating green spaces and preserving nature. In some situations, laws aimed at protecting the environment are used to keep the underprivileged away from protected areas, often through force (Dufy et al., 2019; Masse., 2020). This illustrates how certain wealthy individuals or groups have the right to make use of natural resources,

highlighting the unequal application of land use regulations (Masse′ and Lunstrum 2016). NBS should steer clear of seizing rural and urban areas under the guise of developing new environmentally friendly and resilient cities or landscapes.

4. NBS must primarily refrain from engaging in land speculation in both rural and urban areas, which includes land grabbing in agricultural landscapes and green gentrification in cities. Recent research on NBS has demonstrated how businesses, investors, and developers are seizing natural resources to boost land value and profits, promote new real estate projects, and address "green [Land] gaps" (Garcı′a-Lamarca et al. 2022).

5. For NBS to give priority to environmental values and social goals, it should steer clear of greenwashing - which involves superficially incorporating green objectives - and avoid using nature for profit. Anguelovski and Corbera's recent research illustrates that many NBS projects still focus on flashy green initiatives and creating a green image for projects, companies, cities, or regions, while implementing green projects that have minimal impact on decarbonization or adaptation.

6. NBS should promote inclusivity and empowerment. This means making the often disregarded, non-expert knowledge of residents and users more visible and recognized, particularly for historically marginalized groups. They should genuinely be involved in the design and management of NBS projects. Otherwise, the needs, vulnerabilities, and identities of these groups could risk being pushed aside, while the preferences of higher income or more politically empowered groups are prioritized (Anguelovski, et al. 2020).

7. NBS projects need to address long-term green inequalities in order to achieve their full potential in addressing social and economic objectives as well as environmental and climate goals. In this context, green inequalities refer to the limited opportunities and resources available to low-income residents to benefit from NBS projects through economic initiatives that can support their livelihoods at both the individual and community levels. In various projects that have been examined, NBS are deliberately integrated with measures to promote equity.

8. NBS should also ensure that the connection between people and land and nature is restored and maintained. In various cities throughout the United States and in rural areas across the Global South, land belonging to impoverished and marginalized residents has been taken through urban segregation and urban renewal policies, as well as through extensive land acquisition for conservation, agriculture, or natural resource extraction in rural areas (Brockington and Igoe 2006; Sandig 2021).

NBS may also have a restorative function, particularly in post-conflict or post-war settings, where the establishment of new public green spaces can assist in addressing a history of violence and the associated social and spatial trauma and division. For instance, in Berlin, the development of new large parks has been found by researchers to have contributed to the city's reunification after 1990 by honoring the city's historical legacy and ensuring that the new parks are accessible to all residents (Draus et al., 2019).

From nature-enabled dispossession to nature-inspired justice in NBS policies. Nature-based justice requires a series of principles and associated practices for tackling existing environment

and climate, social, and economic challenges related to NBS, from policy option (blue), decision-making (yellow), implementation (red), to evaluation (purple), with an assumption that the principles we outline may have an overlap in the stages that tackle them, hence the use of gradients. NB: The stages of identifying the environmental problem and setting the policy agenda have been omitted because NBS are already a well-established choice in policy forums and schemes to address global environmental challenges (Anquelovski and Corbera, 2023). (Figure 14)

Figure 14 | From nature-enabled disspossession to nature-based justice in NBS policies *(Source: (Anquelovski and Corbera, 2023))*
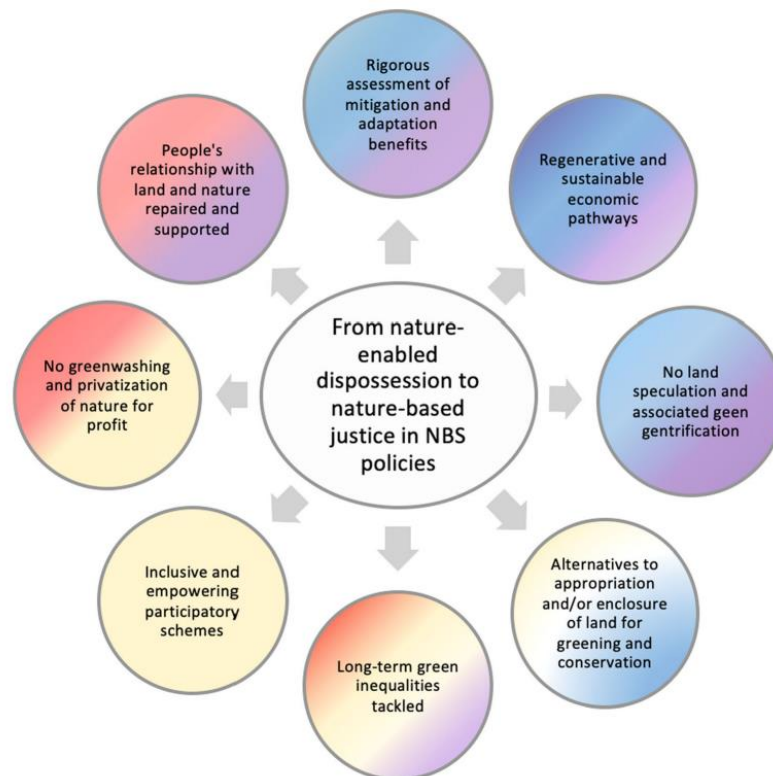
(Table 12) shows steps of integrating justice in Nature-Based Solutions which connected to NBS indicators. In Annex 2, this connection of justice to indicators are illustrated in Sankey Matic graph for better understanding.

Table 12 | Connection of justice steps to NBS indicators

No.	Indicators	Principles of integrating justice in Nature-Based Solutions
01	Population Density	**Step 7:** NBS projects must help tackle long-term green inequalities if they are to fulfill their potential of addressing social and economic objectives in addition to environmental and climate goals. Green inequalities relate here to the lack of opportunity and capacity held by low-income residents to benefit from NBS projects through economic schemes than can support their livelihoods at the individual and community level.

02	Urban Sprawl	**Step 2 & 7.** **Step 2:** NBS also need to guarantee regenerative and sustainable economic pathways and confront unsustainable land use patterns. These range from large-scale farming, biofuel production, and mining and other resource extraction in rural areas to large-scale real estate development via densification and urban sprawl, financial developments, visitor- and tourism-driven economies in urban regions. **Step 7:** NBS projects must help tackle long-term green inequalities if they are to fulfill their potential of addressing social and economic objectives in addition to environmental and climate goals. Green inequalities relate here to the lack of opportunity and capacity held by low-income residents to benefit from NBS projects through economic schemes than can support their livelihoods at the individual and community level.
03	Recreational value of blue-green space	**Step 5, 6 &7.** **Step 5:** No privatization for profit. **Step 6:** NBS should be inclusive and empowering, i.e., they should visibilize and recognize the often overlooked, non-expert knowledge of residents and users, especially so for historically marginalized groups, and genuinely include them in the design and management of NBS projects. **Step 7:** NBS projects must help tackle long-term green inequalities if they are to fulfill their potential of addressing social and economic objectives in addition to environmental and climate goals. Green inequalities relate here to the lack of opportunity and capacity held by low-income residents to benefit from NBS projects through economic schemes than can support their livelihoods at the individual and community level.
04	Access to public amenities	**Step 5, 6 &7.** **Step 5:** No privatization for profit. **Step 6:** NBS should be inclusive and empowering, i.e., they should visibilize and recognize the often overlooked, non-expert knowledge of residents and users, especially so for historically marginalized groups, and genuinely include them in the design and management of NBS projects. **Step 7:** NBS projects must help tackle long-term green inequalities if they are to fulfill their potential of addressing social and economic objectives in addition to environmental and climate goals. Green inequalities relate here to the lack of opportunity and capacity held by low-income residents to benefit from NBS projects through economic schemes than can support their livelihoods at the individual and community level.
05	Land devoted to roads	**Step 2:** NBS also need to guarantee regenerative and sustainable economic pathways and confront unsustainable land use patterns. These range from large-scale farming, biofuel production, and mining and other resource extraction in rural areas to large-scale real estate development via densification and urban sprawl, financial developments, visitor- and tourism-driven economies in urban regions.
06	Place identity and sense of belonging	**Step 8:** NBS must also guarantee that people's relationship with land and nature is repaired and supported.

07	Reclamation of contaminated land: percentage of contaminated area reclaimed	**Step 3 & 4:** NBS should foremost avoid land speculation in both rural and urban areas (and associated land grabbing in agricultural landscapes and green gentrification in cities). With research on NBS increasingly showing how nature is being grabbed by firms, investors, and developers to increase land value and profits, to market new real estate developments, and to close on ''green [land] gaps''. we argue that NBS projects must be decoupled from speculative and profit-driven dynamics, and rather play a much stronger social role for residents and users, in ways that can secure their needs and responsibilities.
08	Cultural Value	**Step 5, 6 &7.** **Step 5:** No privatization for profit. **Step 6:** NBS should be inclusive and empowering, i.e., they should visibilize and recognize the often overlooked, non-expert knowledge of residents and users, especially so for historically marginalized groups, and genuinely include them in the design and management of NBS projects. **Step 7:** NBS projects must help tackle long-term green inequalities if they are to fulfill their potential of addressing social and economic objectives in addition to environmental and climate goals. Green inequalities relate here to the lack of opportunity and capacity held by low-income residents to benefit from NBS projects through economic schemes than can support their livelihoods at the individual and community level.
09	Openness of participatory process	**Step 6:** NBS should be inclusive and empowering, i.e., they should visibilize and recognize the often overlooked, non-expert knowledge of residents and users, especially so for historically marginalized groups, and genuinely include them in the design and management of NBS projects.
10	Impact on social learning	**Step 5 & 6:** **Step 5:** No privatization for profit. **Step 6:** Inclusive and empowering participatory schemes.
11	Safety (e.g., criminal reports in the area) or perceptions of safety	**Step 7:** NBS projects must help tackle long-term green inequalities if they are to fulfill their potential of addressing social and economic objectives in addition to environmental and climate goals. Green inequalities relate here to the lack of opportunity and capacity held by low-income residents to benefit from NBS projects through economic schemes than can support their livelihoods at the individual and community level.
12	Access to housing	**Step 7:** NBS projects must help tackle long-term green inequalities if they are to fulfill their potential of addressing social and economic objectives in addition to environmental and climate goals. Green inequalities relate here to the lack of opportunity and capacity held by low-income residents to benefit from NBS projects through economic schemes than can support their livelihoods at the individual and community level.
13	Cognitive aspects: indicators of trust, attachment to neighborhood, practical help, tolerance, and respect	**Step 8:** NBS must also guarantee that people's relationship with land and nature is repaired and supported.

14	Citizen access to public transport	**Step 5, 6 &7.** **Step 5:** No privatization for profit. **Step 6:** NBS should be inclusive and empowering, i.e., they should visibilize and recognize the often overlooked, non-expert knowledge of residents and users, especially so for historically marginalized groups, and genuinely include them in the design and management of NBS projects. **Step 7:** NBS projects must help tackle long-term green inequalities if they are to fulfill their potential of addressing social and economic objectives in addition to environmental and climate goals. Green inequalities relate here to the lack of opportunity and capacity held by low-income residents to benefit from NBS projects through economic schemes than can support their livelihoods at the individual and community level.
15	Stress reduction	**Step 7 & 8.** **Step 7:** NBS projects must help tackle long-term green inequalities if they are to fulfill their potential of addressing social and economic objectives in addition to environmental and climate goals. Green inequalities relate here to the lack of opportunity and capacity held by low-income residents to benefit from NBS projects through economic schemes than can support their livelihoods at the individual and community level. **Step 8:** NBS must also guarantee that people's relationship with land and nature is repaired and supported.
16	Cardiovascular diseases	**Step 7 & 8.** **Step 7:** NBS projects must help tackle long-term green inequalities if they are to fulfill their potential of addressing social and economic objectives in addition to environmental and climate goals. Green inequalities relate here to the lack of opportunity and capacity held by low-income residents to benefit from NBS projects through economic schemes than can support their livelihoods at the individual and community level. **Step 8:** NBS must also guarantee that people's relationship with land and nature is repaired and supported.
17	Carbon storage and sequestration in vegetation and soil	**Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed.
18	Leaf area index	**Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed.
19	Air temperature	**Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed.
20	Nonspatial indicators of shares: share of emissions (air pollutants) captured/ sequestered by vegetation	**Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed.
21	Energy Savings	**Step 1 & 2.** **Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed. **Step 2:** Regenerative and sustainable economic path ways

22	Reduced energy demand for heating and cooling	**Step 1 & 2.** **Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed. **Step 2:** Regenerative and sustainable economic path ways
23	Annual amount of pollutants captured and removed by vegetation	**Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed.
24	Flood peak reduction	**Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed.
25	Water quality	**Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed.
26	Ground water quality	**Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed.
27	Water exploitation index	**Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed.
28	Water consumption	**Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed.
29	Green space accessibility	**Step 5, 6 &7.** **Step 5:** No privatization for profit. **Step 6:** NBS should be inclusive and empowering, i.e., they should visibilize and recognize the often overlooked, non-expert knowledge of residents and users, especially so for historically marginalized groups, and genuinely include them in the design and management of NBS projects. **Step 7:** NBS projects must help tackle long-term green inequalities if they are to fulfill their potential of addressing social and economic objectives in addition to environmental and climate goals. Green inequalities relate here to the lack of opportunity and capacity held by low-income residents to benefit from NBS projects through economic schemes than can support their livelihoods at the individual and community level.
30	Recreational (number of visitors, number of recreational activities)	**Step 2, 6 & 7.** **Step 2:** Regenerative and sustainable economic path ways. **Step 6:** NBS should be inclusive and empowering, i.e., they should visibilize and recognize the often overlooked, non-expert knowledge of residents and users, especially so for historically marginalized groups, and genuinely include them in the design and management of NBS projects. **Step 7:** NBS projects must help tackle long-term green inequalities if they are to fulfill their potential of addressing social and economic objectives in addition to environmental and climate goals. Green inequalities relate here to the lack of opportunity and capacity held by low-income residents to benefit from NBS projects through economic schemes than can support their livelihoods at the individual and community level.

31	Community garden area/child capita and in a defined distance	**Step 4 & 7:** **Step 4:** Alternatives to appropriation and / or enclosure of land for greening and conservation. envision the increase of urban green space through the cession of empty lots to residents so that these can be managed and farmed as community gardens. **Step 7:** NBS projects must help tackle long-term green inequalities if they are to fulfill their potential of addressing social and economic objectives in addition to environmental and climate goals. Green inequalities relate here to the lack of opportunity and capacity held by low-income residents to benefit from NBS projects through economic schemes than can support their livelihoods at the individual and community level.
32	Distribution of public green spaces	**Step 6:** NBS should be inclusive and empowering, i.e., they should visibilize and recognize the often overlooked, non-expert knowledge of residents and users, especially so for historically marginalized groups, and genuinely include them in the design and management of NBS projects.
33	Area of green space	**Step 5 & 6:** **Step 5:** to prioritize environmental values and social objectives, NBS must avoid greenwashing, that is a superficial integration of green objectives, and the privatization of nature for profit. Yet, in many of these cities, green is rather a brand that is superficially implemented and where nature often becomes privatized. **Step 6:** NBS should be inclusive and empowering, i.e., they should visibilize and recognize the often overlooked, non-expert knowledge of residents and users, especially so for historically marginalized groups, and genuinely include them in the design and management of NBS projects.
34	Land-use intensity	**Step 2, 3, 4, 5 & 6:** **Step 2:** NBS also need to guarantee regenerative and sustainable economic pathways and confront unsustainable land use patterns. **Step 3:** No land speculation and associated green gentrification. **Step 4**: Alternatives to appropriation and / or enclosure of land for greening and conservation. **Step 5:** to prioritize environmental values and social objectives, NBS must avoid greenwashing, that is a superficial integration of green objectives, and the privatization of nature for profit. **Step 6:** NBS should be inclusive and empowering, i.e., they should visibilize and recognize the often overlooked, non-expert knowledge of residents and users, especially so for historically marginalized groups, and genuinely include them in the design and management of NBS projects.
35	Local food production	**Step 1, 2 & 4:** **Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed. **Step 2:** Regenerative and sustainable economic path ways. **Step 4:** Alternatives to appropriation and/ or enclosure of land for greening and conservation.
36	Connectivity of urban green and blue spaces (struct. And funct.)	**Step 1 & 2:** **Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed. **Step 2:** Regenerative and sustainable economic path ways

37	Species diversity	**Step 1 & 2.** **Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed. **Step 2:** Regenerative and sustainable economic path ways
38	% of protected areas (ecologically and/or culturally sensitive)	**Step 3 & 6.** **Step 3:** NBS must also circumvent the appropriation and/ of enclosure of land for greening and conservation.in many cases, environmental protection laws are being enforced to keep the poor out of protected areas -often violently, wealth-generating activities or groups are entitled to access natural resources, thus revealing the unequal enforcement of land use regulations. **Step 6:** NBS should be inclusive and empowering, i.e., they should visibilize and recognize the often overlooked, non-expert knowledge of residents and users, especially so for historically marginalized groups, and genuinely include them in the design and management of NBS projects.
39	Ecological connectivity (eco. Connectivity index)	**Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed.
40	Air quality index	**Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed.
41	Value of air pollution reduction	**Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed.
42	Areas (ha) and population exposed to flooding	**Step 1 & 6.** **Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed. **Step 6:** In several countries, both in urban and rural regions, conservation and sustain able resource management programs and projects aimed at climate adaptation or mitigation have also been disadvantageous to the poorest and politically disempowered social groups.
43	Inundation risk for critical urban infrastructures (probability - economic)	**Step 1:** NBS should count with rigorous, ex ante, assessments of their benefits. Rather than assuming benefits a priori, projects should develop a clear assessment of the mitigation and adaptation benefits to be achieved, and of the climate risks and impacts that can be avoided or addressed.
44	Number of jobs created; gross value added	**Step 2:** Regenerative and sustainable economic path ways

5.5. Impact Assessment of Selected Indicators

The evaluation of impact is a component of a larger effort to make policies based on evidence, and it is crucial for advancing our understanding of how effective interventions are in bringing about the desired changes. To accomplish this, impact evaluation thoroughly and empirically investigates the causal impact of modifications in the constructed or natural environment associated with the NBS intervention. These impacts can be categorized into 12 societal challenges mentioned in previous sections, often affecting various dimensions simultaneously (for example, Place regeneration and Health and Wellbeing). Therefore, impact evaluation is connected to the interpretation of selected indicators for assessing NBS performance and effectiveness in addressing challenges and achieving objectives. (European Commission, 2021)

For answering the research question by conducting an impact assessment on the selected NBS project, the following steps considered:

- While I was studying abroad at the University of Amsterdam for 6 months as an exchange student, I chose to study the Frans Halsbuurt and Gerard Doubuurt neighborhoods. During my research, I found that the project in the Frans Halsbuurt neighborhood was in its final stages of completion, while the project in the Gerard Doubuurt neighborhood was just beginning to be implemented. As a result, I focused on evaluating indicators in the Frans Halsbuurt neighborhood.

- Base on the research question and the goals of NBS project in Frans Halsbuurt, 6 key performance indicators from people part of Sustainable Developments part are selected. In our study on NBS impact assessment, we prioritized social justice. Therefore, we selected 6 KPIs from the people category of societal challenges. We chose these specific indicators because they closely align with the goals of the Frans Halsbuurt project. Assessing these 6 KPIs in Frans Halsbuurt will be more relevant than using other indicators.

- Once the 6 KPIs have been selected, the next phase will consist of identifying an appropriate method for each indicator to evaluate. There may be more than one measurement method for each indicator (e.g., Physical activity can be measured through a self-reported questionnaire, Wearable devices or through heat maps). For each of 6 KPIs in this research at least one measurement method is proposed.

- After selecting appropriate KPIs and related methodologies, the next step is to identify and collect the available data. In this study base on different methodologies and needed data, there is need to collect a sufficient data in two timelines. Once before beginning of the project as a baseline data and once after complementation of project as an ended data. These timelines can differ in each indicator assessment base on the data availability in selected time.

- Next step is to analyze and interpret the collected data, in order to assess NBS performance in achieving established objectives, and assess both positive and negative impacts, as well as synergies and trade-offs in time scales.

In this study, we start the assessment of selected KPIs by brief description of each indicator then continued by related methodology, collected available data and the last step is analyzing and evaluation of collected data.

The selected 6 KPIs in this research are:

5.5.1. Population Density

5.5.2. Access to Public Amenities

5.5.3. Cultural Value

5.5.4. Openness of Participatory Process

5.5.5. Access to Housing

5.5.6. Stress Reduction

In the following section, we will first outline the available methodologies for each indicator. Then, based on the availability of sufficient data, we will choose the appropriate methodology to assess the impact and effectiveness of the NBS project on each indicator.

We used the same framework for these 6 KPIs, which first starts with a brief description of the indicator, followed by the definition, measurement procedure and tool, scale of measurement, data collection frequency, data availability, and, lastly, the analysis and evaluation of the collected data.

5.5.1. Population Density

Based on UnaLab, there are two types of units for calculating population density as shown in (Table 13). In the following steps, the research will focus on CITYkeys' source for calculating population density using the unit Number/Km².

Table 13 | Population Density Indicator *(Source: (UnaLab, 2019))*

Indicator	Unit	Description
Population Density	Number / km²	Number of people per Km²
	Number / ha	Number of inhabitants per ha

5.5.1.1. Description and justification

The density of the population is generally linked to various elements of sustainable urban growth, including the effective functioning of urban infrastructures, the proportion of environmentally friendly transportation methods, the vibrancy of street activity, and the phenomenon of sealing the soil. (CITYkeys, 2017)

- Efficient urban infrastructures: The higher the population density is, the easier it is to operate the public transport, but also water, communication and energy infrastructures at low cost. (CITYkeys, 2017)

- There is strong statistical evidence for a positive correlation between population density and the share of green transport modes public transport, walking and biking. (Newman & Kenworthy 1999, 2006)

- Also, a higher urban population is sometimes associated with lively urban streets. (CITYkeys, 2017)

- Also, a high population density reduces the footprint of urban development and prevents the development of farm land and natural areas. (CITYkeys, 2017)

5.5.1.2. Definition

Number of people per Km². (CITYkeys, 2017)

5.5.1.3. Measurement procedure and tool

Population density is calculated as the ratio of number of inhabitants (numerator) divided by the overall area of the city (km²) (denominator). (CITYkeys, 2017)

5.5.1.4. Scale of measurement

Based on the projects differ. In this study the scale of measurement is in neighborhood scale.

5.5.1.5. Data collection frequency

In this research the data is collected once before project start and once after end of project.

5.5.1.6. (Collected Data) Data availability

To measure the population density in the Frans Halsbuurt neighborhood, data was collected from the (CBS) Statistics Netherlands database in 2018 before the start of the project and in 2023, which was the most recently available data. The population and surface data are presented in the tables below: 2018 data in (Table 14) and 2023 data in (Table 15).

In addition, by gathering data from Amsterdam, it is possible to compare the data between Amsterdam city and the Frans Halsbuurt neighborhood.

Table 14 | Population and Surface data of Amsterdam city and Frans Halsbuurt in 2018 *(Source: (CBS, 2018))*

Subject		Amsterdam	Frans Halsbuurt
Population			
Population	number	854 047	2 615
Population density	number of inhabitants per km²	5 160	23 396
Surface			
Total surface area	ha	21 949	12
Area of land	ha	16 550	11
Surface water	ha	5 399	1

Table 15 | Population and Surface data of Amsterdam city and Frans Halsbuurt in 2023 *(Source: (CBS, 2023))*

Subject		Amsterdam	Frans Halsbuurt
Population			
Population	number	918 117	2 580
Population density	number of inhabitants per km²	4 880	23 369
Surface			
Total surface area	ha	24 365	12
Area of land	ha	18 812	11
Surface water	ha	5 553	1

To gain a comprehensive perspective on population density in all neighborhoods of Amsterdam, including the Frans Halsbuurt neighborhood highlighted with a blue circle, the data is illustrated on the map. The population density for 2018 is shown in (Figure 15) and for 2023 in (Figure 16).

