

## URBREATH [101139711]

**Systemic Integration of Transformative Technical and Nature-based Solutions to Improve Climate Neutrality of European Cities and Regions and tackle Climate Change: the URBreath Approach**



### D2.5 URBREATH platform requirements

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<b>Document description</b>	This document has three aims. First, it provides information about personas that served to guide the co-definition of customer journeys and service blueprints, as well as the latter and the main findings from their analysis. Second, it reports the requirements of the URBREATH Toolbox derived from those findings. Finally, it describes the initial logical architecture of the URBREATH Toolbox and explains its logical components and how they are organised within the architecture.

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## Disclaimer

The URBREATH project is co-funded by the European Union under grant agreement ID 101139711. The information and views set out in this document are those of the URBREATH Consortium only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

## Executive Summary

The objective of the URBREATH project is to enhance climate neutrality in European cities through the adoption of Nature Based Solutions (NBS), and tools that can support Municipalities in their management, through their entire life cycle (e.g. identification of problems and needs, design of potential solutions, their comparison, monitoring of implementation phase and evaluation of generated impact). For this purpose, the project aims to provide the "URBREATH Toolbox", a comprehensive technological framework to support municipalities in managing, implementing, and evaluating NBS interventions.

This document reports the requirements on which the initial design of the logical architecture of the URBREATH Toolbox is based. These requirements have been derived from key findings identified from customer journeys and service blueprints, co-created with all the nine cities involved in the project during dedicated workshops.

Key findings include needs concerning data management capabilities, advanced data visualization and analysis, and solutions to foster the participation of stakeholders in the planning of NBSs.

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## List of Terms and Abbreviations

Abbreviation	Definition
AI	Artificial Intelligence
API	Application Programming Interface
BAF	Biotope Area Factor
DCAT	Data Catalog Vocabulary
DoA	Description of Action
DS <sub>4</sub> SSCC	European data space for smart communities
DSSC	Data Spaces Support Centre
DT	Digital Twin
ETL	Extract, Transform, Load
ETSI	European Telecommunications Standards Institute

GML	Geography Markup Language
IDSA	International Data Spaces Association
INSIPRE	Infrastructure for Spatial Information in Europe
KML	Keyhole Markup Language
KPI	Key Performance Indicator
LDT	Local Digital Twin
MIMs	Minimal Interoperability Mechanisms
NBS	Nature Based Solution
NFR	Nomenclature for reporting
NGSI-LD	Next Generation Service Interface with Linked Data
OGC	Open Geospatial Consortium

# 1 Introduction

## 1.1 Purpose and Scope

This document reports and describes the initial results achieved by the URBREATH project concerning the technological path it will follow during the implementation of the URBREATH Toolbox, which represents the interoperable collection of IT solutions supporting the pilots' activities. The URBREATH Toolbox aims to offer a comprehensive technological framework that will facilitate the Municipalities in managing and implementing the different phases related to NBS interventions (i.e. identification of local needs, the initial design of possible NBSs, simulation of the potential effect of possible solutions and their comparisons to identify the most suitable ones, selection of the solution, monitoring of the implementation and of the generated impacts).

For this purpose, this document reports the results concerning the identification of the requirements of the URBREATH Toolbox, based on the investigations performed together with the cities involved in the project about the functionalities the Toolbox should offer. These are derived from customer journeys and service blueprints investigated with the cities during a series of workshops and analyses.

## 1.2 Approach for Work Package and Relation to other Work Packages and Deliverables

This deliverable is the result of close collaboration within the URBREATH project, which extends beyond WP2 (to which it belongs). Four work packages contributed their activities to the creation of the project knowledge that underpins this deliverable.

Besides being responsible for this deliverable, WP2 contributed by setting the path of the overall methodology of the URBREATH project including the baseline scenarios of interest to the cities involved in the project for what concern NBSs, in which investigations of customer journeys, service blueprints, and the initial design of the URBREATH Toolbox, are in the wake.

In parallel, the two technical work packages (WP3 and WP4) supported identifying and validating the URBREATH Toolbox requirements, evaluated their technical feasibility and identified the initial candidate tools for its concrete implementation.

Finally, the WP5, which aims to put into action the defined methods, approaches and scenarios through a participatory process, also leveraging the URBREATH Toolbox, offered the chance to establish a feedback loop with direct contact with the cities.