Figure 15 | Map of Population Density of Amsterdam neighborhoods in 2018 *(Source: (CBS, 2018))*

5 to 7185 (Number of inhabitants per Km²)
7185 to 14364 (Number of inhabitants per Km²)
14364 to 21544 (Number of inhabitants per Km²)
21544 to 28723 (Number of inhabitants per Km²)
More than 28723 (Number of inhabitants per Km²)
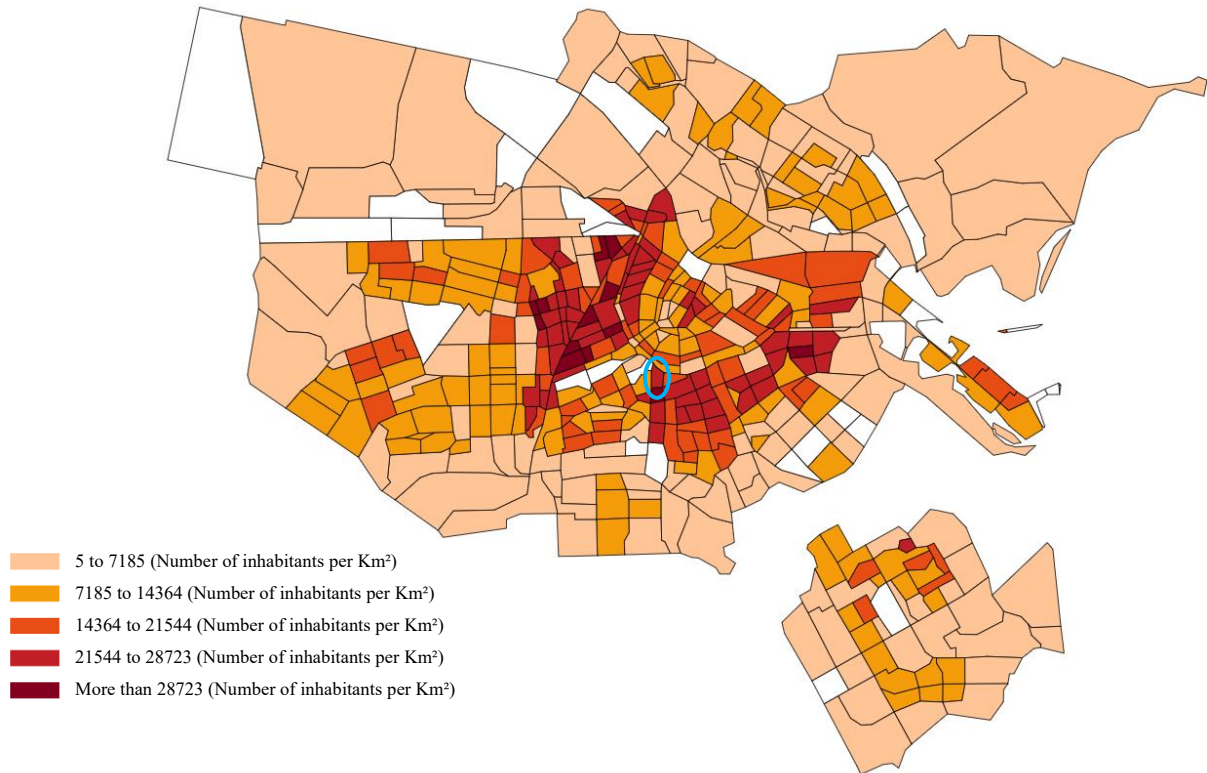
Figure 16 | Map of Population Density of Amsterdam neighborhoods in 2023 *(Source: (CBS, 2023))*

4 to 7012 (Number of inhabitants per Km²)
7012 to 14020 (Number of inhabitants per Km²)
14020 to 21029 (Number of inhabitants per Km²)
21029 to 28037 (Number of inhabitants per Km²)
More than 28037 (Number of inhabitants per Km²)
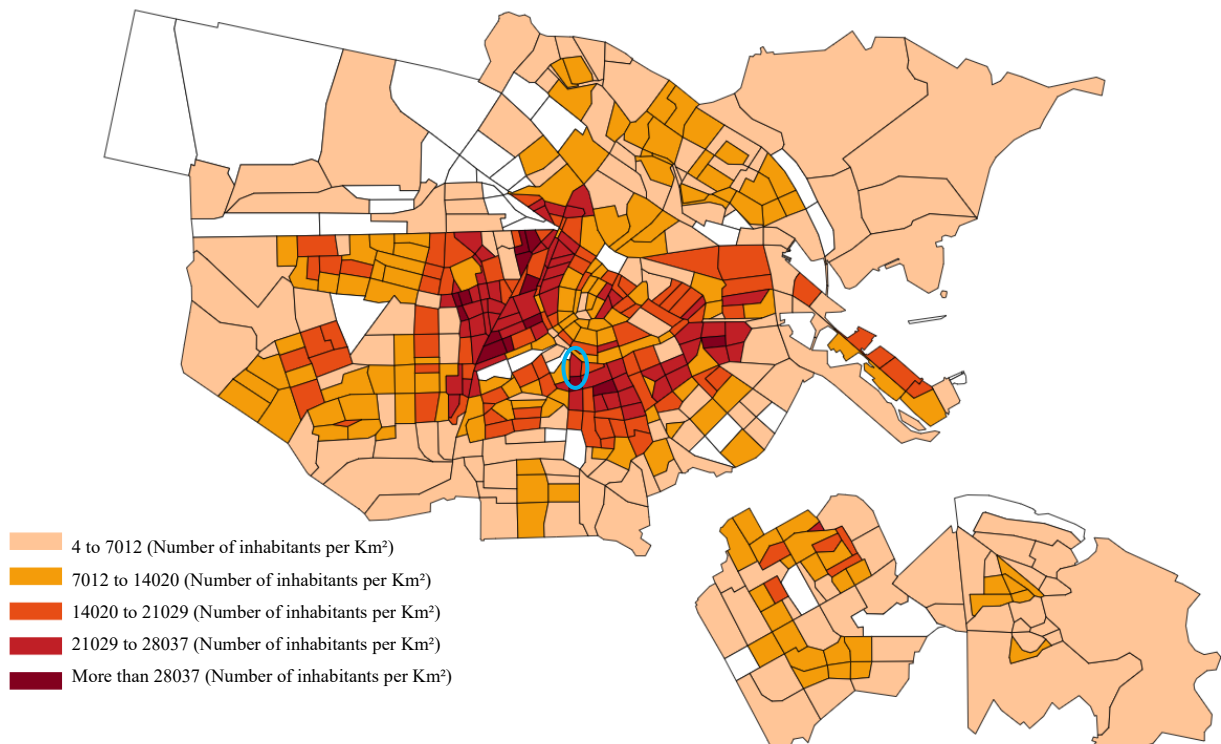
5.5.1.7. Analyzing Data

Based on the data from (Table 14) and (Table 15), the population density in the Frans Halsbuurt neighborhood has remained constant at 23396 inhabitants per square kilometer between the years 2018 and 2023. However, the number of populations in Frans Halsbuurt has decreased from 2615 people to 2580 people during the same time period.

The population density of Amsterdam city decreased from 5160 to 4880 inhabitants per square kilometer between 2018 and 2023. However, the total population increased from 854047 in 2018 to 918117 in 2023. According to (Table 14) and (Table 15), there was an increase in the total surface area during the same period, rising from 21949 hectares to 24365 hectares. The total surface area of Frans Halsbuurt was 12 hectares during the same period.

According to (Figures 15) and (Figure 16), the population density of all neighborhoods in Amsterdam during 2018 and 2023 is illustrated. Based on the maps, it is evident that the Frans Halsbuurt neighborhood is one of the most densely populated neighborhoods compared to others in both years.

Based on the research by Brander and Koetse (2011), it was found that population density was positively and significantly linked to the value of NBS. This suggests that areas with higher population density have a higher value of NBS, supporting the hypothesis of open space scarcity.

According to a study by Marija Bockarjova & W.J. Wouter Botzen from Utrecht University in 2017, there is a positive and significant association between population density in urban areas and housing prices. Depending on the model used, a 1 unit increase in population density leads to a 0.025% to 0.033% increase in the relative value of Natura-based Solutions (NBS) reflected in average house prices, at the average population density level of 1740 persons per square kilometer. Population density is also positively and statistically significantly associated with the per hectare value of NBS. Therefore, in urban areas with higher population density per hectare, the value of NBS is higher compared to areas with lower population density.

We will discuss the impact of the Frans Halsbuurt's NBS project on housing prices in the Housing Affordability indicator. Based on the research conducted, there is a lack of studies directly linking population density and NBS effectiveness. However, the primary analysis of most indicators for evaluating NBS effectiveness is population density.

In general, implementing NBS in densely populated areas can have a greater impact, benefiting more people. In other words, more people can benefit from NBS when it is implemented in areas with high population density.

5.5.2. Access to Public Amenities

According to the CITYkeys report, the evaluation methods for the Access to Public Amenities indicator are mentioned in two different ways. One method is based on the percentage of people within 500 meters, and the other uses a Likert scale. In our study, we will briefly describe both evaluation methods, and based on data availability, we will choose one method or a combination of both to evaluate the Access to Public Amenities indicator in the Frans Halsbuurt neighborhood. (Table 16) illustrates the two different evaluation methods for this indicator as per the CITYkeys report. (CITYkeys, 2017)

Table 16 | Access to Public Amenities *(Source: (CITYkeys, 2017))*

Indicator	Unit	Description
Access to Public Amenities	% of people	Share of population with access to at least one type of public amenity within 500m
	Likert scale	The extent to which public amenities are available within 500m

5.5.2.1. Description and justification

5.5.2.1.1. Access to Public Amenities (% of people)

It is assumed that the presence of nearby amenities contributes to a vibrant neighborhood and reduces the need for car usage. Amenities in urban areas enhance the area's appeal and make it more enjoyable. Public amenities are services and facilities provided by the government or local councils for the public to use, either free of charge or with a fee. Examples of public amenities include social welfare centers, meeting points, theaters, and libraries (Please note that other public amenities such as green spaces, recreational areas, and healthcare facilities are covered separately). Access to public amenities serves as an indicator that partially reveals the diversity and distribution of various functions in an urban area, showcasing the availability of public services in close proximity to residential areas. (CITYkeys, 2017)

5.5.2.1.2. Access to Public Amenities (Likert scale)

The density of public facilities is often used to measure how compact or sprawling urban areas are, as well as how much people rely on cars. Having easy access to local services and amenities can reduce the need for travel, especially by private vehicles, and help create sustainable communities. This measure can also reflect the overall health, well-being, and quality of life in an area. Public amenities encompass the services and facilities provided by the government or local councils for the benefit of the general public, either free of charge or for a fee, such as libraries and social welfare centers. (CITYkeys, 2017)

5.5.2.2. Definition

5.5.2.2.1. Access to Public Amenities (% of people)

Share of population with access to at least one type of public amenity within 500m (CITYkeys, 2017)

5.5.2.2.2. Access to Public Amenities (Likert scale)

The extent to which public amenities are available within 500m (CITYkeys, 2017)

5.5.2.3. Measurement procedure and tool

5.5.2.3.1. Access to Public Amenities (% of people)

$$\frac{Number\ of\ inhabitants\ with\ a\ public\ amenity < 500m}{Total\ population} * 100$$

The total can be obtained by adding up the number of buildings with a public facility within a 500m radius and then multiplying by the population. Inadequate distribution of various public facilities in central urban areas promotes urban sprawl and erodes urban identity. Efforts to evenly disperse these facilities across space can negatively impact various transportation methods, leading to an increase in the use of private motor vehicles. (CITYkeys, 2017)

Possibly, GIS software could be employed. A map of the area could be obtained, public facilities could be identified (available at the city planning office), 500m circles could be drawn around them, and city resident data (accessible in city administrative records) could be used to calculate the count of residential buildings and the number of registered occupants at these locations outside this area. (CITYkeys, 2017)

Based on a study conducted by the European Commission, data collected about the availability of public facilities can serve the following purposes: (CITYkeys, 2017)

• Measure the advantages of nature-based solutions (NBS) in terms of enhancing access to public amenities;

• Evaluate the allocation of important public facilities in relation to planning new green spaces;

• Give priority to the development of public amenities through the design of nature-based solutions.

5.5.2.3.2. Access to Public Amenities (Likert scale)

No public amenities – 1 — 2 — 3 — 4 — 5 — Relatively many public amenities.

1. No amenities: no public amenities whatsoever are available (e.g. no basic nor additional).

2. Relatively few amenities: only few basic public amenities are available (e.g. a small park).

3. A reasonable number of amenities: basic public amenities are available including a few important amenities such as a park and a community center.

4. A sufficient number of amenities: basic public amenities are widely available (e.g. open green spaces, public recreation) as well as many important public amenities (theatres).

5. Relatively many amenities: the area surrounding the project's central living area includes a wide variety of public amenities including numerous basic amenities (e.g. green spaces, public recreation facilities) as well as numerous important public amenities (e.g. theatres, zoos).

The assessor might also consider the amenities that are available; for instance, the presence of public recreational facilities holds more significance than the availability of drinking fountains. While an effort is made to assess this indicator as objectively as possible, there is still some subjectivity involved. Additionally, the indicator does not consider the quality of public amenities or user satisfaction. (CITYkeys, 2017)

5.5.2.4. Scale of measurement

Base on European Commission report the scale of measurement for this indicator can be differ from smaller scale to city-scale and even larger various geographical scales. In this study, the scale of measurement is at the neighborhood level.

5.5.2.5. Data collection frequency

After the project, but can also be used ex-ante to evaluate plans.

5.5.2.6. (Collected Data) Data availability

In this study, we evaluated an indicator by drawing a 500m radius circle around the Frans Halsbuurt neighborhood using maps from the Amsterdam Maps website. One significant amenity added to this neighborhood after a redevelopment project was the installation of underground waste collection containers. (Figure 17) shows the location of these waste collection containers within a 500m radius from the center of the Frans Halsbuurt neighborhood, outlined with red lines on the map. Another important aspect of the NBS redevelopment project in Frans Halsbuurt was the increase in green areas within the neighborhood. (Figure 18) displays the public and green parks within a 500m radius from the neighborhood center, outlined with red lines on the map.

We collected comprehensive data from the Statistics Netherlands (CBS) database; once in 2018 before the start of the project and again in 2022, the latest available data, which was in the middle of the project. This data was calculated as an average over all persons in the area and included proximity to various amenities in Amsterdam and the Gerard Doubuurt and Frans Halsbuurt neighborhoods.

This research focused on the Frans Halsbuurt neighborhood and the relevant subjects in the NBS project. (Table 17) illustrates the proximity to amenities in 2018, while (Table 18) shows the proximity to amenities in 2022. The selected subjects for assessing the Access to Public Amenities are highlighted in both tables.

Figure 17 | Waste collection containers within 500m in Frans Halsbuurt neighborhood (Source: *(Amsterdam Maps, 2024))*

Figure 18 | Public and green parks within 500m in Frans Halsbuurt neighborhood *(Source: (Amsterdam Maps, 2024))*

Subject		Neighborhoods and neighbourhoods		
		Amsterdam	Gerard Doubuurt	Frans Halsbuurt
Region designation				
Municipality name	name	Amsterdam	Amsterdam	Amsterdam
Type of region	Description	Local authority	Neighbourhood	Neighbourhood
Coding	code	GM0363	BU03632401	BU03632402
Change in the layout of districts and neighbourhoods	code	.	1	1
Health and wellbeing				
General practice				
Distance to GP practice	km	0.5	0.4	0.2
Number of GP practices				
Within 1 km	number	4.9	8.3	8.6
Within 3 km	number	37.0	82.6	81.4
Within 5 km	number	84.0	148.2	149.1
Distance to GP post	km	2.9	1.9	2.2
Distance to pharmacy	km	0.6	0.6	0.5
Hospital (incl. outdoor outpatient clinic)				
Distance to hospital	km	2.3	1.9	2.0
Number of hospitals				
Within 5 km	number	2.7	3.1	3.8
Within 10 km	number	7.4	11.0	9.9
Within 20 km	number	16.8	15.1	15.8
Hospital (excl. outdoor outpatient clinic)				
Distance to hospital	km	2.7	1.9	2.2
Number of hospitals				
Within 5 km	number	2.1	2.1	2.8
Within 10 km	number	5.9	9.0	7.9
Within 20 km	number	11.8	11.1	11.8
Distance to clinic	km	.	.	.
Physiotherapist				
Distance to physiotherapist	km	.	.	.
Number of physiotherapists				
Within 1 km	number	.	.	.
Within 3 km	number	.	.	.
Within 5 km	number	.	.	.

Subject		Amsterdam	Gerard Doubuurt	Frans Halsbuurt
Retail				
Shops for daily groceries				
Distance to large supermarket	km	0.5	0.1	0.3
Number of large supermarkets				
Within 1 km	number	5.2	13.0	9.7
Within 3 km	number	38.2	90.9	88.7
Within 5 km	number	87.5	151.5	156.2
Distance to public transport daily. foodstuffs	km	0.4	0.1	0.1
Number of other daily foodstuffs				
Within 1 km	number	32.3	92.2	85.5
Within 3 km	number	249.5	621.1	636.7
Within 5 km	number	565.9	1 002.8	1 021.5
Department store				
Distance to department store	km	1.7	0.6	0.5
Number of department stores				
Within 5 km	number	8.3	15.0	15.0
Within 10 km	number	19.7	23.0	23.0
Within 20 km	number	37.8	35.3	36.8
catering industry				
Cafes and the like				
Distance to café etc	km	0.6	0.1	0.1
Number of cafes				
Within 1 km	number	19.2	59.4	57.5
Within 3 km	number	176.2	534.1	562.9
Within 5 km	number	396.8	730.0	732.0
Cafeterias and the like				
Distance to cafeteria, etc	km	0.4	0.1	0.1
Number of cafeterias, etc				
Within 1 km	number	25.5	85.9	88.8
Within 3 km	number	226.0	634.6	654.7
Within 5 km	number	518.0	939.9	944.8
Restaurants				
Distance to restaurant	km	0.3	0.1	0.1
Number of restaurants				
Within 1 km	number	49.5	193.0	205.0
Within 3 km	number	441.0	1 315.4	1 392.5
Within 5 km	number	993.7	1 827.1	1 833.9
Hotels and the like				
Distance to hotel etc	km	0.9	0.3	0.2
Number of hotels etc				
Within 5 km	number	204.3	365.1	366.4
Within 10 km	number	377.1	417.4	416.9

Subject		Amsterdam	Gerard Doubuurt	Frans Halsbuurt
Within 20 km	number	473.3	480.9	482.4
Childcare				
Daycare				
Distance to daycare center	**km**	0.3	0.2	0.2
Number of daycare centers				
Within 1 km	number	11.8	23.7	19.1
Within 3 km	number	88.6	170.9	182.4
Within 5 km	number	202.2	356.5	363.5
School care				
Distance to after-school care	**km**	0.4	0.6	0.5
Number of after-school care				
Within 1 km	number	5.4	6.4	4.5
Within 3 km	number	42.8	70.4	73.5
Within 5 km	number	100.7	172.0	173.1
Education				
Primary education				
Distance to school	**km**	0.5	0.6	0.6
Number of schools				
Within 1 km	number	3.6	4.4	2.1
Within 3 km	number	26.8	44.2	45.1
Within 5 km	number	63.2	97.8	101.9
Secondary education				
Secondary education total				
Distance to school	**km**	0.9	0.7	0.5
Number of schools				
Within 3 km	number	10.5	26.0	26.0
Within 5 km	number	25.1	43.1	45.1
Within 10 km	number	62.7	75.8	76.6
Vmbo				
Distance to school	**km**	1.0	0.7	0.5
Number of schools				
Within 3 km	number	7.1	13.8	14.9
Within 5 km	number	17.1	29.1	30.7
Within 10 km	number	45.0	54.8	55.6
HAVO VWO				
Distance to school	**km**	1.3	0.7	0.5
Number of schools				
Within 3 km	number	6.8	19.6	20.0
Within 5 km	number	16.3	28.4	30.1
Within 10 km	number	38.1	46.4	46.8

Subject		Amsterdam	Gerard Doubuurt	Frans Halsbuurt
Employment: number of jobs				
AU all economic activities				
Within 10 km	x 1,000	572.4	716.2	717.6
Within 20 km	x 1,000	969.0	962.7	1 018.9
Within 50 km	x 1,000	2 468.2	2 537.9	2 541.8
A Agriculture, forestry and fishing				
Within 10 km	x 1,000	0.1	0.2	0.2
Within 20 km	x 1,000	1.9	2.1	2.4
Within 50 km	x 1,000	16.6	17.2	17.2
BF Industry and energy				
Within 10 km	x 1,000	26.6	33.9	34.0
Within 20 km	x 1,000	63.1	64.1	66.6
Within 50 km	x 1,000	224.0	233.0	233.0
GN Commercial services				
Within 10 km	x 1,000	374.5	466.1	466.7
Within 20 km	x 1,000	624.4	625.6	664.4
Within 50 km	x 1,000	1 401.3	1 440.0	1 440.2
OU Non-commercial services				
Within 10 km	x 1,000	150.9	191.1	191.8
Within 20 km	x 1,000	245.8	237.3	249.3
Within 50 km	x 1,000	742.0	761.1	764.7
Green areas				
Public parks				
Total distance to public green areas	km	.	.	.
Distance to park or public garden	km	.	.	.
Distance to day recreational area	km	.	.	.
Distance to forest	km	.	.	.
Distance to open natural terrain				
Distance to open wet. terrain total	km	.	.	.
Distance to open dry wet. terrain	km	.	.	.
Distance to open wet natural terrain	km	.	.	.
Semi-public green				
Distance to semi-public green total	km	.	.	.
Distance to sports field	km	.	.	.
Distance to allotment garden	km	.	.	.
Distance to residential recreational area	km	.	.	.
Distance to cemetery	km	.	.	.
Distance to recreational inland water	km	.	.	.
Traffic and transport				
Distance to main road entrance	km	2.1	2.4	2.3
Train stations				
Distance to train stations total	km	2.5	2.4	2.4
Distance to major transfer station	km	3.9	3.2	3.0

Subject		Amsterdam	Gerard Doubuurt	Frans Halsbuurt
Leisure and culture				
Distance to library	km	1,2	1.1	0.9
Sport				
Distance to swimming pool	km	2.1	0.7	0.4
Distance to artificial ice rink	km	7.1	4.7	5.1
Museum				
Distance to museum	km	2.7	0.9	0.6
Number of museums				
Within 5 km	number	21.0	38.0	38.0
Within 10 km	number	40.2	45.0	45.0
Within 20 km	number	59.0	59.6	61.3
Performing arts (excl. festivals)				
Total distance to performing arts	km	1.7	0.8	0.9
Number of performing arts total				
Within 5 km	number	21.4	38.0	38.0
Within 10 km	number	44.5	52.0	52.0
Within 20 km	number	60.6	63.0	63.0
Distance to music venue	km	4.3	1,2	1.0
Cinema				
Distance to cinema	km	2.8	0.8	0.7
Number of cinemas				
Within 5 km	number	6.5	12.0	12.0
Within 10 km	number	12.7	14.0	14.0
Within 20 km	number	18.0	19.0	19.0
Recreation				
Distance to sauna	km	2.2	1,2	1.1
Distance to sunbed	km	1.5	0.4	0.6
Distance to attraction	km	3.2	2.0	2.2
Number of attractions				
Within 10 km	number	4.4	5.0	5.0
Within 20 km	number	10.8	10.0	10.0
Within 50 km	number	51.8	52.0	52.8
Distance to fire station	km	1.8	1.0	0.7

Table 18 | Proximity to Amenities and distance location in Amsterdam and Gerard Doubuurt, Frans Halsbuurt neighborhoods in 2022 *(Source: (CBS,2022))*

Subject		Amsterdam	Gerard Doubuurt	Frans Halsbuurt
Region designation				
Municipality name	**name**	Amsterdam	Amsterdam	Amsterdam
Type of region	**Description**	Local authority	Neighbourhood	Neighbourhood
Coding	**code**	GM0363	BU03632401	BU03632402
Change in the layout of districts and neighbourhoods	**code**	1	1	1
Health and wellbeing				
General practice				
Distance to GP practice	**km**	0.6	0.6	0.5
Number of GP practices				
Within 1 km	**number**	3.1	3.6	3.0
Within 3 km	**number**	29.2	61.6	55.9
Within 5 km	**number**	69.7	125.8	127.6
Distance to GP post	**km**	3.0	2.2	2.6
Distance to pharmacy	**km**	0.7	1.0	1.1
Hospital (incl. outdoor outpatient clinic)				
Distance to hospital	**km**	2.6	2.2	2.5
Number of hospitals				
Within 5 km	**number**	2.1	2.8	3.2
Within 10 km	**number**	5.5	7.7	7.1
Within 20 km	**number**	13.0	12.6	12.9
Hospital (excl. outdoor outpatient clinic)				
Distance to hospital	**km**	2.9	2.2	2.6
Number of hospitals				
Within 5 km	**number**	1.6	1.8	2.2
Within 10 km	**number**	4.5	6.7	6.1
Within 20 km	**number**	9.6	9.6	9.9
Distance to clinic	**km**	.	.	.
Physiotherapist				
Distance to physiotherapist	**km**	.	.	.
Number of physiotherapists				
Within 1 km	**number**	.	.	.
Within 3 km	**number**	.	.	.
Within 5 km	**number**	.	.	.