### 1.3 Methodology and Structure of the Deliverable

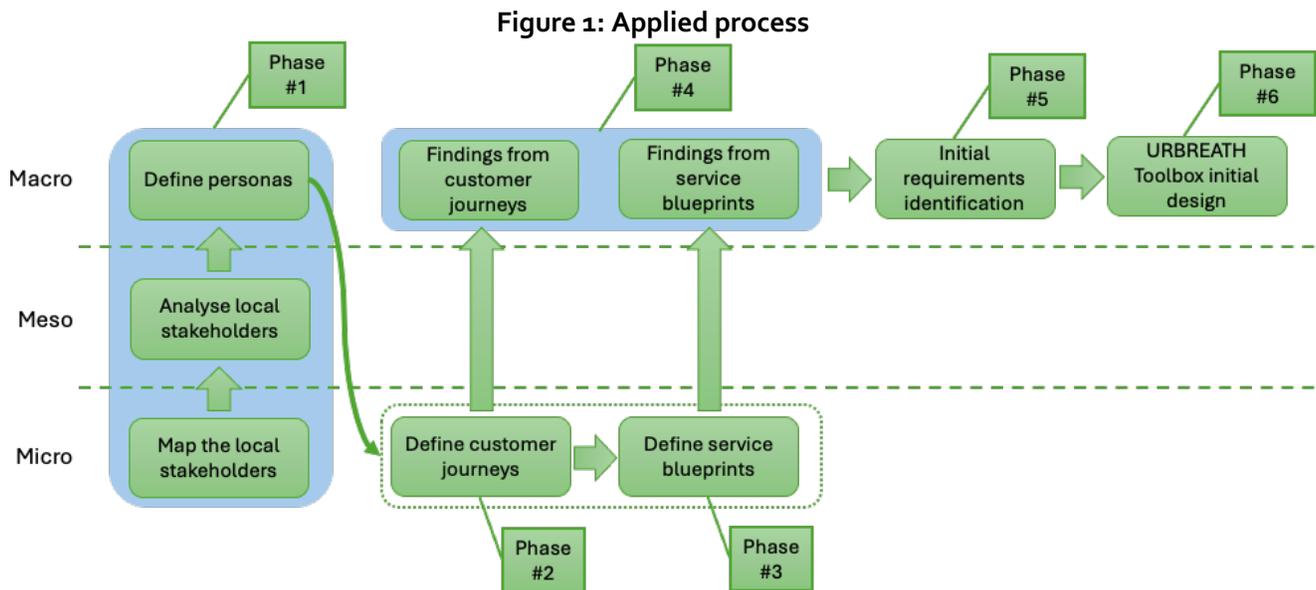
This section offers a summary of the methodology that has been applied to investigate the customer journeys and service blueprints, as well as for the identification of the initial set of requirements of the URBREATH Toolbox, as part of the wider overall URBREATH Methodology (ref. D2.1<sup>1</sup>). This methodology is designed and structured following three methodological principles, which includes the "experimentation" and operational activities with an integration of different scales. These scales consider the different levels at which the URBREATH project works: micro (local or pilot scale), meso (e.g. climatic zone) and macro (European scale). All these levels contribute to create knowledge with different degree of detail, and they are essential in deriving the URBREATH Toolbox requirements that will be presented in this document. Following a bottom-up approach towards the different scales, the applied process is made of six phases. Regarding the process and the tools that have been used to derive and define the URBREATH platform requirements, the Deliverable – based on the Deliverable D2.1 - adopted the co-creation process, integrating both "city" and "non-city" partners, using the service blueprint and service design approach.

1. Definition of personas: based on initial information provided by cities concerning the main stakeholders involved in their pilots and NBSs, a set of six personas have been defined. These aim to represent generic stakeholders that could be involved in NBS related projects, with their needs and objectives. Personas served as a common base for the cocreation session about customer journeys and service blueprints (steps #2 and #3), to obtain as much as possible comparable information from the cities. Personas are reported in Section 2.1. This phase initiated its activities at the micro level, collecting information about local stakeholders and mapping their usual activities, the problems they face in doing them, and what they want to achieve. This information has been analysed to identify common traits among the identified stakeholders (meso level). Finally, the defined personas represent the "types of users" that could benefit the functionalities of the URBREATH Toolbox (macro level).
2. Cocreation of customer journeys: this step leveraged the defined personas to cocreate their customer journeys. Representatives of the cities involved in URBREATH have been invited to an online meeting, where after an initial introduction to the objectives of the cocreation and presentation of the personas, the cocreation activities have been organised in four parallel sessions, one per climatic zone: Atlantic (cities of Leuven and Aarhus), Boreal (cities of Tallinn and Kajaani), Continental (cities of Cluj-Napoca and Pilsen), and Mediterranean (cities of Madrid, Athens, and Parma). In each session, a set of three hypothetical scenarios have been presented. Each scenario involved a specific persona (of the six defined personas), and participants were asked to investigate and debated at least one of the proposed scenarios, to identify and co-define its related customer journey. Customer journeys are reported in Section

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<sup>1</sup> Ref. D2.1 "URBREATH methodological framework for urban greening Living Labs and hybrid/NBS interventions and adaptive pathways - V1", due by March 2025.

0. Debates and investigation around customer journeys have been performed at micro and meso levels, with the aim first to intercept the viewpoints of the representatives of the cities and then to generalise them.
3. Cocreation of service blueprints: this step followed the same approach of the previous one and took in input the customer journeys defined in the previous phase. Also in this case, representatives of the cities involved in URBREATH have been invited to an online meeting. To facilitate investigation and cocreation of the possible functionalities of the service blueprints, the technical partners of the URBREATH project briefly presented a set of IT tools (these were previously identified as initial candidate tools of the URBREATH Toolbox based on the information provided by the cocreated customer journeys). Then, the cocreation activities have been organised in four parallel sessions (per climatic zone). In each session, representatives of the cities were asked to investigate and cocreate (with the support of the technical partners) the service blueprints of the customer journeys previously cocreated. Service blueprints are reported in Section 2.3. Debates and investigation around service blueprints have been performed at micro and meso levels, with the aim first to intercept the viewpoints of the representatives of the cities.
  4. Analysis of codefined customer journeys and service blueprints: this step comprised the desk analysis of the information collected from cities' representatives in steps #2 and #3. The results are reported as findings obtained from both cocreated customer journeys (in Section 0.) and service blueprints (in Section 2.3). Investigations of phase #3 focused on the macro level identifying the most relevant outcome coming from both customer journeys and service blueprint. From now on the remaining phases (#5 and #6) performed their activities at the macro level.
  5. Identification of the initial requirements of the URBREATH Toolbox: this step started from the results obtained from the information collected through the customer journeys and the service blueprints. The result is a list of requirements that served as guide for the initial design of the URBREATH Toolbox as well as identifying the capabilities the toolbox should offer. Furthermore, the complete list of requirements obtained in this step includes also the ones coming from the analysis of the DoA. The requirements are summarized in Section 3.
  6. Design of the initial IT architecture of the URBREATH Toolbox: the final step consisted in the design of the initial version of the logical architecture of the URBREATH Toolbox; its aim is to identify the different logical components of the Toolbox and their mutual relationships, which serve to implement the functionalities envisaged by the requirements from step #5. The logical architecture of the URBREATH Toolbox is reported in Section 4.