Subject		Amsterdam	Gerard Doubuurt	Frans Halsbuurt
Retail				
Shops for daily groceries				
Distance to large supermarket	km	0.6	0.2	0.5
Number of large supermarkets				
Within 1 km	number	4.2	8.7	6.4
Within 3 km	number	37.2	87.1	78.3
Within 5 km	number	89.5	156.2	158.3
Distance to public transport daily. foodstuffs	km	0.4	0.1	0.2
Number of other daily foodstuffs				
Within 1 km	number	21.5	54.8	51.3
Within 3 km	number	207.8	513.7	473.3
Within 5 km	number	502.0	955.6	963.9
Department store				
Distance to department store	km	1.6	0.7	1.0
Number of department stores				
Within 5 km	number	7.7	14.8	14.6
Within 10 km	number	20.2	25.0	25.0
Within 20 km	number	38.5	35.6	35.4
catering industry				
Cafes and the like				
Distance to café etc	km	0.8	0.2	0.3
Number of cafes				
Within 1 km	number	11.0	28.9	27.3
Within 3 km	number	131.7	393.5	339.7
Within 5 km	number	325.2	643.8	645.2
Cafeterias and the like				
Distance to cafeteria, etc	km	0.4	0.1	0.1
Number of cafeterias, etc				
Within 1 km	number	15.7	50.2	47.2
Within 3 km	number	174.2	477.7	428.7
Within 5 km	number	430.4	816.0	820.8
Restaurants				
Distance to restaurant	km	0.4	0.1	0.1
Number of restaurants				
Within 1 km	number	36.8	129.9	115.3
Within 3 km	number	416.6	1 201.0	1 125.0
Within 5 km	number	1 015.0	1 991.0	1 996.0
Hotels and the like				
Distance to hotel etc	km	1.0	0.4	0.4
Number of hotels etc				
Within 5 km	number	193.6	374.1	374.0
Within 10 km	number	388.4	438.4	439.6

Subject		Amsterdam	Gerard Doubuurt	Frans Halsbuurt
Within 20 km	number	504.6	506.9	507.8
Childcare				
Daycare				
Distance to daycare center	km	0.4	0.4	0.5
Number of daycare centers				
Within 1 km	number	7.6	7.5	5.0
Within 3 km	number	70.3	121.2	124.2
Within 5 km	number	169.3	310.1	314.0
School care				
Distance to after-school care	km	0.5	0.7	0.6
Number of after-school care				
Within 1 km	number	3.8	3.0	1.4
Within 3 km	number	36.2	51.6	52.2
Within 5 km	number	90.3	155.4	156.3
Education				
Primary education				
Distance to school	km	0.6	0.9	1,2
Number of schools				
Within 1 km	number	2.5	1.6	0.3
Within 3 km	number	22.8	36.3	35.6
Within 5 km	number	56.8	88.1	90.3
Secondary education				
Secondary education total				
Distance to school	km	1.1	0.9	0.6
Number of schools				
Within 3 km	number	9.6	24.8	24.1
Within 5 km	number	23.7	43.0	43.0
Within 10 km	number	63.6	79.9	79.3
Vmbo				
Distance to school	km	1.1	0.9	0.6
Number of schools				
Within 3 km	number	6.6	12.6	12.3
Within 5 km	number	16.4	28.3	28.4
Within 10 km	number	45.8	57.9	57.3
HAVO VWO				
Distance to school	km	1.3	0.9	0.6
Number of schools				
Within 3 km	number	6.9	19.3	19.5
Within 5 km	number	16.9	31.0	31.9
Within 10 km	number	42.5	53.7	53.3

Subject		Amsterdam	Gerard Doubuurt	Frans Halsbuurt
Green areas				
Public parks				
Total distance to public green areas	km	.	.	.
Distance to park or public garden	km	.	.	.
Distance to day recreational area	km	.	.	.
Distance to forest	km	.	.	.
Distance to open natural terrain				
Distance to open wet. terrain total	km	.	.	.
Distance to open dry wet. terrain	km	.	.	.
Distance to open wet natural terrain	km	.	.	.
Semi-public green				
Distance to semi-public green total	km	.	.	.
Distance to sports field	km	.	.	.
Distance to allotment garden	km	.	.	.
Distance to residential recreational area	km	.	.	.
Distance to cemetery	km	.	.	.
Distance to recreational inland water	km	.	.	.
Traffic and transport				
Distance to main road entrance	km	2.2	2.9	2.8
Train stations				
Distance to train stations total	km	2.9	2.8	2.8
Distance to major transfer station	km	3.9	3.1	2.8
Leisure and culture				
Distance to library	km	1.3	1,2	1.1
Sport				
Distance to swimming pool	km	2.2	1.0	0.8
Distance to artificial ice rink	km	7.3	5.0	5.3
Museum				
Distance to museum	km	2.5	1.0	0.9
Number of museums				
Within 5 km	number	21.3	42.3	42.2
Within 10 km	number	44.1	50.0	50.0
Within 20 km	number	63.5	63.7	63.9
Performing arts (excl. festivals)				
Total distance to performing arts	km	1.8	1,2	1.4
Number of performing arts total				
Within 5 km	number	18.2	34.3	34.4
Within 10 km	number	42.3	53.0	53.0
Within 20 km	number	61.0	61.3	60.4
Distance to music venue	km	3.8	1.5	1.5
Cinema				
Distance to cinema	km	2.9	1.3	1,2

Subject		Amsterdam	Gerard Doubuurt	Frans Halsbuurt
Number of cinemas				
Within 5 km	number	5.6	11.0	11.0
Within 10 km	number	11.9	14.0	14.0
Within 20 km	number	18.2	18.5	17.7
Recreation				
Distance to sauna	km	2.5	2.4	2.4
Distance to sunbed	km	1.8	0.3	0.4
Distance to attraction	km	3.1	2.2	2.6
Number of attractions				
Within 10 km	number	6.4	8.0	8.1
Within 20 km	number	17.0	16.0	16.0
Within 50 km	number	66.0	68.0	68.0
Distance to fire station	km	2.1	1.5	1.1

Unfortunately, CBS did not provide data on the approximate distance to green areas. However, public parks and recreational green areas are important for assessing the effectiveness of the NBS project. To gather enough data about public green parks in the Frans Halsbuurt neighborhood, we collected the maps from the municipality of Amsterdam website.

(Figure 19) provides an overview of Amsterdam city with existing city parks and public recreational greenery. (Figure 20) shows the 1 km buffer zone distance calculated from the middle of the Frans Halsbuurt neighborhood. The area in (Figure 20) is 2.95 km² with a population of 42,372 inhabitants, resulting in a population density of 14,363 inhabitants per km².

Figure 19 | Amsterdam city map with Public city parks and recreational greenery *(Source: (Amsterdam Maps, 2024))*
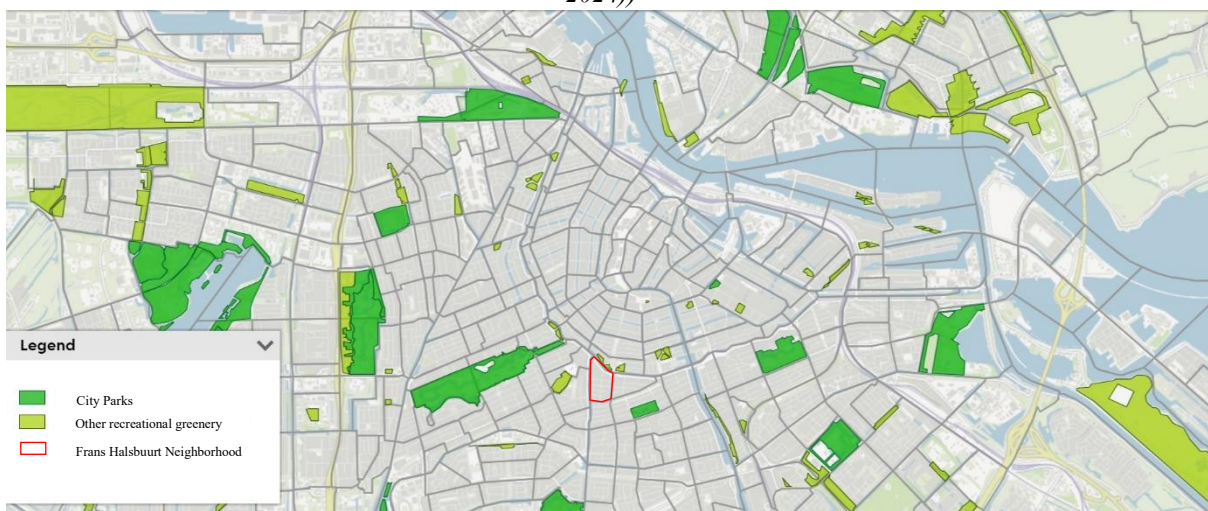
Figure 20 | Frans Halsbuurt neighborhood map with 1Km buffer zone to Public city parks and recreational greenery *(Source: (Amsterdam Maps, 2024))*

5.5.2.7. Analyzing Data

Undoubtedly, most It is clear that the majority of residents in the Frans Halsbuurt neighborhood were satisfied with the amenities that were approximately within a certain distance, according to the 2018 survey conducted before the start of the redevelopment project. However, this study aims to evaluate the impact of the NBS project in the Frans Halsbuurt on access to public amenities after the project has been completed.

In this study, the second qualitative method for evaluating this indicator was chosen over the first method. The first method involved dividing the number of inhabitants with a public amenity less than 500m to the total population and then multiplying by 100. However, using this method would be meaningless because the 500m radius circle drawn in the Frans Halsbuurt neighborhood includes all areas of the neighborhood and even extends beyond it.

The tables (Table 17) and (Table 18) show the approximate distance to amenities in kilometers, while the evaluation methods mentioned for this indicator are in meters. As a result, the data is analyzed accordingly.

In assessing the access to public amenities in the Frans Halsbuurt neighborhood, we relied on data collected from CBS in 2018 before the project began and the latest available data from 2022. The proximity to amenities in the Frans Halsbuurt neighborhood, as provided by CBS, focuses on more general facilities such as hospitals, supermarkets, schools, shops, restaurants, and hotels, which are less affected by the redevelopment project in Frans Halsbuurt.

The redevelopment of Frans Halsbuurt aimed to enhance the neighborhood by upgrading cables, pipes, and pavements. This involved removing car parking spaces, creating more green areas, implementing underground waste collection, and relocating facilities to more accessible locations. As a result, comparing the distances to general neighborhood facilities may not be very relevant in Frans Halsbuurt, except for recreational amenities that were specifically part of the redevelopment project.

The Frans Halsbuurt redevelopment project aimed to implement underground waste collection containers in the neighborhood. (Figure 17) illustrates the waste collection containers within a 500m radius in the Frans Halsbuurt neighborhood. As there is no existing baseline data for waste collection containers, it is not possible to compare the baseline and outcome data. The data collected from (Figure 17) indicates that the amount of waste containers is sufficient and they are distributed properly throughout the neighborhood. Based on the figure, there are 71 residual waste containers, 9 food waste containers, 25 paper waste containers, and 4 textile waste containers.

(Figure 18) illustrates the parks and public green areas within 500m of Frans Halsbuurt. According to the figure, there are no parks or public green spaces inside the Frans Halsbuurt neighborhood, as indicated by the red outline. However, there are a few city parks and recreational green areas located outside the neighborhood but within the 500m radius.

This study will compare the approximate distance and number of attractions in the Frans Halsbuurt neighborhood in 2018 and 2022, considering the redevelopment plan that includes adding playgrounds for children and common spaces for adults.

In 2018, the distance to the attractions in the Frans Halsbuurt neighborhood was 2.2 km, and the number of attractions within 10 km was 5.0. By 2022, the distance to the attractions had increased to 2.6 km, and the number of attractions within 10 km had risen to 8.1. This data was collected from (Table 17) and (Table 18). It is evident that the redevelopment project in Frans Halsbuurt has had a positive effect on the number of attractions. However, it does not seem to have had a positive effect on the distance to attractions, as there were increases in attraction distances. This could be due to the NBS project of Frans Halsbuurt not being completed in 2022, and the new playing grounds not being implemented until 2024, causing this disparity in the results.

Unfortunately, there is no available data on the approximate distance to green areas based on the information collected from CBS. Public parks and recreational green areas are crucial for assessing the effectiveness of the NBS project. In order to gather enough data about public green parks and evaluate the impact of the Frans Halsbuurt neighborhood project on access to public green parks, (Figures 19) and (Figure 20) were collected from the municipality of Amsterdam website.

Based on (Figure 19), it is obvious that there are no public green parks inside the Frans Halsbuurt neighborhood. Since the addition of public green parks to Frans Halsbuurt neighborhood is not included in the redevelopment project, we are unable to assess the effectiveness of the redevelopment project on the accessibility to public green parks.

The redevelopment of Frans Halsbuurt has a positive effect on the entire neighborhood, which can automatically improve access to public amenities in general. However, it is difficult to specifically address the impact of this project on each individual amenity that is not included in the redevelopment goals of the Frans Halsbuurt project.

Before initiating the Frans Halsbuurt project, the results of participatory process surveys from 2018 were reviewed. One of the key positive features of the Frans Halsbuurt, chosen by 56% of residents, was the convenient proximity to amenities.

Based on all the analysis we conducted in this section, it is not possible to provide an exact Likert scale for the "Access to Public Amenities" indicator, but it will definitely be more than 3.

Overall, access to public amenities before the start of this project was adequate. However, we cannot overlook the positive impact of this project on improving public amenities accessibility, even though we were unable to thoroughly assess the access to public amenities indicator.

5.5.3. Cultural Value of blue-green spaces

This indicator is mentioned in the Connecting Nature, (2020) report using two different methods. One method involves evaluating the indicator using applied methods, while the other method involves evaluation through earth observation, remote sensing, and modeling approaches. This study will briefly discuss both methods to determine which one can provide sufficient data for evaluating this indicator. (Table 19) displays the units for the Cultural Value of blue-green spaces indicator and the two different evaluation methods.

Table 19 | Cultural Vale of blue-green spaces *(Source: (Connecting Nature, 2020))*

Indicator	Unit	Description
Cultural Value of blue-green spaces	Number of cultural events / Number of people	Evaluate by using applied methods
	Number of cultural events / Number of people	Evaluate by using earth observation, remote sensing and modelling approaches.

5.5.3.1. Description and justification

5.5.3.1.1. Cultural Value of blue-green spaces (Applied/Participatory Review)

The most fundamental gauge for this measure involves tallying any increase or decrease in the quantity of events that promote cultural advantages held in a green or blue space. This assessment can be conducted before and after a modification in the design or management of the green or blue space to evaluate the overall benefit of a new nature-based solutions initiative. Cultural advantages are some of the intangible benefits of ecosystems, which include offering opportunities for leisure, physical activity, social interaction, and revitalizing capacities (Chen et al. 2019).

A combination of the number of events/visitor metrics and the demographics of attendees can generate the most useful data in relation to the popularity and inclusivity of cultural events, and thus the 'value' of the NBS interventions.

Evaluation of cultural value of blue-green space can be used to:

• Monitor the value of cultural events in relation to visitor numbers;

• Assess that changes related to NBS implementation have a positive impact on visitors in   relation to attending cultural events;

• Ensure that changes related to NBS implementation promote socio-environmental justice.

5.5.3.1.2. Cultural Value of blue-green spaces (Earth Observation/Remote Sensing Review)

Earth observation and remote sensing tools do not directly contribute to assessing the cultural value of blue and green spaces in Nature-Based Solutions (NBS) located in cities. However, these tools can be indirectly utilized for mapping Land Use/Land Cover (LULC) as a foundational layer for mapping and presenting indicator results. The process of image classification is crucial when using remotely sensed data, as high-resolution remote sensing technology can significantly aid the monitoring methods and evaluation indicators utilized in urban environments.

Studying the characteristics of green spaces can also be significant. By utilizing visual interpretation with remote-sensing imagery from Google Earth, it is possible to establish various transects in urban areas that extend from the city center to the periphery. Within each transect, different 450×450 m quadrats can be designated as the study area, serving as a framework for presenting findings.

5.5.3.2. Definition

5.5.3.2.1. Cultural Value of blue-green spaces (Applied/Participatory Review)

A measure of the number of cultural events/number of people involved to evaluate the cultural benefits of blue-green spaces using applied methods.

5.5.3.2.2. Cultural Value of blue-green spaces (Earth Observation/Remote Sensing Review)

A measure of the number of cultural events/number of people involved to evaluate the cultural benefits of blue-green spaces using earth observation, remote sensing and modelling approaches.

5.5.3.3. Measurement procedure and tool

5.5.3.3.1. Cultural Value of blue-green spaces (Applied/Participatory Review)

Along with the fundamental event details, it is possible to gather more comprehensive information regarding the level of event attendance. This information can be obtained by tallying the number of participants through ticket sales, ticket collection on the event day, registration processes, or by monitoring the visitor count through physical tallies or visitor profiling based on specific interests (Cope et al. 2000; Cessford and Muhar 2003).

While these fundamental measurements are directly related to the number of visitors or events, they may not always indicate the cause-and-effect relationship between park events and visitor presence (e.g. visitors may be there because of proximity), or the characteristics of visitors drawn to events. The most common method for obtaining this

kind of information is by directly gathering feedback from users and/or local communities. This is generally done in the form of questionnaires (Schipperijn et al. 2013; Kabisch and Haase 2014; Akpinar 2016). The standard practice for this involves using questionnaires. It is important that the protocol for sampling questionnaires ensures that the people responding are a fair representation of the people attending an event (Kabisch and Haase 2014). Sampling methods can be developed in a way that allows for a comparison of the demographic characteristics of event attendees with those of the local neighborhood or city, in order to make sure that cultural events are appealing to everyone. The analysis of local/regional socio-demographic data is typically carried out by comparing it with the data on event attendees, which involves examining city social datasets such as population size, immigration figures, and the number of individuals aged ≥65 years (Kabisch and Haase 2014).

This enables insight into how urban green-blue spaces are supporting socio-environmental justice in cities (Kabisch and Haase 2014; Snaith 2015; Cronin-de-Chavez et al. 2019).

The strength of the evidence greatly depends on how the questionnaire is designed and the number of respondents in the sample. The number of occurrences at events is clear and strong, but the data's value is restricted without additional information about the attendees and their demographics. Ensuring the reliability of visitor numbers and demographic data can be difficult because accurately capturing representative visitor numbers at certain locations is a challenge.

5.5.3.3.2. Cultural Value of blue-green spaces (Earth Observation/Remote Sensing Review)

There is no specific measurement procedure and tool.

5.5.3.4. Scale of measurement

Analysis is performed on a single site scale and can comprise sites ranging from very large parks and open spaces to micro-scale pocket parks. Typically, replication across sites is used for comparative purpose. City-wide replication would involve substantial effort as remote sensing data is not an option for quantifying attendees or events.

5.5.3.5. Data collection frequency

Evaluation methods can be adopted for short-term snapshots associated with a change in management. They can also be adapted for long-term evaluation of sites as the events 'offer' changes, as the local demographics of a site changes, or as the demand on a site changes.

5.5.3.6. (Collected Data) Data availability

In order to assess the cultural value indicator, we checked various sources such as the websites of museums located in the Frans Halsbuurt neighborhood, Facebook groups related to Frans Halsbuurt, cultural activity websites, and so on. Unfortunately, we were unable to find sufficient data to assess this indicator.

5.5.4. Openness of Participatory Process

The active involvement of citizens in making environmental decisions is highly important, highlighting the need for thorough consideration of the evolving participation procedures at every phase of an urban green project to utilize the empowering potential of individual and collective participatory practices. (Feldman and Westphal, 2000)

The European Commission has identified two indicators for evaluating the openness of participatory processes. The first indicator assesses the general openness of the participatory process, while the second indicator evaluates the proportion of citizens involved in the process (European Commission, 2021). This research will utilize both methodologies to evaluate the transparency of the participatory process. Based on data availability, the focus will specifically be on one methodology for assessing the openness of participatory process indicator in the Frans Halsbuurt neighborhood. The table below provides a brief overview of the units used for the indicators of openness of participatory process. (Table 20)

Table 20 | Openness of Participatory Process indicators base on European Commission *(Source: (European Commission, 2021))*

Indicator	Unit of measurement	Methods of assessment for indicator
Openness of Participatory Process	Number (1-5)	The qualitative score evaluates from 1-5 points, where 1 is Low quality and 5 is High quality.
Openness of Participatory Process: Proportion of citizens involved	%	$\left(\dfrac{Total\ number\ of\ open\ public\ participatory\ process}{Population\ of\ city/100000}\right) * 100$

5.5.4.1. Description and justification

5.5.4.1.1. Openness of Participatory Process (Qualitative method)

Planning methods and governance systems for Nature-Based Solutions must enable access to green spaces while preserving their quality for providing ecosystem services. Dealing with urban environmental issues is often challenging, and effective solutions require collaboration across various scientific fields, as well as active communication among policymakers and the community. In this regard, transdisciplinary approaches to co-producing knowledge offer insights into how and why it's important to involve various knowledge holders: experts, scientists, citizens, and practitioners. The scientific frameworks of urban ecosystem services were brought into the interface between policy and science to inform urban planning and governance. (European Commission, 2021)

5.5.4.1.2. Openness of Participatory Process: proportion of citizens involved

Engagement of the public in NBS projects offers different chances for citizens, non-profit organizations, businesses, and other involved parties to collaborate, implement, and oversee NBS, thereby fostering a sense of ownership. The crucial role of citizens and other stakeholders in NBS projects can impact the transparency of other processes overseen by the local government. Enhancing the transparency of processes like policy planning and execution strengthens the relationships between government agencies and the public they serve. (European Commission, 2021)

5.5.4.2. Definition

5.5.4.2.1. Openness of Participatory Process (Qualitative method)

For this KPI definition "participation" is defined as "a process through which stakeholders influence and share control over development initiatives and the decision and resources which affect them" (World Bank definition, 1996).

5.5.4.2.2. Openness of Participatory Process: proportion of citizens involved

The proportion of public participation processes in a given municipality per 100 000 residents per year (expressed as %).

5.5.4.3. Measurement procedure and tool

5.5.4.3.1. Openness of Participatory Process (Qualitative method)

Participation is often reduced to the dissemination of information and the holding of workshops. These approaches generally do not take into account either the heterogeneity of stakeholders, or the complexity of the decision-making process (Luyet, 2012).

There are defined two steps, data collection and data evaluation.

➢ *Step 1. Data collection and characterization.*

The data collection about the participatory processes would have the following items:

Participation techniques: Reports, Presentations, public hearings, Internet webpage, Interviews, questionnaires and surveys, Field visit and interactions, Workshop, Participatory mapping, focus group, Citizen jury, Geospatial/ decision support system, Cognitive map, Role playing, Multicriteria analysis, Scenario analysis, Consensus conference.

<u>Degrees of participation:</u> The participation action is classified into the following types.

- Information: explanation of the project to the stakeholders.
- Consultation: presentation of the project to stakeholders, collection of their suggestions, and then decision making with or without taking into account stakeholders' input.
- Collaboration: presentation of the project to stakeholders, collection of their suggestions, and then decision making, taking into account stakeholders' input.
- Co-decision: cooperation with stakeholders towards an agreement for solution and implementation.
- Empowerment: delegation of decision-making over project development and implementation to the stakeholders.

<u>Co-creation & Co-production agent:</u> There are identified the following stakeholders' groups:

- Policy makers: The Valladolid City Council Departments, and other local entities.
- Experts: Scientific community and consultants, professionals, technicians.
- Community representatives: Economic agents. Civil society such as civil associations and local communities.

Table 21 | Data collection record table for KPI "Openness to Participatory Process" *(Source: (European Commission, 2021))*

Openness to participatory processes					
Date	**Communication model**	**Participation technique**	**Degree of participation**	**Co-creation & Co-production agent**	**Participation action**
dd / mm / yyyy	Classify: In-person meeting. Video conference / Online meeting. Audio conference / Call.	Classify: Reports, Interviews, Questionnaires, Workshop and others.	Classify: Information, Consultation, Collaboration, Co-decision, Empowerment	Policy maker, Scientific community, Civil society, Economic sector and other stakeholders	Name of the participation action and short description

The following activities might be included to calculate this KPI:

Single Desk actions, open days such as Mobility week or the Day of the Earth, conferences about Smart city, environmental awareness, etc.

> ➢ *Step 2. Evaluation of participatory processes.*

How do we evaluate the stakeholder participation? There are defined two techniques, quantitative and qualitative.

<u>Quantitative evaluation:</u> The "Openness of participatory processes" indicator is expressed through quantitative techniques such as (nº processes/year/participation technique/stakeholder) and population reached (number of attendees/agent type)

<u>Quantitative-Qualitative evaluation:</u> There is also calculated a Global Indicator by a mix qualitative and quantitative technique. There will be assigned a final score from 1 to 5, depending on the following criteria (see next table for scoring criteria):

- The quality of the process (conflict resolution, early involvement, transparency, equity, influence, stakeholder representativeness, integration of all interests and definition of rules).
- The outcomes (capacity building, emergent knowledge, impacts and social learning)
- The political, social, cultural, historical and environmental context.

The qualitative score evaluates from 1-5 points, where 1-Low quality and 5-High quality.

Table 22 | Qualitative scoring for indicator "Openness of participatory processes" *(Source: (European Commission, 2021))*

Criteria	Type of criteria	Scoring (Points)
Scope	Quantitative	International, National, Regional = 1 point. Local = 0 point.
Communication model	Quantitative	In-person meeting = 1 point. Video conference / Online meeting / Audio conference / Call = 0.5 point. Email = 0 point.
Participation technique	Qualitative	From 0-1 depending on the quality and different types of participation techniques.
Degree of participation	Quantitative	Information, Consultation = 0 point. Collaboration = 0.5 point. Co-decision, Empowerment = 1 point.
Attendees type	Quantitative	For > 1 type = 1 point. Only 1 type = 0 point.

Table 23 | Evaluation record table for indicator "Openness to participatory processes" *(Source: (European Commission, 2021))*

Evaluation of participatory processes			
Date	**Participation action**	**Number of attendees**	**Qualitative score**
dd / mm / yyyy	Name of the participation action and short description	Number of people that attend to the activity, for every stakeholder type (political, academia, citizens, etc.)	From 1-5 where 1 is low quality and 5 is high quality.