The information above mentioned is organised in the following structure.

- **Section 2** reports the six personas, the cocreated customer journeys and service blueprints, as well as the findings obtained from their analysis.
- **Section 3** reports a summary of the requirements identified from the analysis of the customer journeys and service blueprints, as well as from the analysis of the DoA.
- **Section 4** reports the initial logical architecture of the URBREATH Toolbox.
- **Section 5** summarises the principles followed for design of the URBREATH Toolbox to enhance its interoperability (i.e. with existing IT systems) and replicability opportunities.
- **Section 6** reports the conclusions and next steps.
- **Section 7** reports the references.
- **Section 8** summarises the use case scenarios defined by the cities.
- **Section 9** reports the initial stakeholders mapping performed by the cities, which served for the definition of the six personas.
- **Section 10** reports the complete list of requirements identified from the analysis of the customer journeys, service blueprints and DoA.
- **Section 11** briefly reports the initial candidate tools composing the URBREATH Toolbox.

## 2 Customer journey and service blueprint

This section documents the results of the analysis of information collected from the nine cities involved in the project concerning the initial set of requirements of the URBREATH Toolbox.

To investigate the initial requirements of the URBREATH Toolbox related to the needs of the project cities, the project leveraged personas, customer journeys, and service blueprints.

Personas are “fictional characters” representing the typical users of a system (e.g. a software application). They are used to support the understanding the real users’ needs and are defined based on information collected from research activities (e.g. interviews, surveys, etc.). Personas provide a common background to all the cities involved in the project for investigating both the customer journeys and service blueprints.

The customer journeys aim to investigate the experience of a customer during the interaction with a process or a system (e.g. an IT system, a software, etc.). A customer journey maps out the different steps of the customer, and related thoughts, feelings, and actions. Its objective is to support the understanding of the perspective of the customer concerning each step and identifying possible problems and opportunities (e.g. for improvement).

The service blueprints aim to investigate what happens behind the “line of the visibility” of the customer, within the processes or the system. It supports to understand how the process/system deals with customer interactions and how it impacts on his/her experience.

In summary, customer journeys focus on the experience of the customer, whereas service blueprints focus more on how a process/system manages requests from the customer. Together, they offer a viewpoint about the needs of the nine cities concerning the policy definition, decision making process, engagement of stakeholders, interaction and communication among stakeholders, participation into participatory process, etc.

The defined personas, and the corresponding investigated customer journeys and service blueprints are reported in the Sections 2.1, 0, and 2.3.

### 2.1 Personas

To investigate both customer journeys and service blueprints for the nine cities involved in the project, first, six personas have been defined, based on the preliminary information collected from the initial stakeholders’ mapping performed by the pilots (see Annex B – Initial stakeholders’ mapping).

Each persona is characterised by a role, objectives or gains (what the persona wants to achieve), pains (the problems the persona encounters while reaching its objectives), gain creators (what could help the persona in reaching its objectives), pain relievers (what could help the persona in solving or mitigating

the problems it encounters). The six identified personas are briefly summarized from Table 1 to Table 6.

**Table 1: Summary of persona #1 Arantxa Sánchez (Urban planner / Policy Maker)**

Role	Arantxa Sánchez is an urban planner and policy maker who specializes in integrating green spaces into urban planning. Her work aims to transform cityscapes into more sustainable environments, enhancing the quality of urban life through the implementation of Nature-Based Solutions (NBS) such as parks, green roofs, and urban forests.
Objectives/Gains	Her main objective is to create sustainable urban environments that can serve as models for future projects. She designs innovative, practical, and adaptable NBSs tailored to the specific needs and characteristics of each city. She also ensures that these solutions comply with all relevant regulations.
Pains	She faces challenges such as the complexity of bureaucratic processes, lack of interdepartmental communication, slow pace of policy-making processes, and resistance to new regulations.
Gain creators	She could benefit from tools such as a Geospatial Analysis Tool, an Integrated Information System, and an Impact Reporting Tool. These tools would provide a comprehensive view of different aspects for NBS design, streamline the process of gathering and analysing data, and provide access to reports and KPIs about the impact generated by NBSs.
Pain relievers	Establishing a well-coordinated internal communication process among departments, a centralized platform for accessing scattered information, and a common communication process with external stakeholders could also help in relieving her pains.