5.5.4.3.2. Openness of Participatory Process: proportion of citizens involved

Openness of participatory processes (%) is calculated as: (European Commission,2021)

$$\left(\frac{Total\ number\ of\ open\ public\ participatory\ process}{Population\ of\ city/100000}\right) * 100$$

5.5.4.4. Scale of measurement

5.5.4.4.1. Openness of Participatory Process (Qualitative method)

City / neighborhood

5.5.4.4.2. Openness of Participatory Process: proportion of citizens involved

District to municipality scale (project-based)

5.5.4.5. Data collection frequency

5.5.4.5.1. Openness of Participatory Process (Qualitative method)

Data are collected monthly. A global indicator is calculated annually. There will be included a statistic analysis of the participatory processes delivered. In this study, the data collection frequency is up to the date of project's participation meetings.

5.5.4.5.2. Openness of Participatory Process: proportion of citizens involved

Annually; at minimum, before and after NBS implementation. But in this study the data collection frequency is up to time of project's participation meetings.

5.5.4.6. (Collected Data) Data availability

This section of the research discusses the results of the participation process in the Frans Halsbuurt project. We will briefly examine how residents and entrepreneurs would like to engage in the participation process and their level of satisfaction with the way they have been informed. This data is sourced from the participation reports of the Frans Halsbuurt neighborhood project, collected from the municipality of Amsterdam.

The Frans Halsbuurt neighborhood has a major influence on the design of public space. In fact, the intention is for the neighborhood to design its own public space. However, the neighborhood consists of approximately 2,500 residents who all have their own ideas about the use of the public area. That is why a process-based approach was chosen in which a design that

is as widely supported as possible can be achieved in a number of steps. An important aspect here is that the individual involved realize that:

- There are established (legal) frameworks for the design of public space.

- Designing public space is not just a creative thing process, but to a large extent a process of analysis and making choices.

It was therefore decided to first make the neighborhood aware of the established frameworks and then initiate a process, where creativity is linked to making choices.

To evaluate the openness of the participatory process in the Frans Halsbuurt neighborhood, we have gathered information on the participation meeting sessions related to the redevelopment project in Frans Halsbuurt. It is important to study these meetings to understand the scope, communication model, participation techniques, the level of participation, and the types of attendees at each meeting. While we have sufficient data for the first meeting, unfortunately, we faced with lack of sufficient data for the last meetings. (Frans Halsbuurt Participation, 2024)

Participatory meeting of Frans Halsbuurt's redevelopment NBS project:

1. Meeting 17-18 October and November 2018: (Heijnen & Bosveld, 2019)

An important aspect of the redevelopment is cooperation with the residents in the area. In this context, two participation meetings were held in October 2018. Another part is conducting a survey among residents and entrepreneurs in the area into their need to participate in the redevelopment. In November 2018, 1,845 addresses in the area were contacted by letter to complete a questionnaire, online or in writing. A total of 266 respondents participated in the survey, a response rate of 14%. From 266 residents and entrepreneurs who completed the survey, 125 did online and 141 completed the enclosed paper questionnaire (Table 24). Of the participants, 224 are residents (84%), 35 are both residents and entrepreneurs (13%) and 5 participants only do business in the neighborhood (2%). The remaining two respondents gave a different answer, or no answer. Of the participants, 12% are younger than 30, 21% are between 30 and 40 years old, 18% are between 40 and 50, 24% are between 50 and 60, 14% are between 60 and 70 and 9% are over 70.

Table 24 | Response of survey *(Source: (Heijnen & Bosveld, 2019))*

Type of survey	Number	Percent %
Online	125	47
Written	141	53
Total	266	100

The response to a request to participate in a study also says a lot about the involvement in the subject: residents who have little to do with possible problems will be less inclined to participate. This must be taken into account when interpreting the results.

In below, the residents were then asked how they would like to participate in the final redesign (Table 25). One could choose a maximum of 3 of the answers presented. About half of the participants in the study (49%) indicate that they want the opportunity to think along and

participate in decision-making about choices at street level. More than a third (35%) want to participate in thinking about and deciding on general choices at neighborhood level. A (33%) also indicate that they would like to be able to follow the redesign process via a website, without participating directly. More than a quarter (26%) would like extensive and accessible information about what is and is not possible during redevelopment and 24% would like to see digital tools to communicate with neighbors and experts about redevelopment.

Table 25 | How would you like to participate in the final redesign? (Max. 3 answers) *(Source: (Heijnen & Bosveld, 2019))*

Participation option	Number	%
The opportunity to think and decide on choices at (my) street level	131	49
The opportunity to think about and decide on general choices at neighborhood level	94	35
The opportunity to follow the process via a website, without having to participate directly	89	33
Extensive and accessible information about what is and is not possible	68	26
Digital tools to discuss redevelopment with neighbors and experts communicate	64	24
Theme/inspirational meetings (with experts) with information on specific topics	26	10
Residents' evenings, where neighbors and designers can brainstorm	24	9
The possibility of actively helping to realize the design, e.g. through the construction of greenery	21	8
The possibility of actively helping to design streets, for example in a workshop	20	8
Neighborhood meetings on the street or at specific locations in the neighborhood	18	7
Physical information points, such as signs, on the street or at shops	17	6
Possibilities to help with management/maintenance of, for example, greenery, benches, playground equipment	9	3
Other, namely	18	7
None of the above options	6	2
Don't know, no answer	10	4

This part examines the satisfaction of residents and entrepreneurs with the way in which they have been informed so far about making the Frans Halsbuurt free of parking. The respondents were also asked which forms of communication they preferred. A large majority of 70% believe that they are well or fairly well informed about making the Frans Halsbuurt parking-free. In addition, 11% indicate that they believe they are neither well nor poorly informed about the measures, 9% believe they are fairly poorly informed and 9% believe they are poorly informed. (Figure 21)

Figure 21 | How do you think you have been informed so far about making the Frans Halsbuurt free of parking? *(Source: (Heijnen & Bosveld, 2019))*
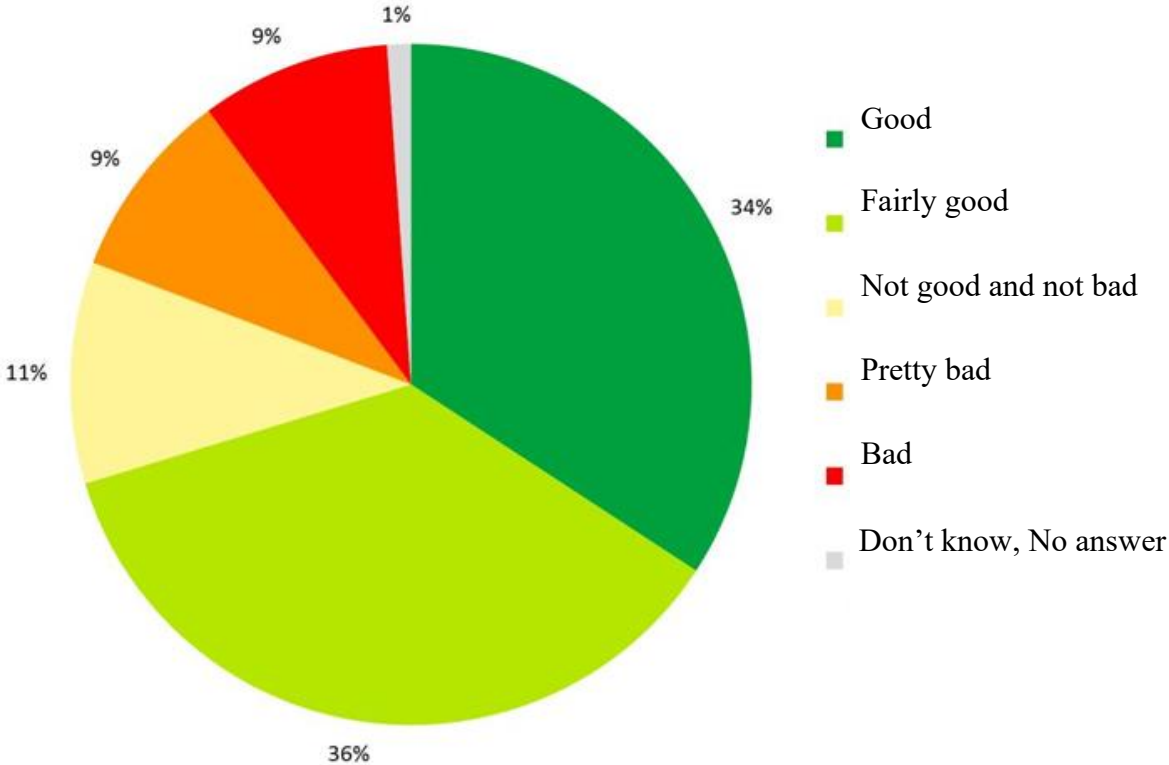
They were then asked how residents and entrepreneurs would prefer to be informed about the progress of the redevelopment process. They could choose a maximum of three answers from the forms of communication included in the table below. (Table 26)

Table 26 | We will inform you in several ways about the progress of the redesign process. Which form of communication do you prefer? (Max. 3 answers) *(Source: (Heijnen & Bosveld, 2019))*

Communication forms	Number	%
Digital neighborhood newsletter	128	48
Interactive website	104	39
Paper resident letter	102	38
Paper neighborhood newsletter	92	35
Municipality project page	60	23
Information meetings	51	19
Social media	47	18
Others, namely	9	3
Don't know, no answer	3	1
Not filled in	2	1

The most popular choice is a digital neighborhood newsletter, 48% of survey participants mention this option. The most popular choice was an interactive website (39%), a paper residents' letter (38%) and a paper neighborhood newsletter (35%). Older participants in the study mention paper letters relatively more often, while younger people choose digital forms of communication relatively more often.

The Municipality of Amsterdam, in collaboration with Pakhuis de Zwijger, is organizing a series of meetings in which residents are involved in the future of their neighborhood. The first meetings were held at The College Hotel on March 6 and 7, which discussed the 'rules of the game' for the final design. With the disappearance of the car from the neighborhood, a lot of space will become available for more bicycle parking, new plants or playgrounds. Choices have to be made. It is up to residents and entrepreneurs to do this.

The first meetings were mainly about the (legal and municipal) frameworks that have already been established and other principles. The evening will be moderated by Natasja van den Berg, a specialist in the field of resident participation. 'It is the start of a unique journey', she introduces. 'We involve residents at the very beginning of the process. There is currently no redevelopment plan in place.' The first evenings kick off with a commitment from Rocco Piers, executive board member of the South district. 'If the residents arrive at a design that is possible within the frameworks specified by the municipality,' Piers promises, 'then this design will actually be implemented after the summer recess of 2020. There should be no political sauce over that, that is allowed.

The frameworks that are discussed on the evening are first about the area: the Ruysdaelkade to the Albert Cuypstraat, the Frans Halsstraat and all side streets between Ruysdaelkade and the Ferdinand Bolstraat. Project leader Pieter van Zijl from the municipality of Amsterdam indicates: 'We are not going to govern beyond our borders, but we will take the rest of the city into account.'

Secondly, 'rules of the game' must be created for the decision-making process. "For decisions that affect the entire neighborhood, the majority of the neighborhood decides, but for decisions that affect the street, the majority of the street decides," Van Zijl indicates. If there is a tie, the project team will decide.

Thirdly, it concerns 'hard' frameworks that we simply cannot ignore, such as current legislation and regulations. There are also 'soft' points of attention that are emphatically preferred, such as the current traffic circulation and the traffic connection with surrounding neighborhoods. Within these frameworks and points of interest, anything is still possible, Van Zijl assures us: 'Let yourself be, don't hold back and come up with ideas.'

To stimulate the imagination of the residents, the designer of the municipality of Amsterdam addresses the various points of interest. 'Try to think creatively and broadly – we are creating a new landscape together.' After the presentations, residents will talk to various experts from the municipality at standing tables. The themes are: traffic, underground waste containers, rainproof, ecology, playing, bicycle and mobility hubs.

Later in the process, the neighborhood will start making designs for its own street (where it lives or does business). The Ruysdaelkade is an exception to this rule. Because this is a common user area, the entire neighborhood can participate in this design. This was criticized during the meeting, not all residents on this quay agree with this.

3. Meeting 26-28 March 2019: (Meeting report, 2019)

The Municipality of Amsterdam, in collaboration with Pakhuis de Zwijger, is organizing a series of meetings in which residents are involved in the future of their Frans Halsbuurt. On

March 26 and 28, the meetings in The College Hotel discussed the frameworks that the residents themselves set for the final design.

Do we want a green neighborhood with plenty of room for bicycles or an emptier street with space for meeting and playing? Do we want to design future playgrounds in combination with water facilities or with art? These and many other questions were central on Tuesday 26 and Thursday 28 March.

The first meetings, at the beginning of March, were mainly about the legal and municipal frameworks that have already been established and other principles. The two meetings on March 26 and 28, which were substantively the same, focused on the frameworks that residents and entrepreneurs themselves set for their own neighborhood. Residents and entrepreneurs were free to use their imagination to create frameworks for the redevelopment of the neighborhood. This happened in several steps.

During a first voting round, residents could give their opinion on a number of statements devised by the project team of the municipality of Amsterdam. Residents were then given the opportunity to create a mood board with their fellow residents at tables. They presented this to the rest of the neighborhood. Even before moderator Natasja van den Berg could give the starting signal for the 'sketch sessions', residents started busy discussing, cutting and pasting. There were different interests, but above all there were connecting solutions.

A second round of voting followed at the end of the evening. The municipality's statements were supplemented with new statements from the residents and a new vote was held. Green gate What immediately stood out from both the mood and the table discussions was the desire for a greener neighborhood. What stood out during the evenings was the will to find a solution together. It was clear to everyone that something was about to happen in the neighborhood.

The number of people who participate in 26 and 28 of March meeting differs regrading each question. The minimum number of 32 people and the maximum number of 40 people participated in 26 of March's meeting survey. The minimum number of 42 people and the maximum number of 56 people participated in 28 of March's meeting survey.

4. Meeting 3 to 19 April 2019:

This meeting was for online consultation with neighborhood and to collect the card and frames which they worked on in previous sessions. Base on the report the number of people who participate in online consultation differs in each question but the maximum number of 174 people and the minimum number of 107 people participated in online consultation and survey.

5. Meeting 22 April 2019:

In this meeting the executive board has established the frameworks and principles for the redevelopment of the Frans Halsbuurt prior to the first meeting. This meeting was for presenting the neighborhood frameworks which weren't open to discussion and points of attention that unlike frameworks, these are open to discussion. Also, this session was for giving feedback to neighborhood based on collected neighborhood cards and frames.

6. April 29 to May 3, 2019:

Establish a memorandum on basic principles of municipal governance frameworks

7. May 2019:

Design sessions per street

8. July 2019:

Presentation of preliminary design concept

9. June 2020:

Online meeting and view the designs per street

10. 27 March 2021:

Online meeting adapted design

11. 1 and 6 of April 2021:

Online street meeting on (April 1) and online street meeting in Albert Cuypstraat on (April 6)

12. 3 June 2021:

Online preliminary design meeting on (June 3)

Adopt a preliminary design and release it for consultation by South District Executive Board

13. July / August 2021:

Consultation on preliminary design

14. September 2021:

Processing responses to participation (Process submitted views in a Response Memorandum)

15. October – December 2021:

Adoption of response memorandum and preliminary design by the executive board.

5.5.4.7. Analyzing Data

This part of the research involves analyzing the collected data regarding the participation process of the Frans Halsbuurt project and connecting it with related secondary research.

The table below attempts to categorize all participation meetings of the Frans Halsbuurt project with the related data collected in the previous section. Due to a lack of sufficient data, it is impossible to assess the openness of the participatory process in all participation meetings using both qualitative and quantitative methods (Table 27). This research aims to assess this indicator using a qualitative method, as we do not have enough data to determine the number of participants for quantitative assessment. Based on the qualitative scoring method for the openness of the participatory process in the Frans Halsbuurt project, some scoring points are consistent across meeting sessions.

The scope of this project is primarily local, as it focuses on the redevelopment of the Frans Halsbuurt neighborhood. However, in a broader sense, the project's scope is regional, as it is interconnected with other regional redevelopment projects. For example, the "Amsterdam Car Free" agenda aims to eliminate 1000 car parking spaces from Amsterdam, which is linked to the Frans Halsbuurt redevelopment project's goal of removing 600 car parking spaces from the neighborhood. Other related regional projects include the Area Agenda, the opening of the North-South line, the Albert Cuyp garage, initiatives to improve air quality, the Underground Waste Collection System (OAIS), South bicycle parking, the multi-year bicycle plan, and the Amsterdam Rainproof project. Due to these interconnections, the scope of the Frans Halsbuurt participation meetings in this study is considered regional, and it has been awarded 1 point for regional participation scope.

Regarding communication model, most of the participation meetings were online due to the COVID-19 period and few were in-person meetings. The point of communication model differs in each participation meetings between 0 and 1 which in-person meetings get 1 point and online meetings get 0.5 points.

In this study, the participation techniques received 1 point. Because in each meeting, different participation techniques used like: Newsletter, Reports, Presentations, Public hearings, Internet webpage, Interviews, Questionnaires and surveys, Field visit and interactions, Workshops, Participatory mapping, Focus group, Citizen jury, Geospatial/decision support system, Cognitive map, Roleplaying, Multicriteria analysis, Scenario analysis.

Degree of participation differs between each meeting and ranging from 0 to 1 point. First participation meetings were more for informing the neighborhood and consultation with participant. Because of this, participation degree for first meetings is given 0 points and increasing to 0.5 points in forward meetings. In the last meetings, the participation degree receives 1point because of co-decision and empowerment.

Attendees type in most of the participation meetings gets 1 point, because more than one type of participants attended in meetings.

Base on this study the total number of participatory meetings considered are 16. In each participatory meeting the minimum point of openness of participatory process is 0 and the maximum is 5. In total for 16 meetings the minimum openness participatory process point is 0 and the maximum point is 80 (16 multiply to 5). Openness of participatory process evaluation

based on these 16 participatory meetings is calculated 62 point which is located between Min. 0 and Max. 80 points. This means that participatory process in Frans Halsbuurt's redevelopment project is openness which is more than mean.

Regarding the proportion of citizens involved in Frans Halsbuurt redevelopment participatory meetings, the number of participants involved in meetings aren't available to calculate this indicator in most of the meetings.

Openness of participatory process base on the proportion of citizens involved in participatory meetings is evaluated just in few meeting sessions. Due to lack of sufficient data, it is impossible to evaluate this indicator with high quality accuracy.

Table 27 | Evaluation of openness of participatory processes in Frans Halsbuurt

Evaluation of participatory processes							
Date	Participation action	Number of attendees	Qualitative score				
			Scope	Communication model	Participation technique	Degree of participation	Attendees type
17 & 18 Oct 2018	Residents meeting, people submitted many wishes and ideas	——	1	0.5	1	0.5	1
Nov 2018	1,845 addresses in the area were contacted by letter to complete a questionnaire, online or in writing	Total participants= 266 Residents= 224 Both residents and entrepreneurs= 35 Entrepreneurs= 5	1	0.5	1	0.5	1
6 & 7 March 2019	Inspiration, information about principles, legal and municipal frameworks & participation meeting	——	1	1	1	0	1
26 & 28 March 2019	Inspiration, information about principles, legal and municipal frameworks & participation meeting	Number of people who participate in this meeting differ in each question. In 26 March the maximum number of people attended was 40 and minimum was 32. In 28 March the maximum number of people attended was 56 people and the minimum was 42 people. Overall Max. people for both days = 96 Overall Min. people for both days = 74	1	1	1	0.5	1

Date	Activity	Notes					
3 – 19 April 2019	Online consultation	Number of people who participate in this meeting differ in each question. The maximum number of people attended is 174 and the minimum is 107 people.	1	0.5	1	0.5	1
22 April 2019	Establishing and presenting frameworks and principles to neighborhood with executive board. Also giving feedback to neighborhoods.	——	1	1	1	1	1
29 April to May 3 2019	Establish a memorandum	——	1	---	1	0	1
May 2019	Design sessions per week	——	1	---	1	1	1
July 2019	Presentation of preliminary design concept	——	1	1	1	0	1
June 2020	Online meeting and view the designs per street	——	1	0.5	1	0	1
27 March 2021	Online meeting adopted design	——	1	0.5	1	0	1
1 & 6 April 2021	Online meeting	——	1	0.5	1	---	1
3 June 2021	Online preliminary design – adopted preliminary design and consultation by south district Executive board.	——	1	0.5	1	0	1
July-August 2021	Consultation on preliminary design	——	1	0.5	1	0	1
Sep 2021	Processing responses to participation	——	1	0.5	1	0.5	1

Oct-Dec 2021	Adoption of response memorandum and preliminary design by the executive board	___	1	0.5	1	0.5	1
Total = 16 participatory meetings			Total = 16	Total = 9	Total = 16	Total = 5	Total = 16
			Total openness of participatory process evaluation = 62				

A participatory approach was crucial for engaging the local community in the decision-making process and clarifying the roles and responsibilities of community members. However, this can only be accomplished if appropriate skills are developed, such as negotiation, understanding of information, acceptance of others, patience, familiarity with local customs, and awareness of power dynamics. Effective facilitation skills, as well as trust and respect, are necessary for establishing connections between stakeholders. The exchange of information is essential for enhancing skills in planning and executing project activities, enabling communities to participate in decision-making and assume leadership roles. (Cohen-Shacham et al, 2016)

Citizen involvement is limited by practical considerations. NBS projects face a major limitation as the solutions usually need to be pre-designed to secure funding and approval, meaning that citizens are only involved in the final implementation phase. Additionally, it is difficult to adequately represent the diversity of city residents within the budget and time limitations of particular projects.

Key suggestions for improved participation in NBS are:

(1) to include citizens as early as possible in the design process,

(2) foster good relationship between grassroots organization and the municipality,

(3) involve citizens in the long-term care and maintenance of solutions,

(4) make the benefits from NBS solutions clear and broadly accessible.

Cities implementing NBS have an important responsibility to involve the population and integrate these efforts into the daily lives of citizens through citizen engagement. It is increasingly recognized as crucial to understand local knowledge through participation to ensure that local needs are addressed (Frantzeskaki, 2019).

Participation comes in various forms and can be viewed as a spectrum that includes top-down approaches involving consultation, as well as co-design, co-production, and the empowerment of bottom-up initiatives created by self-organized citizens (Dorst et al., 2019).

Traditionally, formal participation processes have utilized techniques focused on gathering information (such as surveys, focus groups, and informal interviews), raising awareness (for example, through role-playing exercises, planning walks, and games), and holding public meetings to keep citizens informed and to listen to their complaints or ideas. These activities

mainly aim to achieve transparency as a prerequisite for legitimacy in democratic societies. Typically, citizens have limited opportunities to meaningfully influence plans or to participate in the initial stages of problem formulation or the later stages of evaluating solutions. Nature-based solutions (NBS) are viewed as a novel approach to defining problems and solutions. Supporting participatory approaches can enhance the potential of NBS, as collaborative methods can contribute to increasing understanding and awareness of NBS. (VARCITIES, 2022)

Frantzeskaki (2019) suggests that current practices should go beyond consultative and regulative practices. She believes that participation should be focused on collaborating and learning from various stakeholders.

Continuous learning, including going back and forth between steps, needs to be an essential component of the co-design process (Webb et al., 2019). This might involve conducting webinars or sharing online videos before co-design events; using drawing, ideation cards, or public participatory GIS (Raymond et al., 2016); and engaging in discussions about the established goals. Different methods can also be employed to capture participants' interest from the outset and sustain it, such as social mapping, visual thinking, gamification, flipped classroom, outdoor learning, etc. Additional examples include leveraging social media, writing blogs, hosting community events like "discovery days," and encouraging involvement in conservation volunteer work (Basnou et al., 2020).

The concept of social learning should not be mistaken for participation, although participation can enable social learning. Digital technology can serve as a means for participation and enhance awareness of the local surroundings. According to Mattijssen et al (2020), digital tools can promote new connections with nature, leading to increased backing for nature-related policies. Using apps and webcams to experience nature, for example, has the potential to encourage participation in various ways, involving a range of stakeholders. Individuals who are unable to attend public meetings, for instance, can take part in the planning process through online participation tools (Afzalan and Muller, 2018). As a result, online participation tools can support other types of participation.

Struggles with time constraints and financial limitations hinder planners from involving citizens in authentic participatory or co-production processes. Despite extensive planning literature promoting increased citizen involvement, many planners and policy makers perceive in-depth participatory processes as potential obstacles rather than enhancements to project development (Raymond et al., 2017).

Advocates of incorporating Nature-Based Solutions (NBS) argue that these trials promote trust between the city and its residents, both for the purpose of the experiment and the experimental process itself (Frantzeskaki et al., 2019). However, in reality, this is not always the outcome. If participants feel that their contributions or opinions have little impact, their trust in the process may decline. Allowing decision-making power to be delegated must be balanced with the professional knowledge and technical expertise of planners and engineers. Research has demonstrated how input from citizens can supplement existing areas of expertise, providing new perspectives and local knowledge. Nonetheless, a challenge exists when it comes to the utilization of specialized language within these established areas of expertise. (VARCITIES, 2022)

Inclusive participatory processes should also take into account cultural variations and challenges related to socio-environmental justice and gender (Bjuis et al., 2016; O'Brien et al., 2017). When mapping out a broader range of stakeholders, it's important to consider the scale of the collaborative effort. For instance, local residents may have different needs and priorities for an urban green area compared to visitors coming from farther away (Kabisch and Haase, 2014).

When various stakeholders are involved in implementing NBS, it can lead to a sense of ownership for actors and citizens, which contributes to the overall acceptance of NBS (Lupp et al., 2020). While NBS are typically started by local governments, using a collaborative approach can establish a foundation for municipalities or other stakeholders to take on a facilitating role in later project stages (Frantzeskaki, 2019). This, in turn, will result in a more extensive and deeper participation process, with citizens playing a crucial role in shaping their futures (Puskás et al., 2021). In NBS projects where citizens take on an initiating role, working with local governments can provide valuable knowledge on how to maintain and operate NBS (Frantzeskaki, 2019).

5.5.5. Access to Housing: Affordability and Choice

The Access to Housing indicator is discussed in challenge 6 of the EKLIPSE (2017) report, while the Affordability of Housing is listed as an indicator in the CITYkeys (2017) report. When evaluating the Affordable Housing indicator in the Making City (2019) report, two sub-indicators are identified. Within the CITYkeys indicator list, the Affordability of Housing indicator falls under the Prosperity category, with two different definitions and assessment methods. One definition focuses on housing prices and costs, while the other is more people-oriented. This study primarily examines the people-oriented definition of Affordability of Housing, while also considering income data for a comprehensive analysis. The table below displays the gathered definitions, metrics, and sub-indicators for assessing the Affordable Housing indicator. (Table 28)

Table 28 | Affordable Housing Indicator *(Source: (EKLIPSE & CITYkeys, 2017; Making City, 2019)*

Indicator	Unit	Description
Affordability of Housing	The % of gross household income spent on housing	(Fixed housing costs after the project (€ / year))/ (Gross household income (€ / year)) ×100%
	% of population living in affordable housing	The indicator shall be calculated as the number of people living in affordable housing (numerator) divided by the city population (denominator). The result shall then be multiplied by 100 and expressed as a percentage.
Sub-indicators of Affordable Housing		
Indicator	Unit	Description
Development of housing prices	% of change or % of €/m²	Development of average price for buying an apartment per m2 in the city.
Housing cost overburden rate	%	The percentage of the population living in households where the total housing costs ('net' of housing allowances) represent more than 40 % of disposable income ('net' of housing allowances).

5.5.5.1. Description and justification

Good housing conditions are an important aspect of making and keeping cities attractive and liveable. It is crucial to ensure good living conditions in cities to maintain their appeal and livability. However, numerous European cities are facing challenges due to increasing spatial segregation, driven by social polarization. This makes it harder for low-income or marginalized groups to secure affordable and decent housing. The combination of gentrification and rising housing prices presents obstacles for residents, especially those with lower incomes, in finding housing that they can afford. (Making City, 2019)

The cost of housing is a key factor for residents, with a specific upper limit in mind. This upper limit is often the threshold for achieving satisfactory living conditions, so the affordability of

housing must be taken into consideration. Particularly in projects involving technical interventions, it is important to ensure that these interventions do not raise housing costs. Ideally, they should contribute to reducing housing expenses in the long term. (Making City, 2019)

The average cost of housing compared to income gives an indication of the affordability of the housing in the project area after the project has been executed. The average cost of housing usually differs between owner occupiers (lower) and tenants (higher). The indicator can mostly be applied in projects in which new dwellings are built, as renovation projects generally do not change the population and/or the housing costs in a way that would change the indicator score. However, in the evaluation the physical planning context on a larger scale should be taken into account, as a small area may consciously be developed with more expensive housing to increase the diversity in that particular part of the city. (CITYkeys, 2017)

Smart cities aim to maintain or increase the diversity within neighborhoods to ensure that also inhabitants with low incomes can remain in developing neighborhoods and not being pushed into suburbs or outside the city. As a rule of thumb, no more than 25-40 % of income should be spend on housing in order to be considered affordable. For developed countries the upper limit is between 33-40 %. For this indicator affordable housing is defined as: less than 40% of the household income is spend on housing expenditures. This includes rents, hereditary tenure, mortgage payments, but excludes expenditures for services or utilities. (CITYkey, 2017)

5.5.5.2. Definition

Definitions and circumstances differ greatly throughout Europe. In some cities housing costs are higher than in others, which is socially accepted. The indicator is usually based on averages (for income data often derived from statistics on larger areas) that may compromise accuracy. The indicator is relevant for policies aimed at poverty reduction and increasing the diversity within the city. (CITYkeys, 2017)

5.5.5.2.1. Affordability of Housing

This indicator has two definitions: (CITYkeys, 2017)

- The percentage of gross household income spent on housing.
- Percent of population living in affordable housing.

5.5.5.2.2. Development of housing prices

This indicator's definition is development of average price for buying an apartment per m² in the city. Would be better to look at the development of housing prices (not costs of housing since this includes mortgages, costs of insurance etc.) in relation with interventions. The price reflects strongly the ratio of demand and offerings, i.e. the location, quality of surroundings, reputation, services, trends etc. define the popularity of certain area and when this is compared to the amount of the available apartments, one may get the market price. The technical adjustments may have little effect compared to the effect of the other issues. (Making City, 2019)

5.5.5.2.3. Housing cost overburden rate

This indicator's definition is the percentage of the population living in households where the total housing costs ('net' of housing allowances) represent more than 40 % of disposable income ('net' of housing allowances). (Making City, 2019)

5.5.5.3. Measurement procedure and tool

5.5.5.3.1. Affordability of Housing

This indicator calculated in two methods bases on CITYkeys (2017):

a. The percentage of gross household income spent on housing:

(Fixed housing costs after the project (€ / year)) / (Gross household income (€ / year)) ×100%

The housing costs include all fixed expenditures on housing (such as rents and hereditary tenure or mortgage payments), and excludes expenditures for services or utilities. If costs are reduced, meaning a negative change in percentage points, points will be rewarded according to the following table. If costs increase (positive %point change), a score of 1 will be given. With no change in costs, the score remains 0, which means it will not be taken into account in the calculation of the score. (Table 29)

Table 29 | Affordability of Housing Scoring (CITYkeys, 2019)

%point change	Score
<-5	10
-5	9
-4	8
-3	7
-2,5	6
-2	5
-1,5	4
-1	3
-0,5	2
0	0
>0	1

b. Percent of population living in affordable housing:

The indicator shall be calculated as the number of people living in affordable housing (numerator) divided by the city population (denominator). The result shall then be multiplied by 100 and expressed as a percentage.

5.5.5.3.2. Development of housing prices

This indicator is calculated by % of change and the units for this indicator can be % of €/m2 / % of change, annual average rate / annual average index (unit can differ by country). (Making City, 2019)

5.5.5.3.3. Housing cost overburden rate

This indicator's unit is % of population and calculated with below formula. (Making City, 2019)

(Population living with housing cost overburden / Total city population) × 100

5.5.5.4. Scale of measurement

Base on EKLIPSE the Affordability of Housing indicator can be evaluated in Regional, Metropolitan and Urban scales. (EKLIPSE, 2017)

5.5.5.5. Data collection frequency

At the end of the project, or ex-ante to evaluate the plans.

5.5.5.6. (Collected Data) Data availability

As in previous parts mentioned this research is focused on People category of indicators and as well as in assessing Affordable Housing. For this reason, the data is collected to assess the percent of people live in affordable houses and also for having a general and comprehensive analysis the data about income is collected as well.

The data for assessing the Affordability of Housing indicator in Frans Halsbuurt and Amsterdam is collected from different secondary sources. Like other indicators the data is collected from Amsterdam Municipal Website and Statistic Netherland (CBS) database. The Property Value and Housing data are collected one in 2018 before starting of project and one in 2022 and 2023 which was the middle of the project and in some streets of neighborhood, the first phases of the project were ended. It would be better to have an Income data in 2023for comprehensive and updated analysis but because of limited data availability, the 2022 year's Income data is used in this research and compared with Housing data of 2022 in Frans Halsbuurt neighborhood and municipality of Amsterdam.

Each year, the value of all real estate in Amsterdam is assessed according to the Valuation of Immovable Property Act (*Wet Waardering Onroerende Zaken*, or WOZ). This act establishes how municipalities assess the value of homes and businesses. The WOZ value of a property is used to calculate certain taxes, such as property tax (*onroerendezaakbelasting*). WOZ values are based on market values. Assessments are carried out in the same way throughout the

Netherlands according to strict rules. The WOZ value of a property is based on the building's characteristics, official valuations, and the selling price of nearby properties.

Property Value of Frans Halsbuurt per year:

When determining the average, only WOZ objects that are registered as homes (main residence or home with practice space) are included. The (provisional) average home value is determined using the value reference date of the previous year, for example 2023: value reference date January 1, 2022. If the housing stock is smaller than 20 homes or the number of WOZ objects is smaller than 50, no WOZ value is included. The average WOZ value in Frans Halsbuurt was €586,000 in 2023. The below graph and table show the average WOZ home value per year in the Frans Halsbuurt based on Statistics Netherland (CBS). (Figure 22) and (Table 30)

Figure 22 | Average WOZ home value per year in Frans Halsbuurt *(Source: (Statistics Frans Halsbuurt, 2024))*

Table 30 | Average WOZ home value per year in Frans Halsbuurt *(Source: (Statistics Frans Halsbuurt, 2024))*

Year	Average WOZ home value in Frans Halsbuurt	% difference
2023	€586,000	20%
2022	€490,000	1.66%
2021	€482,000	0.63%
2020	€479,000	9.1%
2019	€439,000	8.1%
2018	€406,000	17%
2017	€346,000	18%
2016	€293,000	16%
2015	€253,000	2.85%
2014	€246,000	-1.99%
2013	€251,000	no data

Property Value of Amsterdam per year:

The average WOZ in the municipality of Amsterdam was 517.000 € in 2023. The development of the data over time follows a clear upward trend: The figures are growing almost every year. The below graph and table show the average WOZ house value per year in municipality of Amsterdam based on data from Statistics Netherland (CBS). (Figure 23) and (Table 31)

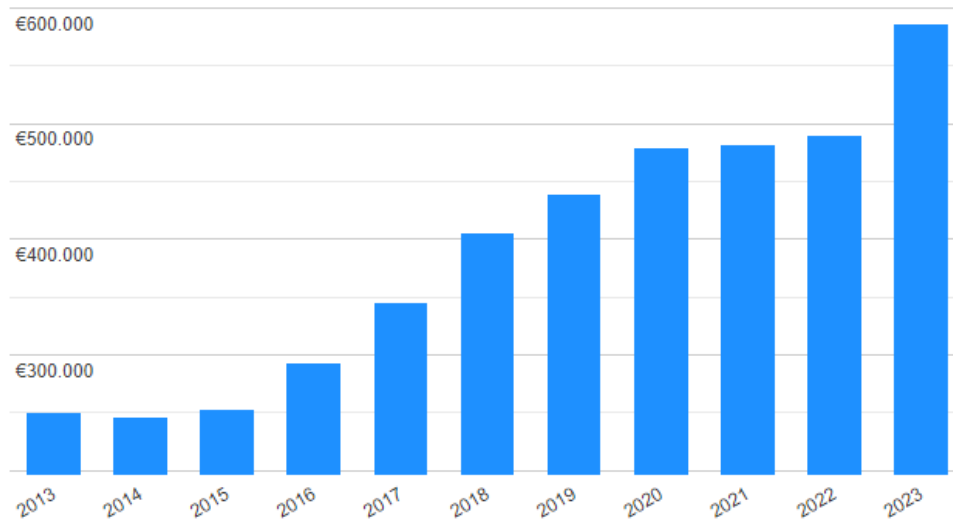**Figure 23 |** Average WOZ home value per year in Amsterdam (Source: (Statistics Frans Halsbuurt, 2024))
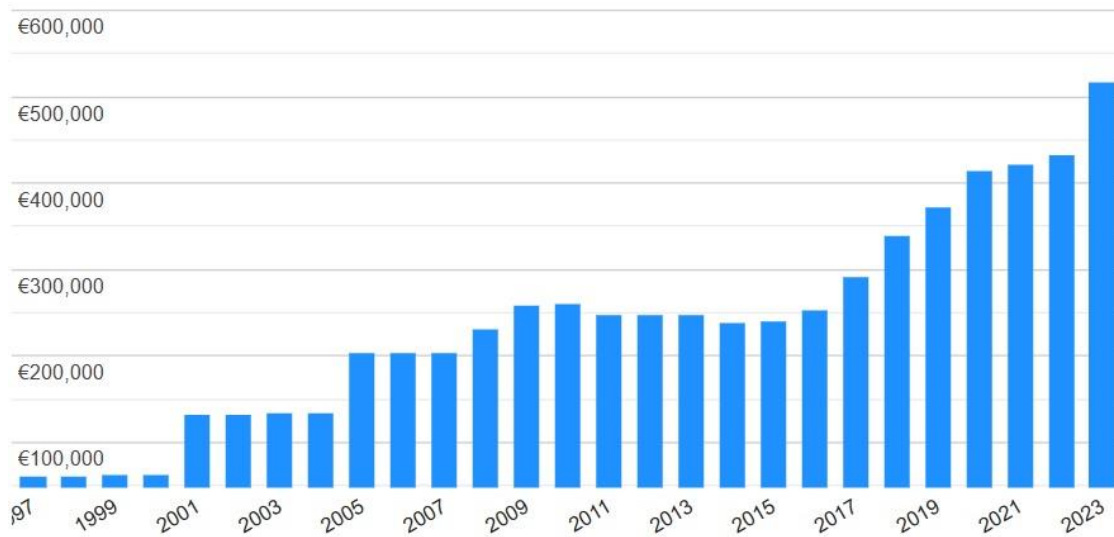
Table 31 | Average WOZ home value per year in Amsterdam *(Source: (Statistics Frans Halsbuurt, 2024))*

Year	Average WOZ home value Municipality of Amsterdam	% difference
2023	From €517,000	19%
2022	From €433,135	2,55%
2021	From €422.354	1,61%
2020	From €415,650	11%
2019	From €373.641	9,7%
2018	From €340,573	16%
2017	From €292.528	16%
2016	From €253,068	4,91%
2015	From €241,220	0,80%
2014	From €239,314	-3,89%
2013	From €248.988	0,05%
2012	From €248.859	0,33%
2011	From €248,041	-4,91%
2010	From €260,856	0,82%
2009	From €258,731	12%
2008	From €231,124	13%
2007	From €204,315	0,13%
2006	From €204.042	0%
2005	From €204.042	51%
2004	From €134.937	0,73%
2003	From €133,958	0,74%
2002	From €132,979	0,02%
2001	From €132.958	113%
2000	From €62,447	0,03%

Housing data of Amsterdam and Frans halsbuurt in 2018, 2022 and 2023:

Base on CBS, the property value and other comprehensive data of housing are collected in one table to compare the Frans Halsbuurt neighborhood and municipality of Amsterdam easily during the 2018, 2022 and 2023 years. (Table 32) - (Table 33) and (Table 34)

Table 32 | Housing Data of Frans Halsbuurt and Amsterdam in 2018 *(Source: (CBS, 2018))*

Subject		Amsterdam	Frans Halsbuurt
Living			
Housing stock	number	432 715	1 688
Average house value	x 1,000 euros	340	406
Houses by type			
Percentage of single-family homes	%	12	1
Percentage of multi-family housing	%	88	99
Houses by occupancy			
Percent occupied	%	94	89
Percentage uninhabited	%	6	11
Homes by ownership			
Owner-occupied homes	%	30	28
Rental properties			
Rental properties total	%	70	71
Owned by housing association	%	42	23
Owned by other landlords	%	27	48
Ownership unknown	%	1	1
Houses by year of construction			
Year of construction before 2000	%	85	98
Year of construction from 2000	%	15	2

Table 33 | Housing Data of Frans Halsbuurt and Amsterdam in 2022 *(Source: (CBS, 2022))*

Subject		Amsterdam	Frans Halsbuurt
Living			
Housing stock	number	458 397	1 715
Average WOZ value of homes	x 1,000 euros	433	490
Houses by type			
Percentage of single-family homes	%	12	1
Percentage of multi-family housing	%	88	99
Houses by occupancy			
Percent occupied	%	93	90
Percentage uninhabited	%	7	10
Homes by ownership			
Owner-occupied homes	%	29	27
Rental properties			
Rental properties total	%	71	73
Owned by housing association	%	40	23
Owned by other landlords	%	30	50
Ownership unknown	%	0	0
Houses by year of construction			
Year of construction before 2000	%	81	98
Year of construction from 2000	%	19	2

According to collected data, the Average WOZ value of houses is illustrated in map to compare all neighborhoods of Amsterdam together. (Figure 24) - (Figure 25) and (Figure 26)

Figure 24 | Average WOZ value of home in Amsterdam neighborhoods in 2018 *(Source: (CBS, 2018))*

64 tot 418 (x 1 000 euro)
418 tot 773 (x 1 000 euro)
773 tot 1 127 (x 1 000 euro)
1 127 tot 1 482 (x 1 000 euro)
meer dan 1 482 (x 1 000 euro)
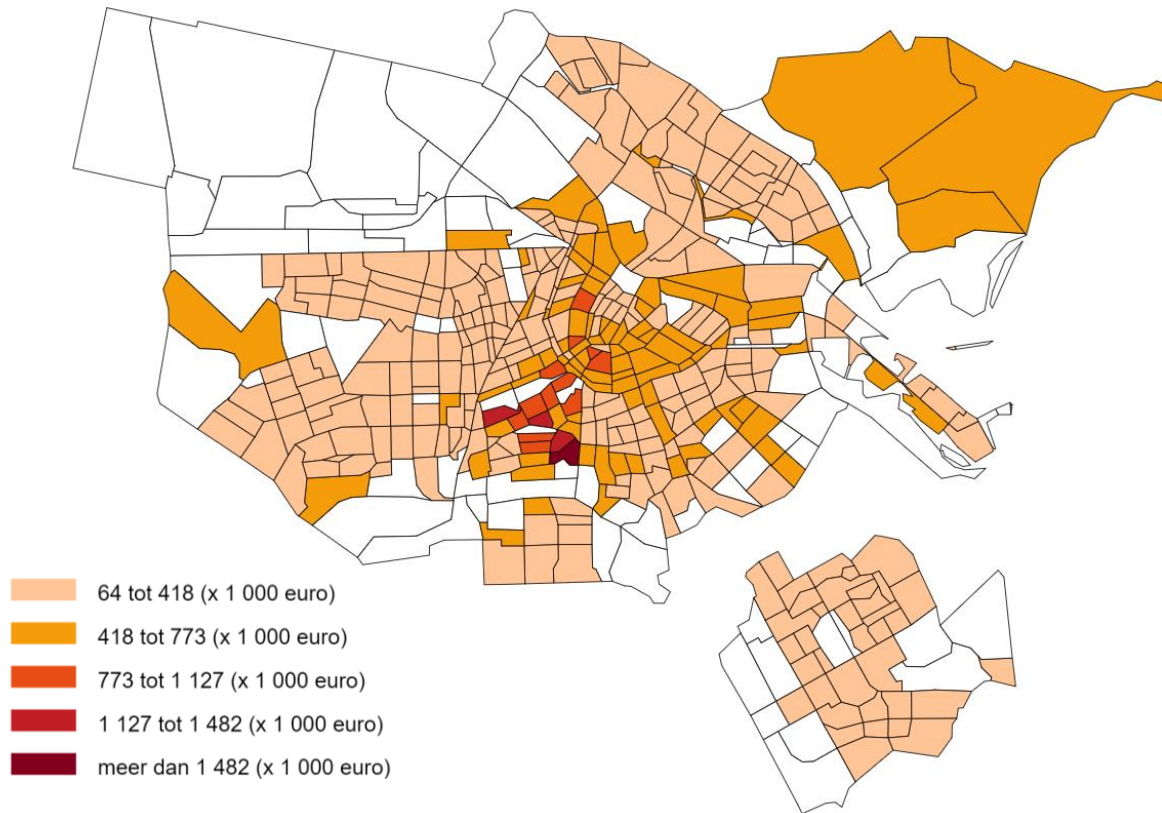
Figure 25 | Average WOZ value of home in Amsterdam neighborhoods in 2022 *(Source: (CBS, 2022))*

28 tot 436 (x 1 000 euro)
436 tot 845 (x 1 000 euro)
845 tot 1 253 (x 1 000 euro)
1 253 tot 1 662 (x 1 000 euro)
meer dan 1 662 (x 1 000 euro)

Table 34 | Housing Data of Frans Halsbuurt and Amsterdam in 2023 *(Source: (CBS, 2023))*

Subject		Amsterdam	Frans Halsbuurt
Living			
Housing stock	number	474 866	1 719
Average WOZ value of homes	x 1,000 euros	517	586
Houses by type			
Percentage of single-family homes	%	13	1
Percentage of multi-family housing	%	87	99
Houses by occupancy			
Percent occupied	%	94	91
Percentage uninhabited	%	6	9
Homes by ownership			
Owner-occupied homes	%	30	28
Rental properties			
Rental properties total	%	70	72
Owned by housing association	%	40	23
Owned by other landlords	%	30	49
Ownership unknown	%	0	0
Houses by year of construction			
Year of construction before 2000	%	80	98
Year of construction from 2000	%	20	2

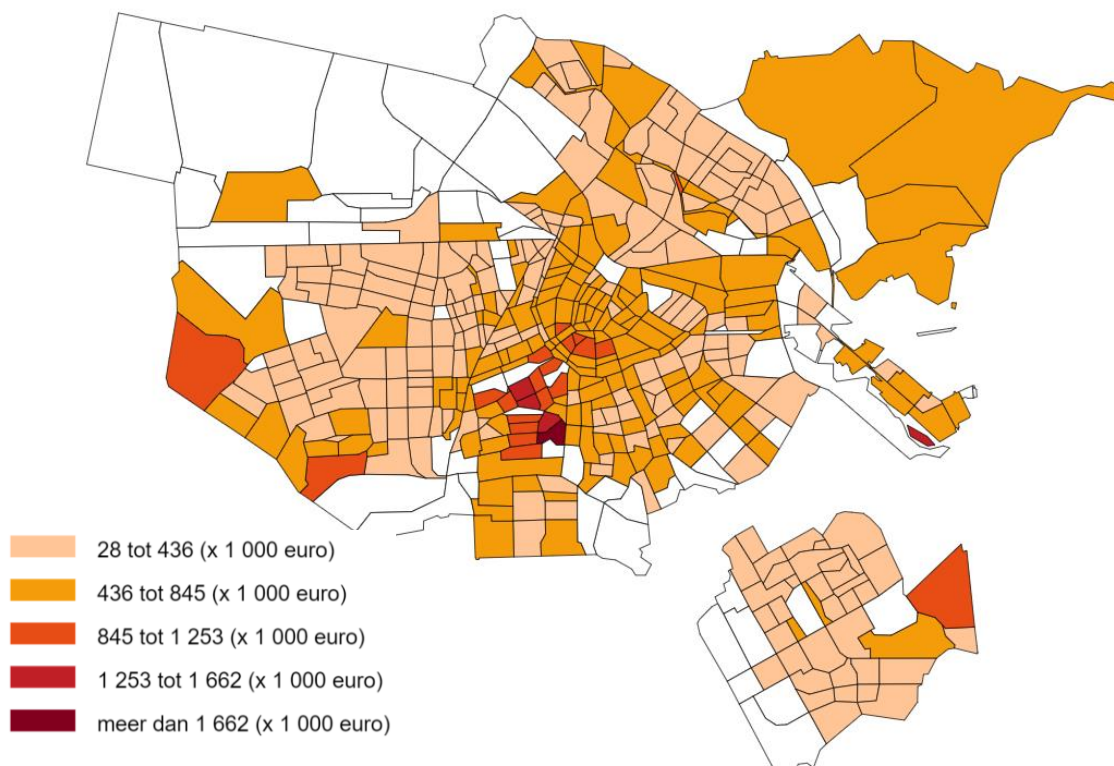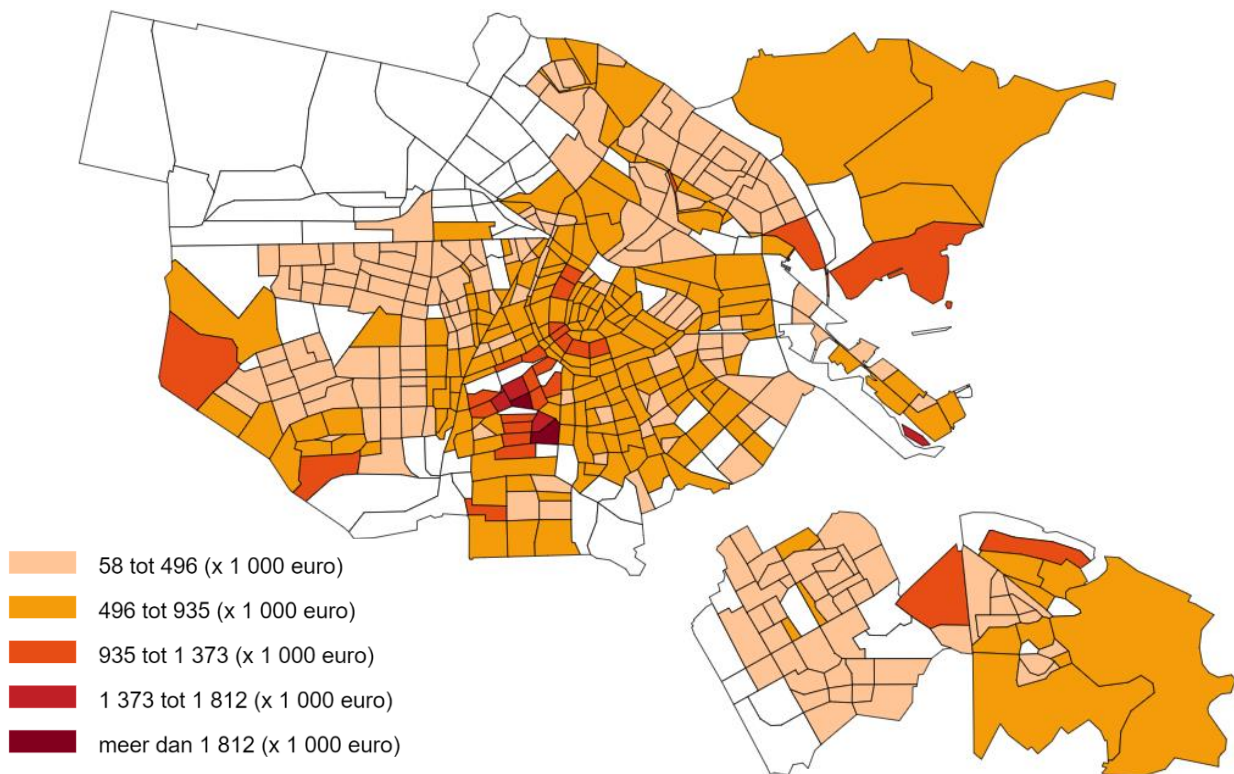**Figure 26 |** Average WOZ value of home in Amsterdam neighborhoods in 2023 *(Source: (CBS, 2023))*