**Table 2: Summary of persona #2 Luigi Riva (Local Government Official)**

Role	Luigi Riva, a Local Government Official, plays a crucial role in overseeing the regulatory compliance and funding of Nature-Based Solutions (NBS). He ensures that all NBS projects meet environmental and safety standards and secures funding for these projects. Luigi also serves as a liaison with various stakeholders, facilitating communication and collaboration.
Objectives/Gains	His objectives include ensuring compliance with local and national regulations and achieving public consensus for NBS initiatives. He is committed to delivering solutions that are effective and legally compliant. Luigi also seeks to engage with the public, educating them about the benefits of NBSs, and incorporating their feedback into his projects.
Pains	Luigi faces challenges with interdepartmental coordination and securing adequate funding for his projects. Differences in priorities, communication styles, and bureaucratic procedures can lead to misunderstandings and delays. Additionally, securing funding can be a time-consuming and challenging process due to competition for limited resources.

Gain creators	He could benefit from an Impact Reporting System (to access reports and KPIs about the impact generated by NBSs), an NBS Information Hub (to access scattered information related to NBSs managed by different departments of the Municipality), an NBS Support Design System (offering a comprehensive view of the different aspects to be considered for the design of suitable NBSs), an NBS Case Studies Repository (containing simple-to-understand case studies about NBSs and their role in facing climate change), and a Communication/Collaboration Platform (to establish a common communication/collaboration process among departments).
Pain relievers	In addition, he could also benefit from a clear representation of the procedures and related processes, including contact points and responsibilities (to reduce uncertainties); a common communication/collaboration process among departments and towards stakeholders such as local associations, citizens, etc.; and a platform to communicate with citizens to provide them support in understanding reports/documents about interventions such as NBSs and their expected impact.

**Table 3: Summary of persona #3 Kim Clijsters (Environmental Scientist / Technology Developer and Data Analyst)**

Role	Kim Clijsters, an Environmental Scientist, Technology Developer, and Data Analyst, is involved in the monitoring, data analysis, technology development, and decision-making support for Nature-Based Solutions (NBSs). She monitors the environmental impact of NBSs, analyses data related to NBS project outcomes, develops digital tools for NBS modelling and monitoring, and supports decision-making with data insights.
Objectives / Gains	Her goals are rooted in environmental sustainability, data-driven decision-making, and digital innovation. She ensures that NBS projects are environmentally beneficial, data-driven, and efficient. She also aims to create digital solutions that enhance the implementation of NBS.
Pains	She faces challenges related to the accessibility and reliability of environmental data, obtaining regular feedback to improve her tools, slow adoption rates of the tools she implements, and the need for better data collection methods.
Gain creators	She could benefit from Data Integration Tools (to facilitate connection to heterogeneous data sources and harmonize collected data), NBS Impact Evaluation System (to support the evaluation of the impact of potential NBSs), Digital Twins Case Studies Repository (containing simple-to-understand case studies about the use of Digital Twins), Digital Twin Sandbox/Playground (a dedicated environment where Kim could experiment with and test the functionalities of Digital Twins).
Pain relievers	In addition, she could also benefit from a unique point to search and access documents/datasets owned by different departments of the Municipality, and

	a common communication/collaboration process among departments and towards stakeholders.
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**Table 4: Summary of persona #4 Gheorghe Hagi (Real Estate Developer / Investor)**

Role	Gheorghe Hagi is a Real Estate Developer and Investor who integrates and funds Nature-Based Solutions (NBSs) into his developments. His projects contribute to biodiversity, climate resilience, and the well-being of the community. He collaborates with various professionals to create designs that incorporate sustainable elements.
Objectives / Gains	His objectives are centred around sustainability, enhancing property value through sustainable practices, attracting eco-conscious tenants, and achieving a balance between financial return and social impact through NBSs.
Pains	He faces challenges such as balancing construction costs with the demand for sustainable features, managing investment risks, and obtaining comprehensive information about the impact of NBSs.
Gain creators	He could benefit from an Information System about Nature-Based Solutions (NBSs) and specific areas of the city. This system allows him to access information about the location and design of proposed/planned NBSs and specific areas. Also, an Impact Estimation Tool that enables the production of forecasts about the potential impacts of NBSs, could support him. These tools should be updated regularly to help Gheorghe stay updated and make timely decisions.
Pain relievers	In addition, tools such as a Digital Repository (providing access to reports produced by the Municipality about the potential impact of NBSs) could allow Gheorghe to stay informed about the latest developments and their potential impacts.

**Table 5: Summary of persona #5 Emilio Butragueño (Community Leader / NGO Representative)**

Role	Emilio Butragueño is a Community Leader and NGO Representative who advocates for Nature-Based Solutions (NBSs) in his community. He ensures that the community’s interests are always considered in NBS projects, and he advocates for ethical implementation of these projects.
Objectives / Gains	His objectives revolve around community engagement, sustainable development, and protecting community interests. He aims to foster a participatory planning process and maintain strong community support.
Pains	He faces challenges such as ensuring all community voices are heard by the local government, managing conflicting interests, encountering opposition from business interests, and dealing with limited resources.
Gain creators	To enhance his work, he could benefit from tools such as a Communication Platform, an NBS Information System, and an Impact Analysis tool. These tools would facilitate communication with citizens, provide access to information about the proposed/planned NBSs, and provide access to reports and KPIs about different aspects.
Pain relievers	Establishing a user-friendly digital platform that allows easier communication with citizens could also help in relieving his pains.