58 tot 496 (x 1 000 euro)

496 tot 935 (x 1 000 euro)

935 tot 1 373 (x 1 000 euro)

1 373 tot 1 812 (x 1 000 euro)

meer dan 1 812 (x 1 000 euro)

Income data of Amsterdam and Frans Halsbuurt in 2018, 2022 and 2023:

Base on CBS, the Income data of the Frans Halsbuurt neighborhood and municipality of Amsterdam are collected in one table to compare easily during the 2018 and 2022 years. (Table 35) and (Table 36)

Table 35 | Income data of Frans Halsbuurt and Amsterdam in 2018 *(Source: (CBS, 2018))*

Subject		Amsterdam	Frans Halsbuurt
Income			
Income of individuals			
Number of income recipients	number	673 500	2 200
Average income per income recipient	x 1,000 euros	36.6	51.2
Average income per inhabitant	x 1,000 euros	29.7	44.4
40% people with the lowest income	%	39.7	31.9
20% people with the highest income	%	23.9	33.3
Household income			
Avg. standardized household income	x 1,000 euros	29.8	36.5
40% households with lowest income	%	51.6	50.7
20% households with the highest income	%	17.1	19.8
Low-income households	%	13.5	12.6
Huish. below or around the social minimum	%	12.7	12.0
Households up to 110% of the social minimum	%	17.1	14.6
Households up to 120% of the social minimum	%	20.2	16.9
Median wealth of private households.	x 1,000 euros	7.6	14.8

Table 36 | Income data of Frans Halsbuurt and Amsterdam in 2022 *(Source: (CBS, 2022))*

Subject		Amsterdam	Frans Halsbuurt
Income			
Income of individuals			
Number of income recipients	number	708 900	2 200
Average income per income recipient	x 1,000 euros	43.9	.
Average income per inhabitant	x 1,000 euros	36.5	50.9
40% people with the lowest income	%	39.8	32.3
20% people with the highest income	%	25.4	34.7
Household income			
Avg. standardized household income	x 1,000 euros	36.8	.
40% households with lowest income	%	50.0	48.0
20% households with the highest income	%	18.1	19.0
Low-income households	%	6.2	6.0
Huish. below or around the social minimum	%	12.1	9.8
Households up to 110% of the social minimum	%	16.0	13.0
Households up to 120% of the social minimum	%	18.6	14.9
Median wealth of private households.	x 1,000 euros	12.9	21.9

According to collected data, the Average income per inhabitant value is illustrated in map to compare all neighborhoods of Amsterdam together. (Figure 27) and (Figure 28)

Figure 27 | Average income per inhabitant value of Amsterdam neighborhoods in 2018 *(Source: (CBS, 2018))*
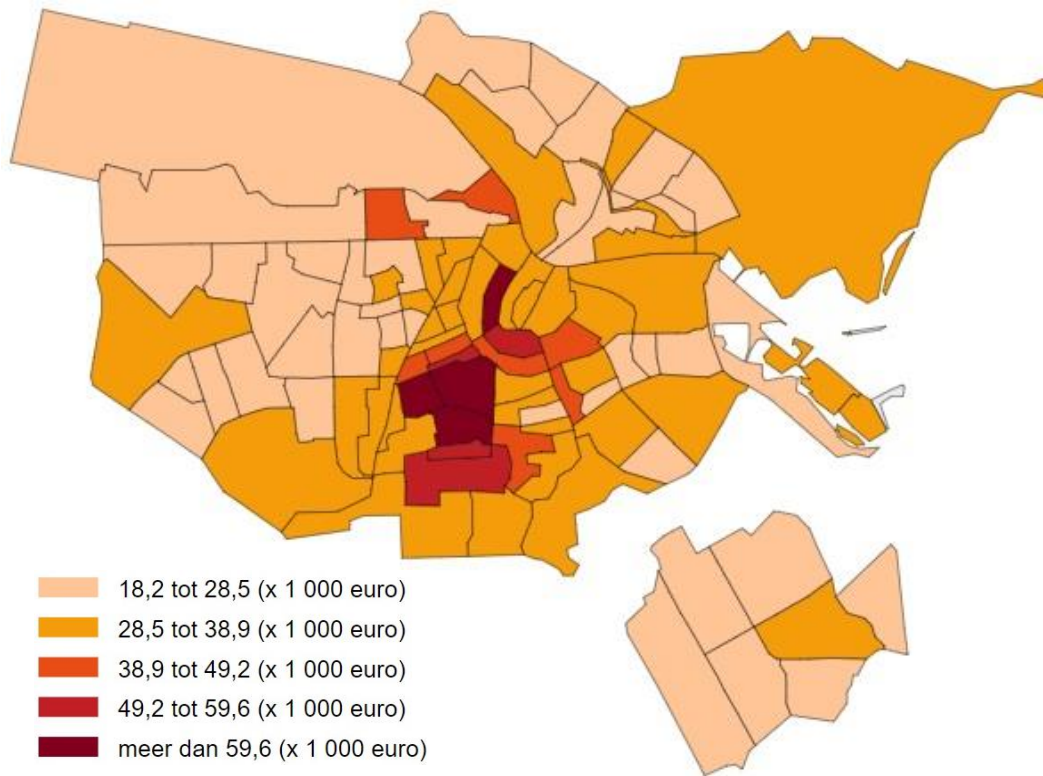

- 18,2 tot 28,5 (x 1 000 euro)
- 28,5 tot 38,9 (x 1 000 euro)
- 38,9 tot 49,2 (x 1 000 euro)
- 49,2 tot 59,6 (x 1 000 euro)
- meer dan 59,6 (x 1 000 euro)

Figure 28 | Average income per inhabitant value of Amsterdam neighborhoods in 2022 *(Source: (CBS, 2022))*

- 21,6 tot 32,6 (x 1 000 euro)
- 32,6 tot 43,5 (x 1 000 euro)
- 43,5 tot 54,5 (x 1 000 euro)
- 54,5 tot 65,4 (x 1 000 euro)
- meer dan 65,4 (x 1 000 euro)
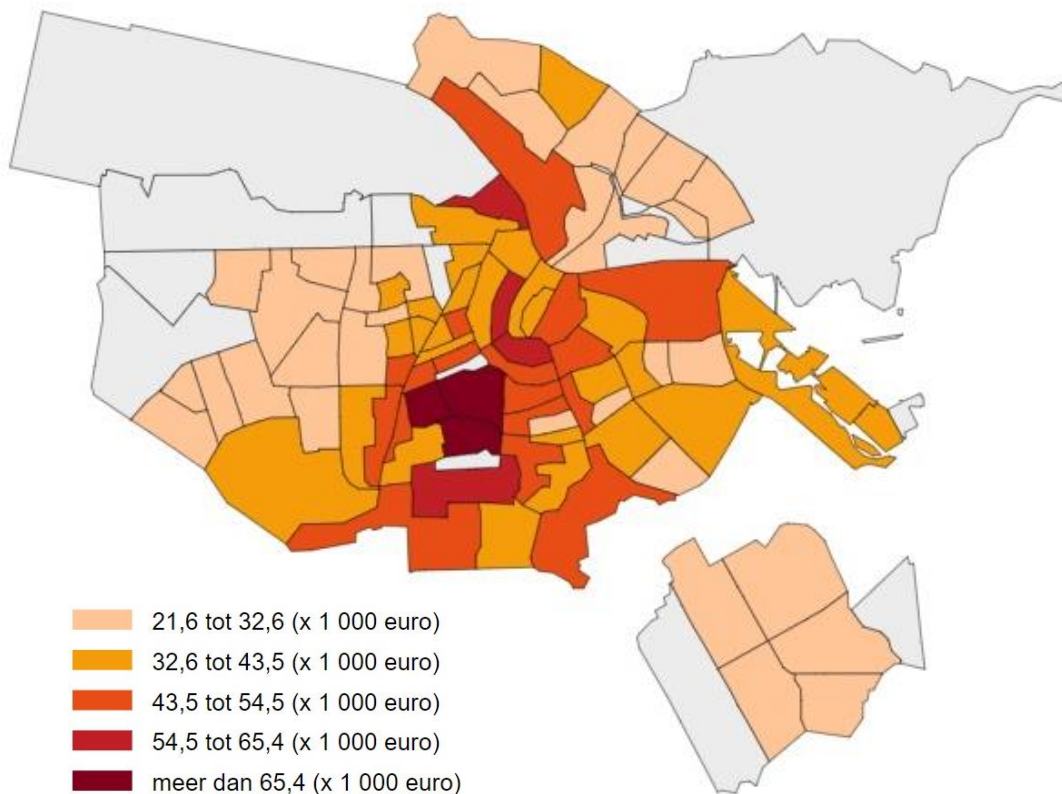
5.5.5.7. Analyzing Data

In order to evaluate the effectiveness of Frans Halsbuurt's NBS project in improving the Affordability of Housing, the analysis is done base on the collected primary and secondary data once in 2018 and once in 2022.

Based on UNaLab (2019), the land and property values are indicators to evaluate the mean or median value of land and property within a specified distance from NBS. The change in attractiveness of an area due to the presence of public green space or other NBS can be determined by an individual's willingness to pay for, and thus the sale price or value of, land or property located in proximity to the NBS (Gore et al., 2013).

Similar effects are likely to occur when implementation of NBS encourages development of new housing areas. A survey of real estate developers and consultants from across Europe revealed that 95% of respondents believe that open space readily adds value to commercial. On average, property developers would be willing to pay ≥3% more for the opportunity to be near public open space, with some putting the premium as high as 15-20%. The type and size of a given NBS, and the different recreational opportunities and aesthetic values associated with the NBS, will largely determine the extent (in distance or time) and magnitude of its impact on local land and property values. (UnaLab, 2019)

As above mentioned, the NBS project can affect the price of land and property value of area which the NBS is implemented and for this reason the analysis starts with comparing the property value in Frans Halsbuurt during the 2018 and 2022 years.

Base on (Figure 22) and (Table 30) in pervious part the average WOZ home value in the Frans Halsbuurt has increased by 335,000 € from 251,000 € in 2013 to 586,000 € in 2023 (that is a growth of 133%). The average difference per year over the entire period from 2013 to 2023 was 33,500 € (9.1%). The development of the data over time follows a clear upward trend: The figures grow almost every year.

To have a broad analysis for understanding the reason of property value growth in Frans Halsbuurt neighborhood is implementation of NBS or it is a widespread phenomenon in all Amsterdam city, the Amsterdam's property value data is collected as well as Frans Halsbuurt neighborhood in 2018 and 2022 years.

According to (Figure 23) and (Table 31) the average WOZ home value in the municipality of Amsterdam has increased by 456,597€ from 60,403€ in 1997 to 517,000€ in 2023 (which is a growth of 756%). The average difference per year over the entire period from 1997 to 2023 was 17,561€ (10%).

Regarding the maps which illustrate the average WOZ value of home in Amsterdam neighborhoods during 2018 (Figure 24), 2022 (Figure 25) and 2023 (Figure 26), it is obvious that the average WOZ value of home is increased dramatically by changing from range of (64,000 to 418,000) € in 2018 to range of (496,000 to 935,000) € in 2023.

According to the above analysis the increase of property value is widespread in all neighborhoods of Amsterdam city and even in all Netherland. For this reason, implementation of NBS in Frans Halsbuurt neighborhood can affect the property prices of this area but it is not the one and only reason for this property value growth.

Urban nature has positive impacts on house value in the areas surrounding it, which depend on population density, distance to, and the type of urban nature. (Bockarjova et al, 2020)

One benefit of implementing nature-based solutions in urban areas is that they often offer various additional advantages (Raymond et al., 2017). Utilizing ecosystem services for green urban revitalization increases property market value as the impact of being near natural surroundings influences property prices and rental rates, attracting wealthier residents and displacing lower-income inhabitants (Anguelovski et al., 2018).

It is important to take into account the potential for green gentrification in urban planning, as it may result in the most disadvantaged individuals being excluded from the ecosystem services and benefits provided by urban nature. The process of gentrification is commonly linked with the United States, but the idea of green gentrification is not unfamiliar in Europe and other regions. Several major cities have observed low-income residents leaving areas with improved green spaces. (Bockarjova et al, 2020)

The phenomenon of gentrification has become increasingly concerning for urban planners and residents, as a higher percentage of lower-income neighborhoods were displaced in the 2000s compared to the 1990s (Maciag, 2015). Gentrification is the result of various underlying processes and has recently been linked to the growing suburbanization of low-to-middle-income earners in Europe, as well as the concentration of high-income earners in urban areas (Hochstenbach and Musterd, 2018).

An inadvertent result of incorporating green initiatives in urban areas is that green gentrification indicates hidden social processes that urban planners must recognize, monitor, and address to ensure that the benefits of urban nature and its ecosystem services can be universally promoted. Therefore, the potential gentrification effects of green revitalization or other forms of green initiatives in residential areas must be carefully evaluated before, during, and after their implementation. It is important to consider how environmental managers could direct efforts and investments to strike a balance between environmental opportunities and the ongoing priorities of creating socially inclusive, ecologically diverse, and climate change-resilient green spaces (Bell et al., 2017).

Price increases as a result of the development of nature in cities may under certain circumstances result in gentrification, if lower-income households cannot afford the high prices and are replaced over time by new residents with higher incomes.

Bockarjova et al, (2020) observed that various interventions lead to different expected outcomes on property values, particularly in terms of the range at which a positive effect is observed and the magnitude of the effect. The variations in property values resulting from these interventions are influenced by the prevailing property values in different areas, which vary across the city. It is reasonable to assume that proximity to multiple urban natural areas would contribute more to the property value in a specific location compared to the proximity to a single piece of nature.

Neighborhoods in the vicinity of multiple green interventions may experience higher percentage increase in house value due to the cumulative effects. Clearly, the absolute amount of house value changes depends on local conditions, such as prevailing house value in the area, which may vary substantially within a city.

Nature-based solutions frequently have an impact on the housing market, leading to an increase in both house and rental prices. This often results in the unintentional displacement of lower-income populations by wealthier residents, depriving them of the benefits of urban nature that are particularly valuable to them (Lovell et al., 2018). It is essential to closely monitor these processes of green gentrification, which can be facilitated by evaluating the effects of newly developed green and blue areas on housing markets.

The result show that urban nature has an impact on house prices in the areas surrounding it, and that the magnitude of this effect decreases as house distance from nature increases, revealing conventional distance decay relationship. Furthermore, the results show that the impact on property prices differ by type of nature intervention. In particular, homebuyers value the presence of a park or blue nature in the vicinity of their property more the presence of other types of urban nature. This effect can be explained by the high direct use value (Hein et al., 2006) created by many ecosystem services of urban parks and blue nature such as aesthetics, recreational opportunities and local climate regulation.

By depending on pervious paragraph for having an information about income level of Frans Halsbuurt neighborhood and Amsterdam city, the related data is collected in (Table 35) and (Table 36).

Average income per inhabitant was 44,400 € in Frans Halsbuurt neighborhood in 2018 year which increased to 50,900 € in 2022 means (14.63 %) growth between these four years. Same increase also occurred in Amsterdam's average income per inhabitant factor with difference in growth percent (22.89 %) which changed form 29,700 € in 2018 to 36,500 € in 2022. In other side there is a growth of (23.48 %) in Average standardized household income that raised from 29,800 € in 2018 to 36,800 € in 2022 in Amsterdam city. The Average standardized household income in Frans Halsbuurt neighborhood was 50,900 € in 2018. Base on obvious overall increase in income factors for sure the Average standardized household income increased between the 2018 and 2022 years but it is difficult to say the exact number because of limited available data.

The average WOZ value of homes in Frans Halsbuurt had a growth of 20.68%from 2018 to 2022 years which the increase of average income per inhabitant was 14.63% in same timeline. For sure there was a growth in average standardized household income but because of data absence in 2022, the exact growth percent couldn't be calculated. The average WOZ value of home in Amsterdam city had a rise of 27.35% from 2018 to 2022 which the increase of average income per inhabitant was 22.89% and the growth of average standardized household income was 23.48% in same time period.

For calculating the percent of population living in affordable housing in Frans Halsbuurt neighborhood between the years of 2018 and 2022, the number of households in total divided to the total number of populations in this neighborhood and then multiplied to 100. This calculation is done with the sufficient data which could collected for this research with a difference in using the number of households instead of number of people living in affordable housing in original formula. Because there is no data regarding the affordability of these households in Frans Halsbuurt neighborhood, it is difficult to say the percent of population living in housing is affordable or not. Also, in this research the scale of this formula is changed from city level to neighborhood level.

The original formula for calculating percent of population living in affordable housing is:

$$\frac{People\ living\ in\ affordable\ housing}{Total\ city\ population} * 100 \quad \text{changed to} \quad \Longrightarrow \quad \frac{No.of\ households\ in\ total}{Total\ city\ population} * 100$$

Base on CBS the total population of Frans Halsbuurt neighborhood was 2615 and the total number of households was 1735 which the percent of population living in affordable housing is 66.34 %.

$$\frac{Households\ in\ total = 1735}{Total\ FH\ population = 2615} * 100 = 66.34\%\ people\ living\ in\ affordobale\ housing\ in\ 2018$$

The percent of population living in affordable housing in Frans Haslbuurt in 2022 was 67.11% based on the data collected from CBS. The total population of this neighborhood was 2600 and the total number of households was 1745 in 2022.

$$\frac{Households\ in\ total = 1745}{Total\ FH\ population = 2600} * 100 = 67.11\%\ people\ living\ in\ affordobale\ housing\ in\ 2022$$

The result shows that the percent of population living in affordable housing is increased from 2018 to 2022. As mentioned before because there is no any information regarding the affordability of households in Frans Halsbuurt, it is difficult to say the result of this formula is percent of population living in affordable housing or just housing.

Above all, based on limited time and available data, it is not possible to calculate the accurate affordability of housing indicator in Frans Halsbuurt neighborhood. According to analysis is done base on collected data, there is no obvious positive or negative effect of Frans Hasbuurt NBS project on Affordability of Housing indicator and maybe it is early to talk about effectiveness of Frans Halsbuurt NBS project on Affordability of Housing indicator before completion of all project phases.

5.5.6. Chronic Stress (Perceived Stress)

The World Health Organization identifies stress and lack of physical activity as two of the primary causes of early death in developed nations. According to the American Psychological Association, many Americans engage in unhealthy stress management behaviors, and a national survey revealed an increase in stress levels, with 44% of adults experiencing heightened stress over the last five years. Work and financial challenges, family and relationship complexities, and various other everyday challenges characterize modern life and can lead to chronic stress, anxiety, burnout, depression, and decreased overall productivity for many people. (House et al, 2016)

An individual's productivity can significantly decrease due to stress, and in extreme cases, stress can also pose a threat to life and health. Numerous diseases such as cardiovascular disease, diabetes, cancer, and asthma are linked to chronic stress. Additionally, chronic stress can have a negative impact on individuals' decision-making abilities. Stress can also lead to burnout, which is a condition that imposes a significant financial burden on society, with an estimated annual cost of $4.6 billion attributed solely to the effects of physician burnout. Consequently, extensive research has been carried out on the physical and mental aspects of health, as well as cognitive function. In psychology, it is believed that stress arises from an imbalance between the demands one faces and their self-perceived ability to handle these demands. (Baumgartl et al, 2020)

This research is focused on assessing Chronic Stress for analyzing the effectiveness of Frans Halsbuurt NBS project in decreasing the stress. Based on the European Commission there are different indicators that relates to Chronic Stress with two quantitative methodologies for assessing. (Table 37). The preferred methodology for assessment of Chronic Stress in this study is using survey or questionnaire method.

Table 37 | Chronic Stress related indicators base on European Commission *(Source: (European Commission, 2021))*

Indicator	Unit of measurement	Examples of methods of assessment for indicator
Level of Chronic Stress (Perceived Stress)	Number (0-4)	The indicator is obtained using a survey which is taken by a sample of the general population.
Prevalence of Chronic Stress	%	Quantitative P: Scale/Scale inventory/Questionnaire (survey procedure, paper-and-pencil administration, computer-based administration)
Incidence of Chronic Stress	% per year	Quantitative P: biochemical assessments of diurnal cortisol secretion (hair, blood, salivary cortisol)

5.5.6.1. Description and justification

According to European Commission (2021), Stress reduction is one of the well-established mechanisms underlying the health benefits of the green spaces. However, evidence from natural experiments is lacking.

The importance of natural environment exposure is emphasized by numerous authors. They suggest that it can help improve the overall wellbeing of urban residents who face chronic stress and insufficient physical activity. This exposure can promote mental and physical health and decrease the rates of illness and death in urban communities. It achieves this by providing psychological relaxation and stress relief, boosting immune function, fostering social cohesion, encouraging physical activity, and reducing exposure to air pollutants, noise, and extreme heat.

The positive impacts of being exposed to nature or interacting with it have been explained using two related theoretical frameworks. Attention Restoration Theory (ART) focuses on how nature helps in reducing mental exhaustion and suggests that nature facilitates recovery from the tiredness caused by sustained focus, leading to improved cognitive function.

Stress Recovery Theory (SRT) highlights the importance of natural settings in reducing physical stress. It suggests that natural environments affect emotional states by helping to recover from stress and reducing arousal and negative thoughts through mind-body pathways.

The onset, progression, and worsening of different illnesses, such as depression, cardiovascular diseases, and immune-related disorders, are believed to be significantly influenced by psychological stress, which has also been linked to increased overall mortality.

5.5.6.2. Definition

Stress involves the way a person reacts mentally, physically, and through actions to a situation that challenges or threatens their well-being. The mental aspect encompasses cognitive assessment of the situation, feelings like fear, anger, and sorrow, and coping mechanisms. (European Commission, 2021)

5.5.6.3. Measurement procedure and tool

The indicator is obtained using a survey which is taken by a sample of the general population. The survey includes the Perceived Stress Scale questionnaire, which includes 4 items on the amount of time in the last month that the participant felt a certain way. The answers are on a scale from 0 (low stress) to 4 (high stress).

The Perceived Stress Scale is a self-report tool designed to assess how individuals perceive situations in their lives as excessively stressful in relation to their ability to cope. There are currently three standard versions of the PSS: the original 14-item form (PSS-14), the PSS-10, and a four-item form (PSS-4). The PSS-10 is considered the optimal version and they recommended its use in future research. The Perceived Stress Scale consists of questions about your feelings and thoughts over the past month. You will be asked to indicate the frequency with which you felt or thought a certain way in each case. Some questions are similar, but each should be treated as a separate question. It is best to answer each question quickly and without trying to tally the number of times you felt a particular way. Simply choose the alternative that seems like a reasonable estimate. (European Commission, 2021)

For each question choose from the following alternatives:

0 = Never

1 = Almost never

2 = Sometimes

3 = Fairly often

4 = Very often

In the last month, how often…

1 …have you been upset because of something that happened unexpectedly?

2 …have you felt that you were unable to control the important things in your life?

3 …have you felt nervous and "stressed"?

4 …have you felt confident about your ability to handle your personal problems? (R)

5 …have you felt that things were going your way? (R)

6 …have you found that you could not cope with all the things that you had to do?

7 …have you been able to control irritations in your life? (R)

8 …you felt that you were on top of things? (R)

9 …you been angered because of things that were outside your control?

10 …have you felt difficulties were piling up so high that you could not overcome them?

Base on the National Institute for Public Health and Environment (RIVM) in collaboration with the Municipal/Regional Health Services (GGDs) and Netherland Statistics (CBS) there are different levels (Low, Moderate, High) of anxiety, depression and Stress according to large-scale questionnaire surveys.

Moderate/high risk of anxiety or depression:

Having a moderate or high risk of an anxiety disorder or depression among people aged 18 and over. This is based on a commonly used questionnaire for screening anxiety and depression (Kessler-10 questionnaire). The answers are summarized in a score. (Statistics Frans Halsbuurt, 2024)

In questionnaire each question has 5 answer categories:

1 = Always
2 = Most of the time
3 = Sometimes
4 = Occasionally
5 = Never

For answer (1= Always) you get the highest score in this case and for answer (5 = Never) you get the lowest score 1. (If 3 or more items are missing, the indicator is given the value missing. If 1 or 2 items are missing, the value is imputed based on the average score on that item)

The following questions are about how you felt in the past 4 weeks:

1. How often have you felt very tired for no apparent reason?
2. How often did you feel nervous?
3. How often have you been so nervous that you couldn't calm down?
4. How often have you felt hopeless?
5. How often did you feel restless or restless?
6. How often have you felt so restless that you could no longer sit still?
7. How often did you feel sad or depressed?
8. How often have you felt like everything took a lot of effort?
9. How many times have you felt so down that nothing could cheer you up?
10. How often have you found yourself blameworthy, inferior or worthless?

The answers to the K10 are summarized in a score between 10-50.
10 to 15: no or low risk
16 to 29: moderate risk
30 to 50: high risk of an anxiety disorder or depression.

5.5.6.4. Scale of measurement

The scale of measurement is general population in residential neighborhoods. The scale which is studied in this research is whole Frans Halsbuurt neighborhood.

5.5.6.5. Data collection frequency

Twice; once before the implementation of the nature-based solutions and once after. This survey is repeated before and after the implementations of NBS in order to observe a potential change in mental health status.

According to Frans Halsbuurt's project timeline and health data availability in Amsterdam, the 2016 year is selected for analyzing the period before the project and 2022 instead of 2024 for analyzing the period after the project.

5.5.6.6. (Collected Data) Data availability

Health monitors are large-scale questionnaire surveys organized by the National Institute for Public Health and the Environment (RIVM) in collaboration with the Municipal/Regional Health Services (GGDs) and Statistics Netherlands (CBS). The Health Monitors provide an overview of the health, social situation and lifestyle of the Dutch population. To this end, GGDs collect local, regional and national figures on these aspects every four years in a questionnaire survey. Two datasets were used: the first dataset is based on data from the 2016 Health Monitor for adults and the elderly and with more than 457,000 respondents. The second dataset

concerns the Health Monitor for Adults and the Elderly 2020 from the GGDs, CBS and RIVM. The net sample size for the 2020 data is almost 540,000 people. (Statistics Frans Halsbuurt, 2024)

As mentioned before the health data relate to stress is collected every four year and because of this unfortunately there is no data availability for 2024 year. In this section the analysis of stress is done base of the data arability in the Frans Halsbuurt neighborhood in 2020 within three age categories (18 years old or older, between 18-65 years old, 65 years old or older) (Table 38). The comparison of Moderate, high and very often stress is illustrated in graph (Figure 29).

Table 38 | Mental health of Frans Halsbuurt neighborhood in 2020 (Source: (RIVM health monitor, 2020)

Age	Mental Health	Precent
18 years of age or older	Very often stress in the past 4 weeks	25 %
	High risk of anxiety or depression	28 %
	Moderate risk of anxiety or depression	54 %
18 to 65 years old	Very often stress in the past 4 weeks	27 %
	High risk of anxiety or depression	8 %
	Moderate risk of anxiety or depression	56 %
65 years of age and older	Very often stress in the past 4 weeks	9 %
	High risk of anxiety or depression	5 %
	Moderate risk of anxiety or depression	40 %

Figure 29 | Mental health of Frans Halsbuurt neighborhood in 2020 *(Source: (RIVM health monitor, 2020)*
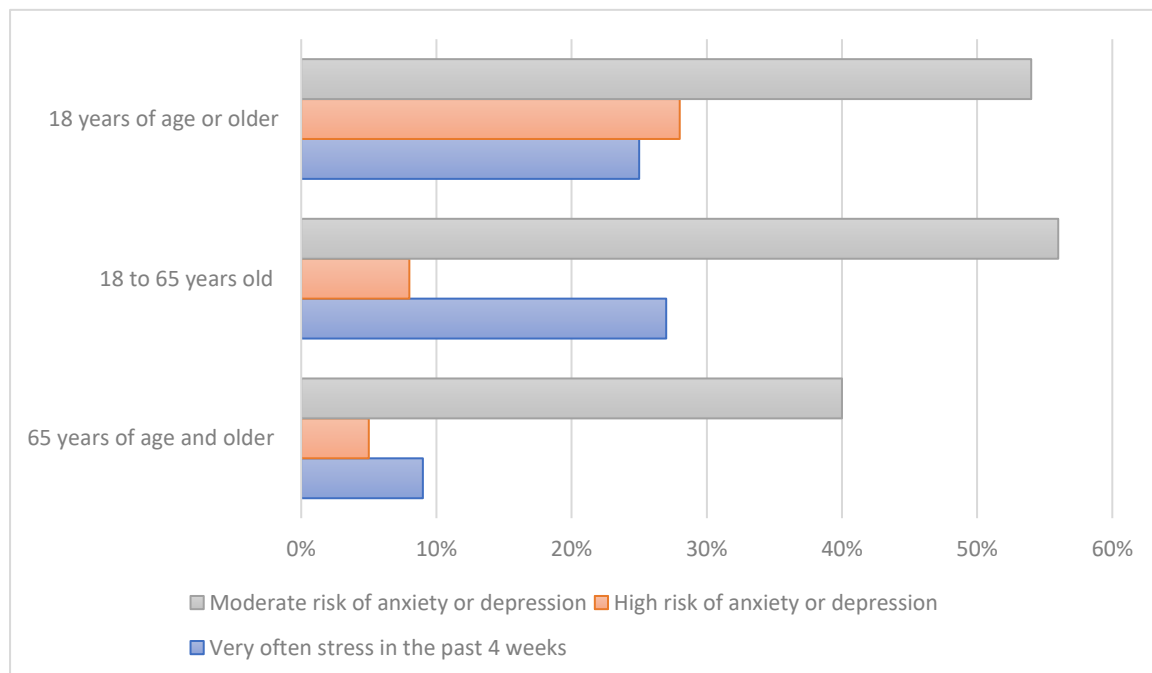
Also, for having more information the data is collected about serious psychological problems between the years of 2016 and 2020 in Frans Halsbuurt neighborhood and compared with Amsterdam city. (Figure 30)

Figure 30 | Percentage of serious psychological problems in Fran Haslbuurt comparing with Amsterdam
(Source: Municipality of Amsterdam Dashboard)
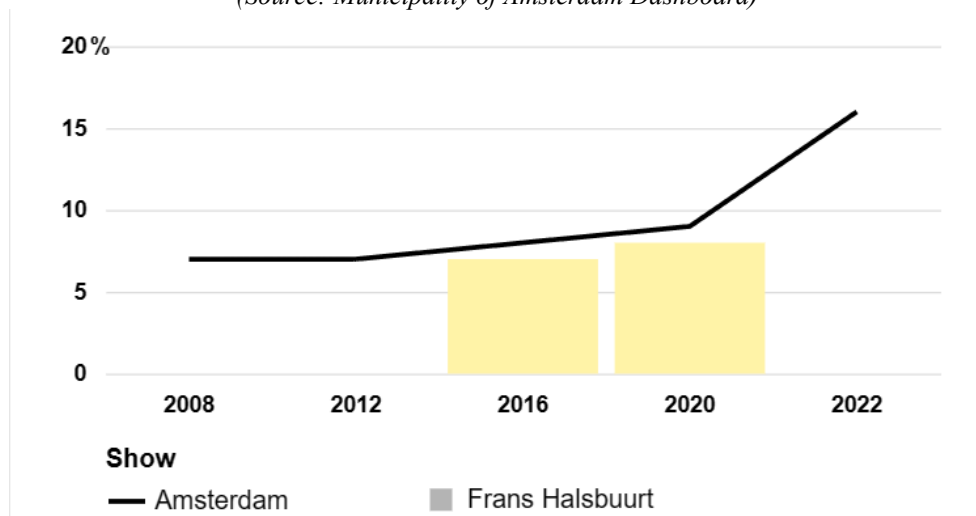
For having a general analysis about stress between 2016 and 2020 years, the research is analyzed the available data about stress in Amsterdam and Netherland. Below the health monitor of population aged 18 and over in 2016 is showed in (Table 39) and the health monitor of people aged 19 and over in 2020 is declared in (Table 40) by comparison between Amsterdam and Netherland.

Table 39 | Health Monitor of 2016 *(Source: RIVM)*

Subject		Netherlands	Amsterdam
Perceived health (good/very good)	%	75,6	75,6
Physical health			
One or more long-term conditions	%	33,9	31,3
Restrictions			
One or more physical disabilities	%	14,8	14,0
High risk of anxiety or depression	%	6,5	7,9
Underweight and overweight			
Degree of overweight			
Severely overweight	%	13,8	11,6
Smoker	%	20,3	26,9
Alcohol consumption			
Complies with alcohol guideline	%	40,0	39,0
Move			
Complies with exercise guideline	%	51,7	59,6
Weekly Exercisers	%	50,7	55,7
Loneliness			
Severe/very severe lonely	%	10,0	12,6
Giving informal care			
Caregiver	%	14,2	9,0
Receiving informal care			
Receiving informal care now (65+)	%	9,9	8,8
Voluntary work	%	29,6	22,1
Elder abuse			
Psychological violence at home	%	4,0	4,7
Noise nuisance			
Serious noise nuisance road < 50 km/h	%	5,5	10,3

Table 40 | Health Monitor of 2020 *(Source: RIVM)*

Subject		Netherlands	Amsterdam
Move			
Complies with exercise guideline	%	50,4	56,9
Perceived health (good/very good)	%	79,1	79,3
Underweight and overweight			
Degree of overweight			
Severely overweight	%	14,7	11,2
Smoke			
Smoker	%	16,7	21,8
Alcohol consumption			
Complies with alcohol guideline	%	43,4	40,5
Physical health			
One or more long-term conditions	%	32,2	28,7
High risk of anxiety or depression	%	6,4	9,0
Stress			
(Very) much stress in the past 4 weeks	%	17,7	22,4
Loneliness			
Severe/very severe lonely	%	11,0	14,6
Giving informal care			
Caregiver	%	13,5	9,4
Voluntary work	%	25,4	17,3
Elder abuse			
Psychological violence at home	%	4,4	5,1
Noise nuisance			
Serious noise nuisance road < 50 km/h	%	6,6	11,1

5.5.6.7. Analyzing Data

In order to evaluating the effectiveness of Frans Halsbuurt's NBS project in decreasing the stress, the data should be collected once before starting the project and once after completing the project. Because of limited data availability, the study couldn't find the sufficient data for Frans Halsbuurt neighborhood in 2024 to compare with 2016th health related indicators and assess the Chronic Stress indicator. But base on the other collected secondary data, the research tried to analyze the Chronic Stress in 2016 to 2020 timeline. On the other hand, findings cause to comparison between Fran Halsbuurt, Amsterdam and Netherland.

Base on the (Table 38) and (Figure 29), it is obvious that the Moderate risk of anxiety or depression is higher than other levels of stress between all age categories in 2020. High risk of anxiety or depression is noticeable in 18 years of age and older category than other age ranges. The factor of very often stress in the past 4 weeks is less in comparison with Moderate and High risk of anxiety factors and exactly in 65 years of age and older category.

(Figure 30) is illustrating the percentage of serious psychological problems in Frans Halsbbuurt neighborhood during the 2016 and 2020 periods comparing with Amsterdam from 2008 till 2022. The slightly increase of serious psychological problems is considerable in Frans Halsbuurt neighborhood between 2016 and 2020 periods. The psychological problems of Frans Halsbuurt in 2016 is almost in a same percentage of 7% with Amsterdam in 2008.

It is clearly evident from graph that the precent of serious psychological problems is steady in same precent of 7 during the 2008 and 2012 years in Amsterdam. Since 2012, the psychological problens rate is slightly increasing from 7% to 9% until 2020. From 2020 to 2022, the psychological problems in Amsterdam increased sharply from 9% to 16%. This rapid increase of psychological problems in Amsterdam during 2020 and 2022 years is exactly in parallel with COVID-19 period. (Yang et al, 2023)

As a result of the COVID-19 pandemic, people worldwide encountered numerous mental health difficulties, underscoring the necessity for fresh community-based psychosocial interventions. The global populace has faced a range of mental health issues due to the COVID-19 pandemic, with widespread long-term ramifications. Throughout the pandemic, over half of the general population experienced a moderate-to-severe impact from the COVID-19 outbreak, and there was 28% global prevalence of depression, 35% for anxiety, and 53% for stress in the general population. Compared to before the COVID-19 pandemic, there was an almost threefold increase in depression and anxiety symptoms during the pandemic. People with existing mental disorders in particular experienced a greater psychological burden due to COVID-19 and had less access to services and support. Mental health professionals have expressed concerns about the long-term effects of COVID-19 on mental health and have recommended the development of new community-based treatments for the public. Additionally, physical activity decreased during the pandemic due to social restrictions, leading to serious long-term physical and mental health issues caused by COVID-19. To tackle the public mental health issue and the lasting effects of the pandemic, sustainable psychosocial interventions are necessary at the community level. (Yang et al, 2023)

In particular, several studies highlight the effectiveness of nature-based activities and green spaces in reducing psychological distress and enhancing well-being through mental restoration. (Yang et al, 2023)

That is right, there is no sufficient data about psychological problems in Frans Halsbuurt during COVID-19 period but base on the available data about Amsterdam the increase of psychological problems is expected also in Frans Halsbuurt neighborhood.

According to (Table 39), the precent of High risk of anxiety or depression is decreased very less in Netherland from 2016 to 2020. But in Amsterdam the High risk of anxiety or depression is increased from 7.9% to 9.0% during 2016 and 2020 years.

Air pollution, noise, and a lack of restorative environments are more profound in cities than in rural areas, a condition that leads to stress symptoms in a significant portion of urban populations. Because urbanization is predicted to double over the next 30 years, stress will most probably increase in city dwellers. Urbanization fragmentation and reduction of urban green spaces is problematic because green spaces reduce stress and increase well-being. (Hedblom et al, 2019)

The control of detrimental exposures such as air quality, ambient air temperature, and noise might contribute to decreasing the prevalence of mental illnesses. If green spaces are effectively incorporated into nature-based solutions, they can mitigate outdoor air pollution. Given that there is proof linking air pollution to an increased risk of mental disorders, it is reasonable to support this hypothetical pathway. (Kabisch, 2023)

According to the recorded noise and air pollution because of plenty number of cars in Fran Halsbuurt neighborhood before starting the NBS project and also base on the studied papers which mentioned above, another reason for growing of psychological problems in Frans Halsbuurt can be a noise and air pollution. The solution of eliminating the car parking lots base on Fran Halsbuurt's NBS project, from one side can have positive effect on decreasing stress level because of decreasing the noise and air pollution. From other side people who living in neighborhood may have a problem with finding a place to park their car or having a problem with price of Albert Cuyp underground parking area which can affect the stress level negatively in Fran Halsbuurt neighborhood.

The health and well-being of city dwellers are greatly impacted by the urban surroundings. Urban green spaces are intended to enhance the health and well-being of city residents by providing ecosystem services. Nature-based solutions can contribute to a range of positive psychological and physiological outcomes. Studies have shown the positive effects of urban green spaces on urban residents through psychological relaxation and stress relief and enhanced opportunities for physical activity. Researches have also found that being close to urban green spaces and having a view of greenery can have positive effects on health. In addition, it has been suggested that these factors are associated with reduced depression and improved mental well-being. (EKLIPSE, 2017)

Increased presence of greenery in the area was associated with reduced levels of depression, anxiety, and stress. Additionally, engaging in leisure activities (such as strolling in parks compared to urban settings and gardening) for mental restoration and relaxation in natural green spaces has been extensively researched and indicates significant mental health benefits from nature experiences. (European Commission, 2021)

Modern urban life style is associated with chronic stress, insufficient physical activity and exposure to anthropogenic environmental hazards. Urban green space, such as parks, playgrounds, and residential greenery, can promote mental and physical health and reduce morbidity and mortality in urban residents by providing psycho logical relaxation and stress alleviation, stimulating social cohesion, supporting physical activity, and reducing exposure to air pollutants, noise and excessive heat.

The evidence supporting the positive impact of nature and green spaces on mental restoration and relaxation is well-documented. Research suggests that exposure to nature, such as having views of green spaces, can positively influence individuals with high stress levels by shifting them towards a more positive emotional state. Additionally, it has been noted that stimuli in natural environments can help restore a sense of well-being in individuals experiencing mental fatigue. There is significant evidence supporting the potential advantages of interacting with nature in preventing health issues linked to chronic stress and attentional exhaustion. However, they also highlighted that previous research primarily showcased temporary rejuvenating effects of occasional nature encounters. (Kabisch, 2017)

There is a growing body of research across various fields indicating that natural environments can have positive impacts on human health. Natural environments, defined as areas relatively unaffected or undisturbed by human activities, encompass a wide range of landscapes, from remote wilderness areas visited by humans for short periods, to areas shaped, manipulated, or altered by human interventions. Such areas typically include parks, green spaces, gardens, and waterfront locations. There are various ways in which contact with nature may contribute to improved health, such as through better air quality, increased physical activity, stronger social connections, and enhanced quality of life. (Ewert, 2018)

Maas et al. (2009) examined large-scale representative medical record data in the Netherlands and found reductions in the annual prevalence rates of depression and anxiety disorder related to an increasing proportion of green spaces in people's living environments.

Above all, it is challenging to say that the level of Chronic Stress will decrease or not after completing NBS project in Frans Halsbuurt exactly with limited time and data availability. In comparison with positive and negative effects NBS in Chronic Stress, health and wellbeing, for sure positive effects will weigh more base on collected secondary data and studied papers.

5.6. Conclusion

In this part, we summarized the assessments of KPIs in one table. Below (Table 41) shows all 6 KPIs and the method which opted to evaluate each indicator.

Table 41 | Assessment of KPIs

No.	Indicator	Method	Evaluation	Result of Assessment
1	Population Density	Number / km²	Evaluated	There is no direct linkage between Density of people and NBS projects. Overall, if NBS implement in densely populated areas that can impact more people. In other words, more people can benefit from NBS when the NBS implement in high population density areas.
		Number / ha	-------	
2	Access to Public Amenities	% of people	-------	This indicator before the beginning of this project was suitable but also, we can't neglect the positive effect of this project on improvement of public amenities accessibility although we couldn't assess the access to public amenities indicator in detail.
		Likert Scale	Evaluated	
3	Cultural Value blue-green spaces	Number of cultural events / Number of people (Applied methods)	There is lack of data for evaluation.	There is lack of data for evaluation.
		Number of cultural events / Number of people (Remote sensing)		
4	Openness of Participatory Process	Number (1-5)	Evaluated	Openness of participatory process evaluation base on these 16 participatory meetings is calculated 62 point which is located between Min. 0 and Max. 80 points. This means that participatory process in Frans Halsbuurt's redevelopment project is openness which is more than mean.
		% of people involved	-------	

5	Access to Housing	The % of gross household income spent on housing	Lack of data	Overall, based on limited time and available data, it is not possible to calculate the accurate affordability of housing indicator in Frans Halsbuurt neighborhood. According to analysis is done base on collected data, there is no obvious positive or negative effect of Frans Hasbuurt NBS project on Affordability of Housing indicator and maybe it is early to talk about effectiveness of Frans Halsbuurt NBS project on Affordability of Housing indicator before completion of all project phases.
		% of population living in affordable housing	Evaluated	
		Development of housing prices (% of change or % of €/m²)	Evaluated	
		Housing cost overburden rate (%)	-------	
6	Stress Reduction	Level of Chronic Stress (Number (0-4))	-------	Above all, it is challenging to say that the level of Chronic Stress will decrease or not after completing NBS project in Frans Halsbuurt exactly with limited time and data availability. In comparison with positive and negative effects NBS in Chronic Stress, health and wellbeing, for sure positive effects will weigh more base on collected secondary data and studied papers.
		Prevalence of Chronic Stress (%)	-------	
		Incidence of Chronic Stress (% per year)	Evaluated	

Annex 1:

			Selected Indicators with related units and metrics
No.	**Indicators**	**Unite of measure**	**Metric**
01	Population Density	Number / Km2 (Source:Unalab (CITYkeys))	Number of people per km2
		Number / ha (Source: Unalab (MAES-urban))	Number of inhabitants per ha
02	Urban Sprawl	% (Source:Unalab (MAES-urban))	Percent of built-up area
		Open space / built form (Source:Unalab (EKLIPSE))	Ratio of urban open space to build form. Open spaces are spaces undeveloped and accessible to the public (EPA). Area of open space divided by built area. Level of aggregation: city or neighborhood.
		Number (Source:Unalab (SDG 11 indicator 11.3.1))	Ratio of land consumption rate to population growth rate.
		Number (Source:Unalab (Arribas-Bel (2011)))	Decentralization. Proportion of the population living outside the city core. Calculate as (PopR-PopC)/PopC, where PopC = population living in the core of the city and PopR = population living outside city core, using census data. Level of aggregation: city.
03	Recreational value of blue-green space	Number (Source: Connecting Nature, EU)	This indicator represents a quantification of the number of visitors/recreational activities within a greenspace or blue-green space in order to evaluate, or measure an increase in, recreational benefits as a result of NbS. Examples of features and activities that can attract visitors to NbS include features such as large trees, benches, education days, and communication zones for picnicking. Examples of characteristics used to measure blue-green space attractiveness in the Sugiyama et al. (2010) and Kimpton (2017) studies include: Presence of walking paths - Shade, water features - Irrigated lawn - Lighting - Birdlife - Type of surrounding roads - Being adjacent to a beach or river - BBQ & Tables - Buildings - Dog Enclosure - Place Managers (e.g. kiosk operators) - Formal Sport Features - Informal Sport Features - Playground Features - Public Transport Stop - Seating
04	Access to public amenities	Likert scale (Source: EU, Connecting Nature, Unalab(CITYkeys))	The extent to which public amenities are available within 500 m
		% of People (Source: EU, Connecting Nature, Unalab (CITYkeys))	Share of population with access to at least one type of public amenity within 500 m
05	Land devoted to roads	% (Source: Unalab (EKLIPSE))	Change in the percentage of NBS project area occupied by roads
		% (Source: Unalab (EKLIPSE))	Percentage of city surface occupied by roads

06	Place identity and sense of belonging	(Source: EU)	Jorgensen and Stedman (2001): • SOP is an individual's favorable or unfavorable attitude toward spatially demarcated object. SOP can be inferred from responses of a cognitive, affective or conative nature. • Place identity can be regarded as an individual's cognitions, beliefs, perceptions or thoughts that the self is invested in a particular spatial setting. • Place attachment can be defined in terms of an individual's affective or emotional connection to a spatial setting. • Place dependence can be considered as the perceived behavioral advantage of a spatial setting relative to other settings.
07	Reclamation of contaminated land: percentage of contaminated area reclaimed	% (Source: Unalab (EKLIPSE))	Percentage of contaminated area reclaimed through implementation of NBS project
		Area % (Source: Unalab (Kabisch et al., 2016))	Regeneration of derelict areas & brownfield sites
08	Cultural Value	Number / 100 000 (Source: Unalab (EKLIPSE))	Number of cultural events, people involved, or children in educational activities (Kabisch and Haase, 2014)
09	Openness of participatory process	- (Source: Unalab (EKLIPSE))	Openness of NBS project participatory processess (Frantzeskaki and Kabisch, 2016; Luyet et al., 2012; Uittenbroek et al., 2013)
		% (Total number of open public participation processes / (population of city / 100000)) * 100 (Source: EU, Unalab (Bosch et al., 2017))	The proportion of public participation processes in a given municipality per 100 000 residents per year (expressed as %). Public participation in NBS projects encompasses a wide range of different opportunities for citizens, nongovernmental organizations, businesses, and other stakeholders co-create, co-implement and co-manage NBS, concomitantly creating a sense of ownership. The integral role of citizens and other stakeholders in NBS projects can influence the openness of other processes managed by the municipality. Increasing the openness of processes such as policy planning and implementation strengthens the connections between government agencies and the public they serve. This metric provides an indication of the alignment between citizens need and desires and the decision-making processes in a municipality. In addition, citizen and other stakeholder involvement in NBS planning and implementation can be qualitatively evaluated using separate Likert scales to assess community involvement.
10	Impact on social learning	- (Source: Unalab (EKLIPSE))	Social learning concerning urban ecosystems and their functions/services (Colding and Barthel, 2013)
11	Safety (e.g., criminal reports in the area) or perceptions of safety	- (Source: EU (Naturvation))	Perception of safety is related to public and community safety and measures citizens' fear of crime and harassment in public green spaces (e.g., parks, urban forests). For certain cases, perception of safety can report proportions of the population or a proportion of a study sample who feel safe "walking alone after dark", or measure the perception of safety or threat in a neighbourhood or in public parks.