**Table 6: Summary of persona #6 Elizabeth Bennet (Citizen)**

Role	Elizabeth Bennet is a dedicated citizen and active community member who enjoys a balanced lifestyle. She works at a local company, enjoys outdoor activities, and actively participates in public debates promoted by the Municipality.
Objectives/Gains	Her primary objective is to gain a deeper understanding of the initiatives and projects undertaken by the Municipality. She wants to be informed about these initiatives to better understand her community’s direction and contribute to its growth and development.
Pains	She faces challenges in accessing public information about these initiatives and attending public debates due to their in-person format and her personal circumstances.
Gain creators	She could benefit from a Municipality Initiative Discovery Tool (to facilitate the discovery of initiatives or projects in the municipality).
Pain relievers	In addition, she could also benefit from Public Debate Platform (providing access to summaries of public debates and allows remote and/or asynchronous participation, and a unique point of access to search and access documents/datasets owned by different departments of the Municipality).

## 2.2 Customer journey

This section provides a summary of the customer journeys the cities investigated during a dedicated cocreation session (held on 30<sup>th</sup> May 2024). During the cocreation session, representatives of the nine

URBREATH cities together with the technical partners, had the chance to discuss about possible actions and touchpoints for each of the persona reported in Section 2.1. The cocreation outcomes served as base for a second cocreation session, aimed to investigate the service blueprints.

Sections from 2.2.1 to 2.2.6 detail the customer journey as defined during the first cocreation. Each section includes a short description of the scenario investigated to produce the customer journey during the cocreation session, a table reporting the most relevant and pertinent contributions provided by the participants during the workshops<sup>2</sup>, a picture of the customer journey resulted from the cocreation session, and the main findings.

### 2.2.1 Arantxa Sánchez - Urban planner / Policy Maker

**Scenario:** Being informed about ongoing activities (external professional), she wants to participate, doesn't know how.

**Table 7: Arantxa Sánchez customer journey - summary<sup>3</sup>**

Step	Notes on steps (if any)	User Action	Touchpoints
Step #1	-	Search for further information about the NBS Scenario to be implemented at local technical department / municipal authorities.	<p>Access open datasets mapping NBS solutions in the city.</p> <p>Stakeholders representing authorities should have a common space with the public and professionals and provide all information needed.</p> <p>Tool to visualize the different municipality areas and project that are being implemented at the same location/level.</p>
Step #2	-	The users are involved in the renovation through incentives. As an example, the local administration gives to restaurants and bars the	A public space where users can form a proposal which if raising a lot of supports (as voting) then the users (those representing

<sup>2</sup> Collected contributions from participants have been reviewed to improve their readability, also considering the discussions held during the workshop that clarified them; however, tables reported in this section aim to report contributions provided by the participants as much as possible faithful to reality.

<sup>3</sup> Steps #6 and #7 have been removed from the table since no input was provided by participants during the workshop.

		right to put tables and chairs on the public squares, Patio, you can reduce the contribution if they couple it to NBS actions.	authorities) can make it a draft policy as a collaborative legislation.
Step #3	-	<p>Establish a territorial data collection mechanism.</p> <p>Awareness on available tools /platforms.</p> <p>What the administration does for the users? Example does the administration spend public resources for new green areas?</p>	<p>Specific communication activities addressed to professionals.</p> <p>IOT and monitoring tools.</p>
Step #4	-	<p>System for territorial monitoring.</p> <p>Understanding the kind of context the city has, based on different requirements.</p> <p>How to monitor the awareness on NBS? Is a survey the only way to monitor it? Example: subscription to a mailing list or an Instagram page then count the followers.</p>	<p>Data collection related to territory to be used for his/her activities.</p> <p>Understanding the kind of context the city has, based on different requirements.</p>
Step #5	-	<p>Draft a supplementary case describing her views on how to add value to the NBS solution.</p>	<p>We can do sponsorship or free involvement of the administration to projects that use NBS solutions.</p> <p>What is the way the partners of the project URBREATH can interact as association or organization? As example, BASURAMA can develop urban project (such as urban design) with urban wastes.</p>
Step #8	-	<p>Understand the drivers that make sustainable the NBS solutions already implemented.</p>	-

**Figure 2: Arantxa Sánchez customer journey**

Persona

**Arantxa Sánchez**  
Urban planner / Policy Maker

Scenario

Being informed about ongoing activities (external professional), she wants to participate, doesn't know how.

Service Blueprint



	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	
<b>User actions</b> What does the user do?	Search for further information about the NBS Solutions to be implemented at local technical department / municipal authorities.	What needs are required in the administration about NBS? Do an example of local administration about NBS and how they are implemented. How can we reduce the contribution of any digitalization?	Establish a territorial data collection system.  Awareness on available tools, platforms.	How to monitor the awareness on NBS? It is a survey the only way to monitor it? Example: subscription to a mailing list or a Instagram page then count the followers.	system for territorial monitoring	Draft a supplementary case describing her views on how to add value to the NBS solution			understand the drivers that make sustainable the NBS solutions already implemented
<b>Touchpoints</b> Interactions between the user and the service	Public space where users can have a personal contact with the public and professionals and provide information needs.  Digital monitoring: authorities can make a digital survey or a collaborative legislation.	Public space where users can have a personal contact with the public and professionals and provide information needs.  Digital monitoring: authorities can make a digital survey or a collaborative legislation.	IoT and monitoring tools  Specific communication activities addressed to professionals	Understanding the kind of content the city has, based on different requirements (data)  Data collection related to territory to be used for further activities	Understanding the kind of content the city has, based on different requirements (data)  Data collection related to territory to be used for further activities	We can do sponsorship or free involvement of the administration to projects that use NBS solutions...			