12	Access to housing	- (Source: Unalab (EKLIPSE))	Affordability and choice
13	Cognitive aspects: indicators of trust, attachment to neighborhood, practical help, tolerance, and respect	- (Source: Unalab (EKLIPSE))	
14	Citizen access to public transport	Likert scale (Source:Unalab(CITYkeys))	The extent to which public transport is available within 500 m
		- (Source: Unalab (EKLIPSE))	Public transport links: walking distance to nearest facilities
15	Stress reduction	- (Source: Unalab (EKLIPSE))	Reduction in chronic stress and stress-related diseases measured through repeated salivary cortisol sampling (Roe et al., 2013; Ward Thompson et al., 2012) and hair cortisol (Honold et al., 2016); use cortisol slope and average cortisol levels as an indicator of chronic stress.
		Perceived stress on a scale from 0 (low stress) to 4 (high stress) (Source: EU (ProGIreg))	This is an indicator of the level of psychological stress experienced by the participants based on a validated questionnaire. Stress reduction is one of the well-established mechanisms underlying the health benefits of the green spaces. However, evidence from natural experiments is lacking.
16	Cardiovascular diseases	- (Source: EU (Connecting to Nature))	Cardiovascular Diseases (CVD) generally refers to conditions that involve narrowed or blocked blood vessels that can lead to a heart attack, chest pain (angina) or stroke (Heart Disease, n.d.). They include: high blood pressure, hypertension, arrhythmias (abnormal heart rhythms), heart failure, heart valve disease, cardiomyopathy (heart muscle disease), vascular disease (blood vessel disease).
		Number (Source: Unalab (EKLIPSE))	Reduced number of cardiovascular morbidity and mortality events (Tamosiunas et al., 2014).
17	Carbon storage and sequestration in vegetation and soil	Total carbon removed or stored (tonnes/ha/y or similar units). To evaluate C removal or storage per unit area per unit time: FCS=(FIA rate/ FOREST mean-pct) * NONF mean-pct,i * NONF area,i (source: EU (Unalab))	Accounting for C stored in soil and vegetation in an urban area can indicate the condition of natural green spaces, total free surface area and total quantity of vegetation in the area examined. Measures of C storage and sequestration also provide a tangible connection to climate change mitigation, and the impacts of local land use, planning and management decision-making. It is important to note the substantial variation in C sequestration and storage capacity of different types of NBS.
18	Leaf area index	- NBS analysis of an area and calculation (eg with GREENPASS® system and tools) - Numerical value in m2 (Source: EU (Nature4Cities))	The LA (Leaf Area) is a Key Performance Indicator of the GREENPASS® system. It expresses the sum of leaf area of NBS within project area. The Leaf Area is the operating surface of NBS and therefore, decisive for climate regulation, carbon storage and air purification.

19	Air temperature	°C (Source: EU (Connecting to Nature))	Measurement of the cooling effect of NBS by evapotranspiration and/or shading using applied methods
20	Nonspatial indicators of shares: share of emissions (air pollutants) captured/ sequestered by vegetation	(Source: Unalab, EU)	Vegetation can remove air pollutants (particles and gases) by the process of dry deposition. Deposition is the transport from a point in the air to a plant surface, which is mainly related to near-surface pollutant concentration, weather conditions and vegetation properties. Most plants have a large surface area per unit volume, increasing the probability of deposition compared with the smooth, manufactured surfaces present in urban areas.
21	Energy Savings	kWh/y (Source: Unalab (EKLIPSE))	Reduction in energy usage from reduced building energy consumption
		- (Source: EU (URBAN GreenUP))	Green Infrastructure can play a role in reducing the negative impacts of the energy sector, by: (1) reducing energy consumption; (2) providing bioenergy; and (3) providing carbon uptake and storage. The KPI presented aims at quantifying both the energy savings and the bioenergy generated by all the NBS implemented in Valladolid. This KPI will be calculated converting into energy savings the benefits already considered by means of other KPIs. Therefore, in this KPI, all the NBS that provide an ecosystem service which has a direct link to an energy saving or the ones that generate electricity themselves will be considered.
22	Reduced energy demand for heating and cooling	- (Source: Connecting to Nature (EKLIPSE))	The use of vegetation/wetlands in urban areas to reduce peak air temperatures with the objective of reducing energy demand for cooling. In particular, the implementation of green roofs can help decrease the use of energy for cooling and heating buildings by between 20% and 25%, depending on the construction materials used and whether or not green roofing is being used (Leal Filho et al., 2017; Sahnoune and Benhassine, 2017; Susca et al., 2011).
23	Annual amount of pollutants captured and removed by vegetation	t / year (Source: Unalab (EKLIPSE))	Annual amount of pollutants captured by vegetation (Bottalico et al., 2016)
		% (Source: Unalab (EKLIPSE))	Proportion of emissions (air pollutants) captured/sequestered by vegetation (Baró et al., 2014)
24	Flood peak reduction	% (Source: Unalab (EKLIPSE))	Reduction in absolute height of peak floodwaters (Iacob et al., 2014)

		- (Source: EU (Connecting to Nature))	Assessment of co-benefits/dis-benefits of different SuDS options - in relation to peak flow reduction (e.g., % reduction in absolute height of peak floodwaters) and/or delay (e.g,. increase in time to flood peak in hours). NBS can help tackle flood risk, for instance by increasing infiltration and evapotranspiration. Changing precipitation patterns due to climate change are expected to exacerbate flooding problems, for instance more intense rainfall events that exceed existing sewage system capacity. Applied approaches to flood peak reduction/delay include monitoring of SuDS performance using in-situ gauges. Typically, a weather station or weather radar data is used in combination with flowrate or water depth monitoring devices (e.g., datalogging v notch weirs, tipping bucket rain gauges, in-line turbine flowmeters, depth sensors, soil moisture sensors, and infiltrometers). The weather data is used to calculate total rainfall entering the study area (e.g., rainfall depth/unit time x catchment area). Monitoring devices are then used to calculate the rate that water enters and/or leaves a nature-based solution feature. If compared to a control feature (without nature-based solution) or a baseline calculated for the site before the nature-based solution was installed, it is possible to calculate the percentage reduction in absolute height of peak floodwaters and the delay to peak flow
25	Water quality	To be defiend (Source: Unalab)	SUGGESTED PARAMETERS AS APPROPRIATE BASED ON LOCAL CONDITIONS: pH; oxidative-reductive potential (ORP) or dissolved O2 (DO); electrical conductivity (EC); turbidity, as indicator of total suspended solids (TSS); nitrate (NO3-); phosphate (PO43-); chemical oxygen demand (COD); 5-day biological oxygen demand (BOD5); total coliform bacteria by membrane filtration or MPN. Suggest monitoring/measurement of WQ parameters only as appropriate, e.g. option to not measure parameter(s) that are not applicable or not affected by NBS implementation. TF2.0 TO REVIEW WFD CHEMICAL PARAMETERS
		-(Source: EU (PHUSICOS))	Indicators of Effects on Water Quality sub-criterion will assess the effects of project scenarios on water quality, in terms of physical, microbiological, biological and chemical parameters. Physical parameters of water, together with chemical and microbiological properties, determine the water quality. Main quality characteristics of natural waters include temperature; colour; taste and odour; turbidity; total solids; conductivity; pH, and dissolved oxygen. All of these must be evaluated to obtain a comprehensive assessment of the water quality of the waterbodies.
		-(Source: EU (Connecting to Nature))	Run-off water in cities represents a threat to water quality by conveying high pollutant loads into receiving water bodies and ground water aquifers. NBS can help manage and improve urban water quality through settlement, filtration, bioretention and phytoremediation. Emerging techniques using remote sensing technology includes using high resolution satellite or airborne optical imagery (visible and infrared), DSM (Digital Surface Model) height information and existing building out-lines maps (footprints) to estimate the percentage of vegetated areas on building roofs and to identify potential green roof sites, providing municipalities with the opportunity to use this data for urban planning decisions in the field of climate modelling, drainage system calculation and biodiversity networks.

			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.
26	Ground water quality	% (Source: Unalab)	Proportion of groundwater resources contaminated by nutrients, metals/metalloids, organic compounds or other pollutants.
		% (Source: Unalab (EKLIPSE))	Reduction in water pollutant content, i.e. nutrients, metals/metalloids, organic compounds
27	Water exploitation index	% of m3. WEI= (Volume of water abstraction / Volume of renewable freshwater resources) * 100 (Source: Unalab (CITYkeys))	Annual total water abstraction as a percentage of available long-term freshwater resources in the geographically relevant area (basin) from which the city gets its water
28	Water consumption	Litres / capita / year (Source: Unalab (CITYkeys))	Total water consumption per capita per day
		% in m3 (Source: Unalab (CITYkeys))	Percentage reduction in water consumption brought about by the project
29	Green space accessibility	- (Source: EU (RECONECT))	Proportion of the population living within a 300 m maximum linear distance to the boundary of urban green spaces of at least 0.5 ha in size. Green space accessibility is an important metric to evaluate the potential for the realisation of recreational opportunities and related co-benefits. Accessibility of green space can also be used to evaluate the relative success of urban greening policies focused on the provision of and equal access to urban green spaces, and to assess NBS co-benefits as a function of distance from accessible public green space.

		Distance or Time (Source: Unalab)	Accessibility (measured as distance or time) of urban green spaces. One way to estimate the impacts of urban green space is to evaluate green space accessibility. As one of the indicators in EEA's Interactive map for Green infrastructure indicators, effective green infrastructure is presented. EEA defines effective green infrastructure as a potential distribution of green infrastructure element in the territory or in the neighbouring area.
		% (Source: Unalab (Adapted from CITYkeys))	(Increase in) urban green space OR public open space within 500 m. Public open spaces are spaces undeveloped and accessible to the public (EPA). Open space within 500m or (open space within 500 after the project divided by open space within 500 before the project)*100. A proxy could be the area of residential area within a buffer of 500 m around open spaces. Level of aggregation: city of neighbourhood.
		%. = 100 * (Population with convenient access / City population). (Source: Unalab (SDG 11 indicator 11.2.1))	Increase in the proportion of population that has convenient access to a public green space / blue green space. Can be disaggregated by sex, age and persons with disabilities. Identify population served by distance or travel time from public green space / blue-green space, overlying service area with socio-demographic data. Population with access to public green space / blue-green space (in %):
		Number or %. (Source: Unalab (MAES-urban))	Accessibility to public parks, gardens and playgrounds (more than 50 ha) (inhabitants within 10 km from a park)
		Number or %. (Source: Unalab (MAES-urban))	Accessibility to public parks, gardens and playgrounds (between 10 and 50 ha) (inhabitants within 1 km from a park)
		Number or %. (Source: Unalab (MAES-urban))	Accessibility to public parks, gardens and playgrounds (between 2,5 and 10 ha) (inhabitants within 10 km 500 m from a park)
		Number or %. (Source: Unalab (MAES-urban))	Accessibility to public parks, gardens and playgrounds (between 0,75 and 2,5 ha, or smaller but important green spaces) (inhabitants within 250 m from a park)
30	Recreational (number of visitors, number of recreational activities)	% or Number / 100 000. (Source: Unalab (EKLIPSE)	Change in the number of visitors, or number of recreational activities in the area affected by NBS project (Kabisch and Haase, 2014)
		Number / 100 000 (Source: Unalab (EKLIPSE))	Number of visitors, or number of recreational activities (Kabisch and Haase, 2014)
31	Community garden area/child capita and in a defined distance	- (Source: Connecting to Nature (EKLIPSE))	A measure of per child capita garden area per target distance - public community gardens provide places of active learning in nature and opportunities for healthy play. Measuring community gardens as part of the greenspace network in cities provides evidence on a wide range of services provided by such spaces. This includes: accessible greenspace provision and preservation, diversity of land use for humans and biodiversity, sustainable use of vacant land, climate regulation (cooling, stormwater, reduced GHG emissions associated with food transportation), food security, physical activity, access to healthy food/fruit and vegetable consumption, community cohesion and empowerment.

32	Distribution of public green spaces	-(Source: EU, Connecting to Nature (EKLIPSE))	Measure of the distribution of public greenspace (total surface or per capita) and categories (i.e. street trees, residential gardens, school green areas, parks) using more applied and participatory approaches as an index to increase quality/quantity of green/blue existing, restored and new NBS with a high degree of multifunctionality (informed by ES Valuation e.g. includes cultural ES value, needs of residents, socio-economics etc) and adapted to the type of urban area (e.g. size of urban area/landscape structure). Public greenspace in cities contributes to quality of life in terms of environmental services and social and psychological services. Public greenspace distribution can therefore be an important factor for making a city sustainable. Decisions on where to create greenspace/NBS should be based on criteria related to maximising the equitability of distribution, focusing on areas lacking greenspace and in areas where ES valuation identifies greatest benefit/need.
		Total surface, Per capita. M2 per capita (Source: Unalab)	Distribution of public green space expressed as a proportion of total urban surface area or per capita. Multiple studies have documented the positive impact on quality of life that is derived from accessible urban green spaces, including parks, street trees, school green areas, public institutions' gardens, residential gardens, cemeteries, sportsgrounds, squares, urban forests, green spaces of the industrial and commercial production, green roofs, vertical gardens, arable lands, vacant lands, and greenhouses (e.g., Badiu et al., 2016). It is important that within cities, the urban green spaces are equally distributed. The European Environment Agency defines the distribution of green urban areas as the relationship between green area boundaries (edges) and all the other elements in the city. With unequal distribution of urban green areas, benefits are focused on fewer city elements (neighbourhoods, streets, buildings or houses) and it also prevents connectivity of all the available green spaces in the ecological network. (EEA network.)
33	Area of green space	m2	
34	Land-use intensity	m2 / person. (Source: Connecting to Nature)	Measure of artificial area per inhabitant (m2/person) - implement nature-based solutions to minimise artificial areas. The land take assessment produced by the European Environment Agency (2017) for 2006–2012 reports that "based on the average for the EU-28, 52% of all areas that changed to artificial surfaces were arable land or permanent crops in 2006". This means that several land cover types change to impervious cover, which in turn compromises the provision of important services provided by vegetation and soils, namely the storage and filtering of water, and the transformation of nutrients and contaminants —a direct call for the phenomenon to be monitored at proper spatial and temporal scales (European Environment Agency, 2017)

		m2 / person. (Source: Unalab (MAES-urban))	Land annually taken up for built-up areas per person
		Number / km2. (Source:Unalab (EEA (2006), Kasanko (2006), Sidentop and Fina (2010)))	Residential density: population density in residential area. Number of residents divided by their residential area based upon population (census) and land use data. Level of aggregation: residential area.
		%. (Source: Unalab (MAES-urban))	Proportion of urban green space
		%. (Source: Unalab (MAES-urban; Yuan & Bauer))	Proportion of impervious surface area. Indicator for flooding (reduced water infiltration), urban sprawl (relates to change in land use) and urban heating (impervious surfaces increase the surface temperatures,especially asphalt). Area of impervious surfaces divided by the total urban area based on land use data. Level of aggregation: city or neighbourhood.
		%. (Source: Unalab (EEA (2006))	Percent of built-up area to describe urban sprawl pattern. Built up area divided by total urban area, based on land use data. Level of aggregation: city of neighbourhood.
		%. (Source: Unalab (EEA (2006))	Share of low/dense residential areas. Describe the residential patterns of the area: Low density areas are areas with less than 80% of built-up areas (buildings, roads and other structures). Calculate as Dense (low density) area / Total residential areas using land use data with dense and low density areas specified. Level of aggregation: city.
		Patches/km², patches/ inhabitants. (Source: Unalab (Arribas-Bel (2011)))	Scattering Index. Differentiate urban sprawl from compact urban expansion: characterize how are urban patches dispersed in the landscape. Patches = urban areas laying less than 200m apart. Measure as Number of patches / Total area or Number of patches / number of inhabitants using land use data with the urban patches delimited. Level of aggregation: city.
		%. (Source: Unalab (MAES-urban))	Proportion of natural area
		%. (Source: Unalab (MAES-urban))	Proportion of protected area
		Km2 or ha. (Source: Unalab (MAES-urban, Johnson (2001))	Loss of environmentally fragile land: environmentally fragile land lost due to urban sprawl, based on land use data. In the context of NBS it can be rather a "gain" in environmental fragile lands, since new ecological spaces will be added to the landscape. Level of aggregation: city or neighbourhood.
		%. (Source: Unalab (MAES-urban))	Proportion of agricultural area
		%. (Source: Unalab (MAES-urban))	Proportion of abandoned area
35	Local food production	% of tonnes. (Source: Unalab (CITYkeys))	A share of food consumption produced within a 100 km radius.

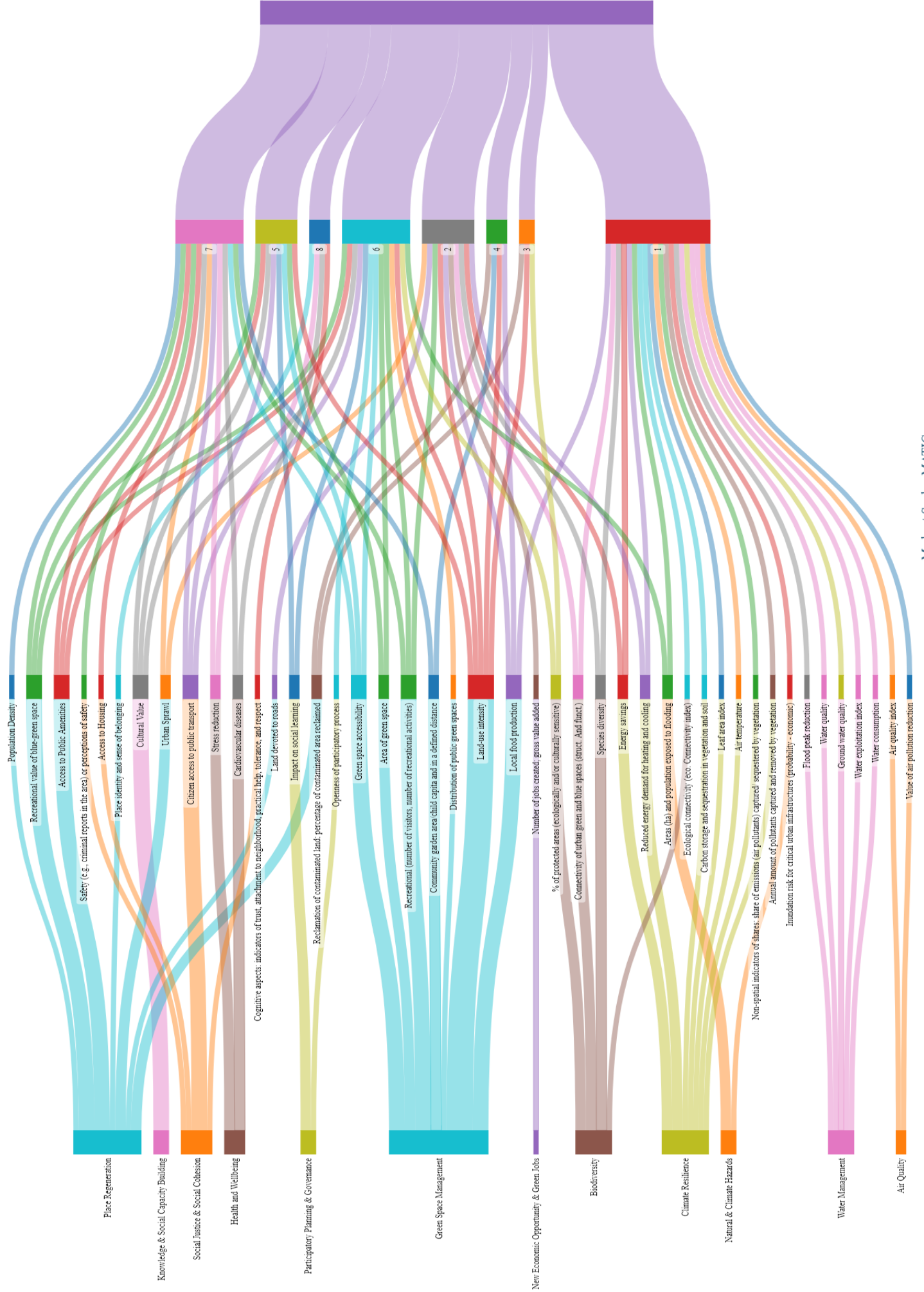| 36	Connectivity of urban green and blue spaces (struct. And funct.)	- (Source: EU, Connecting to Nature (EKLIPSE))	A more applied and participatory focus to measuring the potential for green or blue areas to amplify the connectivity and multifunctionality of other urban green/blue areas. Connectivity of landscapes can be evaluated in terms of: • Structural connectivity – relating to the spatial configuration of patches, without considering the movement of individual organisms among these patches (Ioja et al. 2014) and • Functional connectivity – relating to the ability of organisms to move among patches (Tischendorf and Fahrig 2000).
		%. (Source: Unalab (MAES-urban))	Connectivity of green infrastructure
		Mesh density per pixel. (Source: Unalab (MAES-urban))	Fragmentation of green infrastructure
		Mesh density per pixel. (Source: Unalab (MAES-urban))	Fragmentation by artificial areas
37	Species diversity	- (Source: Connecting to Nature)	Changes in overall number of species/species diversity/biodiversity indices within area affected by NBS using more applied/participatory methods. Population counts for species or groups of species can provide an intuitive biodiversity metric which also has public resonance and the data can be used to populate indicators and measure progress towards conservation policy targets. Whilst survey of individual target conservation species and/or umbrella species can be of value in relation to specific conservation objectives, quantification of biodiversity indices can also have value in providing a more holistic insight into overall biodiversity and greater representation of a range of taxa (Buckland et al. 2005).
		Number per unit area (Number / ha). (Source: Unalab (MAES-urban))	Number and abundance of, e.g., species of birds (#/ha)
		Number. (Source: Unalab (MAES-urban))	Number of different (e.g. lichen) species
38	% of protected areas (ecologically and/or culturally sensitive)	Proportion (%) of a designated area (e.g., Formal Urban Area) belonging to Natura 2000 network per grid cell. (Source: EU (Connecting to Nature))	There are a range of restrictions to agricultural and forestry related activities within these areas which contribute to foster the development and recovery of rare species. Proportion of a specific area (typically a Formal Urban Area) which fall under special protection by the Natura 2000 directive, and this includes a variety of different biodiversity rich and sensitive habitats. This represents a proxy measure for the contribution that an area is making to biodiversity conservation strategies.
39	Ecological connectivity (eco. Connectivity index)	Number. (Source: Unalab (EKLIPSE, Ioja et al (2014)))	Dispersion of natural patches that influence the movement of species between habitats, useful for comparison. Calculate using the Proximity index (PROX) of the FRAGSTATS software. Need land use data with natural patches delimited.

40	Air quality index	Index. (Source: Unalab (CITYkeys))	Annual concentration of relevant atmospheric pollutants
		- (Source: EU (URBAN GreenUP))	The European Air Quality Index allows users to understand more about air quality where they live, work or travel. Displaying up-to-date information for Europe, users can gain insights into the air quality in individual countries, regions and cities. The Index is based on concentration values for up to five key pollutants, including: ☐ Particulate matter (PM10); ☐ Fine particulate matter (PM2.5); ☐ Ozone (O3); ☐ Nitrogen dioxide (NO2); ☐ Sulphur dioxide (SO2). The air quality index is not a tool for checking compliance with air quality standards and cannot be used for this purpose.
41	Value of air pollution reduction	€. (Source: Unalab (EKLIPSE))	Value of improved air quality. Value of air pollution reduction by implemented NBS (Manes et al., 2016)
42	Areas (ha) and population exposed to flooding	- (Source: EU (URBAN GreenUP))	This KPI can evaluate the increasing on green areas and its relation with the flooding risks. This indicator has been mainly defined for a floodable park but it could also be applied to scale the impact of other types of NBS on areas and population exposed to flooding. The areas and population exposed to flooding will be compared before and after the installation of the NBS to know if the intervention has influence in mitigating effects from flood risks.
		% / area. (Source: Unalab (MAES-urban))	Flood protection by appropriate land coverag. (Population exposed to flood risk).
		ha. (Source: Unalab (MAES-urban))	Flood protection by appropriate land coverag. (Areas exposed to flooding).
43	Inundation risk for critical urban infrastructures (probability - economic)	- (Source: EU (Connecting to Nature))	Probability of a reduction of inundation risk for critical urban infrastructures based on more applied and participatory hydraulic modelling and GIS assessment. Metrics are based on the quantification of infrastructure that has a reduced risk of flooding due to NBS implementation. Ultimately, this relates to a reduced economic cost of flooding, or increased health & wellbeing of communities due to reduced stress levels associated with flooding or risk of flooding. It should be noted that, if NBS is poorly designed or well-designed but poorly constructed, it has the potential to lead to increased local flooding risk for some areas.
		Probability. (Sources: Unalab (EKLIPSE))	Inundation risk for critical urban infrastructure (Pregnolato et al., 2016)
44	Number of jobs created; gross value added	Number. (Source: Unalab (EKLIPSE))	Number of jobs created by the project
		Number. (Source: Unalab (EKLIPSE))	Number of jobs created (Forestry Commission, 2005)
		€ / capita. (Source: Unalab (EKLIPSE))	Gross value added (Forestry Commission, 2005)

| | | | | The impact assessment of the implementation of NBS in terms of new business creation and improvement on business rates. This KPI, related to economic aspects measurements, evaluates how NBS interventions can increase the attraction of businesses, or how to increase the value of the existing ones. This value, evaluated through the measurements of number of new business created and the percentage of the gross value added, will reflect the economic opportunities and potential of NBS solutions. |
| | | - (Source: EU (URBAN GreenUP)) | | - Number of business created (direct value buss related NBS by zone) Direct value on business created by zone NBS affected, before and after implementation, during the established period. Number of business created= n * Z [(nº business) (€/m2)] Where n is referring to the number of business and Z to its increased value (NBS related by zone), during the established period of implementation (directly related to the each particular NBS) - Gross value added (GVA) Defined as the difference between the value of goods and services produced and the cost of raw materials and other non-labour inputs, which are used up in production. The research should conclude what is the total contribution of NBS in % of the total GVA to the region/area economy in Euro/ by year. |

Annex 2:

Connection of indicators to Justice

Integrating Justice in NBS

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Chapter 6

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