### Main findings from Arantxa Sánchez's customer journey

The main findings from Arantxa Sánchez's customer journey can be summarised in six key aspects, that could be considered relevant for an Urban planner / Policy Maker:

- **Information Access:** easy access to information about ongoing and planned Nature-Based Solutions.
- **Incentives for Participation:** encourage participation in NBS projects to understand the needs of various stakeholders.
- **Awareness and Communication:** awareness campaigns and specific communication activities (e.g. targeted at professionals) to inform stakeholders about NBS-related projects.
- **Data Collection and Monitoring:** robust data collection mechanisms and solutions for territorial monitoring, that include IoT and other technologies to collect relevant data.
- **Collaborative Legislation:** a public space where the stakeholders can propose and contribute to the definition of policies, towards a collaborative city governance.
- **Sustainability Drivers:** understanding the drivers that make NBS solutions sustainable to ensure their long-term success.

## 2.2.2 Luigi Riva Local - Government Official

**Scenario:** Effectively conduct obligations and policy and make decisions regarding urban greening.

**Table 8: Luigi Riva customer journey - summary<sup>4</sup>**

Step	Notes on steps (if any)	User Action	Touchpoints
Step #1	-	<p>Assess situation of restraints and goals for the design.</p> <p>Assess existing political plans/strategies regarding urban greening.</p>	<p>Integrate with existing systems that store existing plans and completed works.</p> <p>Integrate with existing systems that store long term views on the cities, etc.</p> <p>Integrate with existing systems that store local heat plan, water plan, etc.</p>
Step #2	-	<p>Matching overall plan/strategy with the local physical context (e.g., population density, slope of the area, existing nature).</p> <p>Develop focus objectives to focus on within own resp. &amp; KPIs</p> <p>Prioritise goals for the design.</p> <p>Have a good view on impact of the priority chosen.</p>	<p>Environment where the existing physical conditions in the area are.</p>
Step #3	-	<p>Match these with local wishes/needs.</p> <p>Check with experts.</p> <p>Select an area.</p> <p>Design the solution, build layers based on the desired programme.</p>	<p>Participation tools.</p> <p>Environment where the progress of the project can be managed and followed.</p>

<sup>4</sup> Step #7 has been removed from the table since no input was provided by participants during the workshop.

		Political ideas.  Be informed on the participation process.	
Step #4	-	Publish proposed solution.  Design process.	Environment where proposed solutions are shown in the different scenarios.  Environment where proposed solutions can be voted on.
Step #5	-	Engage with citizens to explain and gather input.	Environment where politicians can see the real detailed plans (Autocad).
Step #6	-	Assess the impact using in-your-face visualisations.	Very clear environment where the results of scenarios is depicted in all its aspects (air pollution, water, heat, traffic, etc.)
Step #8	-	Publish agreed solution.	A clear proposal that can be voted yes/no on in the city council.

Figure 3: Luigi Riva customer journey



**Main findings from Luigi Riva’s customer journey**

The main findings from Luigi Riva's customer journey can be summarised in six key aspects, that could be considered relevant for a Government Official:

- **Assess restraints and goals:** integrate with existing systems devoted to the management of local plans and city strategies (e.g. long-term city views), such as for heat and water management, to ensure that all relevant information is considered during the decision-making process.

- **Matching plans and priorities:** find matches between city urban greening strategies and the potential areas of intervention. The availability of specific KPIs can foster this process, also considering prioritisation of plans and estimation of their potential impacts.
- **Public engagement and feedback:** experts' engagement in the planning and design of NBSs can help in the selection of the most appropriate areas for urban greening projects; the design of proper NBSs that address local needs can leverage participatory processes. At the same time, publishing proposed solutions can further foster citizens' engagement, to include their input and contributions to the design of NBSs. With this regard, platforms, where proposed solutions can be shown to collect feedback, can offer a technical solution.
- **Clear understanding of the potential impact:** clear visualisations of the potential impact of an intervention (e.g. an NBS), to easily understand different scenarios and their details.
- **Final approval:** the possibility to publish and document the agreed solutions and clearly present them; this point is related to decision-making processes, where the formalisation of the decision is needed, such as through a voting session in the city council.

### 2.2.3 Kim Clijsters - Tech specialist

**Scenario:** Identify specific challenges a city has (e.g. from citizens, city, etc.) - collecting data and information related to the challenges (including live data from sensors, but also static information, e.g. land-use) to work towards an integrated solution (overarching single silos/policy levels).

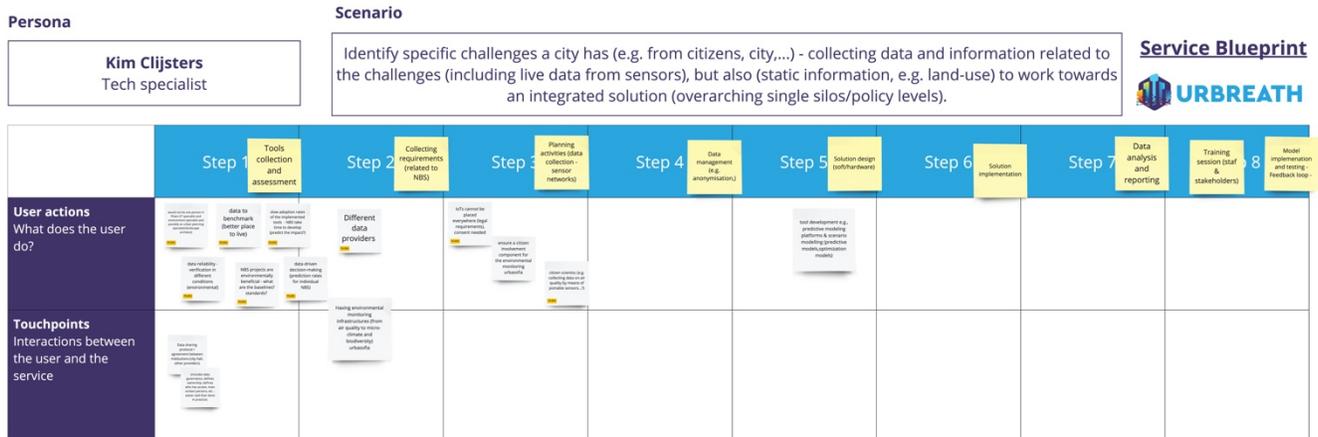
Table 9: Kim Clijsters customer journey - summary<sup>5</sup>

Step	Notes on steps (if any)	User Action	Touchpoints
Step #1	<p>Tools collection and assessment.</p> <p>Would not be one person in Pilsen (IT specialist and environment specialist and possibly an urban planning specialist/landscape architect).</p> <p>Slow adoption rates of the implemented tools - NBS take time to develop (predict the impact?)</p>	<p>Gather data to benchmark (better place to live).</p> <p>Gather data on reliability - verification in different conditions (environmental).</p> <p>Contribute to data-driven decision-making (prediction rates for individual NBS).</p>	<p>Data sharing protocol / agreement between institutions (city hall, other providers) which includes data governance, defines ownership, defines who has access, main contact persons, etc. - easier said than done in practice.</p>

<sup>5</sup> Steps #6 and #7 have been removed from the table since no input was provided by participants during the workshop.

	NBS projects are environmentally beneficial - what are the baselines? standards?		
Step #2	Collecting requirements (related to NBS).	Combine different data providers.	Having environmental monitoring infrastructures (from air quality to micro-climate and biodiversity).
Step #3	Planning activities (data collection - sensor networks).	IoT's cannot be placed everywhere (legal requirements), consent needed.  Ensure a citizen involvement component for the environmental monitoring using Citizen science (e.g. collecting data on air quality by means of portable sensors?).	No Touchpoints defined during the workshop.
Step #4	Data management.	No User Actions and Touchpoints defined during the workshop; however, participants expressed the need of data management solutions.	
Step #5	Solution design (soft/hardware).	Tool development e.g., predictive modelling platforms & scenario modelling (predictive models, optimization models).	No Touchpoints defined during the workshop.
Step #8	Training session (staff & stakeholders).  Model implementation and testing - Feedback loop.	No User Actions and Touchpoints defined during the workshop; however, participants expressed the need of training sessions to make sure that the personnel of the Municipalities and the stakeholders in generale can properly use the provided technological solutions. At the same time, they expressed the need of solutions (also organisational) to enable feedback loops.	

Figure 4: Kim Clijsters customer journey



### Main findings from Kim Clijsters’s customer journey

The main findings from Kim Clijsters's customer journey can be summarised in three key aspects, that could be considered relevant for a tech specialist:

- **Data management:** access, collect, and assess data for benchmarking and predicting the impact of NBSs, through establishing data-sharing protocols and agreements between institutions for that purpose and to ensure the integrity of the collected information; in some cases, data access could imply anonymization, to protect privacy. Data could also be collected from different data providers; this could increase complexity (from both the technical and organisational perspectives), or from monitoring infrastructures (e.g. available in the Municipality) to gather data (e.g. about air quality, micro-climate, biodiversity, etc.).
- **Planning activities:** having a clear view and synchronisation of the different activities involved in data collection is essential; in particular, this is relevant when activities involve setting up of sensor networks (e.g. due to legal implications for obtaining the needed consents, the identification of the places where install the sensors, etc.), or in the case of citizen science activities that imply the citizens' involvement (e.g. for environmental monitoring initiatives).
- **Tools to support solution (i.e. NBS) design:** to support the design of NBS, the development of tools (such as predictive models) is necessary. Such tools should provide data analysis and reporting capabilities (i.e. to analyse the collected data and report the findings to inform decision-makers and planners). However, development of such tools could suffer a slow adoption rate from planners and decision-makers. This would impact their implementation and continuous improvement, due to lack of feedback. These issues could be addressed thanks to the organisation of training sessions, followed by feedback collection.

## 2.2.4 Gheorghe Hagi - Real Estate Developer / Investor

**Scenario:** Design and test solutions, considering compliance with regulations, to increase the quality of living and the environmental impact.

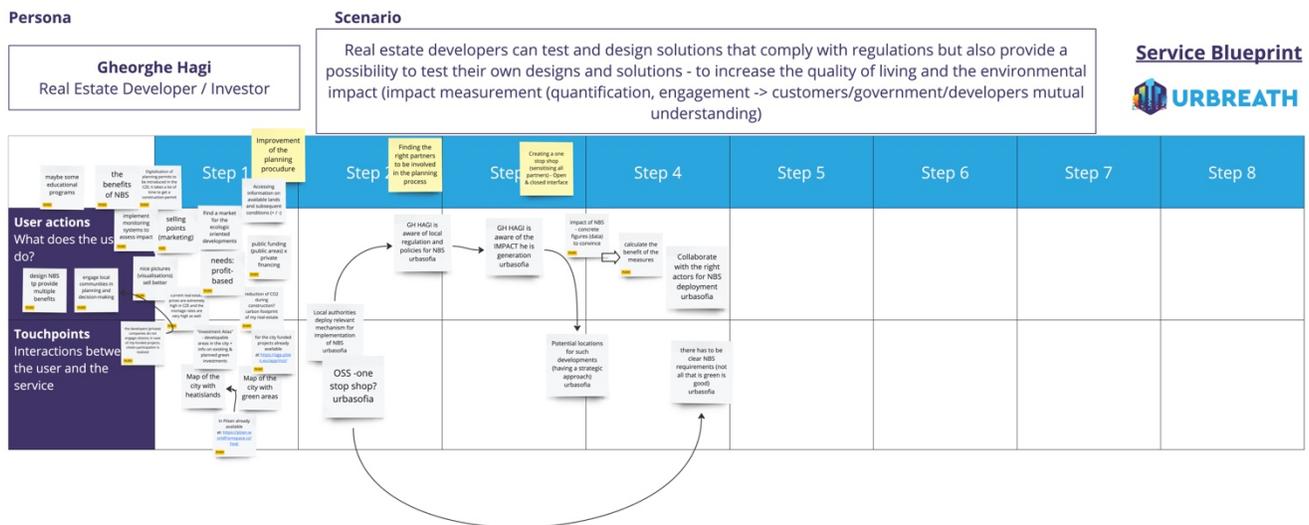
**Table 10: Gheorghe Hagi customer journey - summary<sup>6</sup>**

Step	Notes on steps (if any)	User Action	Touchpoints
Step #1	Improvement of the planning procedure.	<p>Digitalisation of planning permits to be introduced in the CZE; it takes a lot of time to get a construction permit.</p> <p>Implement monitoring systems to assess impact.</p> <p>Find a market for the ecologic oriented developments.</p> <p>Accessing information on available lands and subsequent conditions.</p> <p>Explore Public funding (public areas) for private financing options.</p> <p>Nice pictures (visualisations) sell better.</p> <p>Reduction of CO2 during construction? Calculate Carbon footprint of my real estate.</p> <p>Engage local communities in planning and decision-making.</p> <p>Design NBS to provide multiple benefits.</p>	<p>"Investment Atlas" - developable areas in the city + info on existing &amp; planned green investments.</p> <p>Map of the city with heat islands.</p> <p>Map of the city with green areas.</p>

<sup>6</sup> Steps #5, #6, #7 and #8 have been removed from the table since no input was provided by participants during the workshop.

Step #2	Finding the right partners to be involved in the planning process.	Hagi is aware of local regulation and policies for NBS.	Local authorities deploy relevant mechanism for implementation of NBS.
Step #3	Creating a one stop shop (sensitising all partners) - Open & closed interface.	Hagi is aware of the IMPACT he is generating.	Potential locations for such developments (having a strategic approach).
Step #4		Impact of NBS - concrete figures (data) to convince.  Calculate the benefit of the measures.  Collaborate with the right actors for NBS deployment.	There must be clear NBS requirements (not all that is green is good).

Figure 5: Gheorghe Hagi customer journey



### Main findings from Gheorghe Hagi's customer journey

The main findings from Gheorghe Hagi's customer journey can be summarised in four key aspects, that could be considered relevant for a real estate developer and investor:

- **Efficient planning process:** An efficient planning process that leverages digital tools (e.g. environmental analysis across city areas, such as the heat island effect) to reduce the time

required to obtain or evaluate permits and support the identification of markets for ecologically oriented developments. An efficient planning process cannot ignore the need to access comprehensive information (e.g. on available lands and their conditions), as well as public funding opportunities, or the possibility of better understanding the carbon footprint and CO2 potential reduction during the construction phase.

- **Community engagement:** investments that involve NBS interventions should include the engagement of local communities during the design phase.
- **Partnerships and collaboration:** facilitate the creation of partnerships and collaborations among stakeholders (both public and private) can help to better face and be compliant with local regulations, in particular during the design and planning phase.
- **Data-driven approaches:** evaluating the potential impact of NBSs and the value of the benefits they can bring should be demonstrated through a data-driven approach.

### 2.2.5 Emilio Butragueño - Community Leader

**Scenario:** Activate the pilot area with community involvement and greening of the area.

**Table 11: Emilio Butragueño customer journey - summary**

Steps	Notes on steps (if any)	User Action	Touchpoints
Step #1	-	<p>Identify locations where NBSs are needed.</p> <p>Identify different groups to engage.</p> <p>Identify potential NBS locations and add it to an information system.</p> <p>Reach out to local government for possible support.</p>	<p>Open a map to visualize the location of planned interventions.</p> <p>Open a map to visualize map layers about different topics such as level of air pollutions, age distribution, local furniture (e.g. benches).</p>
Step #2	-	<p>Identify the needs.</p> <p>Schedule interviews to perform a needs analysis</p>	<p>Select one of the interventions visualised on the map to access its details.</p>
Step #3	-	<p>Engage on-site with the community.</p> <p>Hold an onsite informative event together with municipality.</p> <p>Allow community engagement by advertising about the potential NBS that can be considered.</p>	<p>Using AI to imagine how the pilot site may look with more greening etc.</p> <p>Need for considering digital gap (old people and children) when performing on-site activities.</p>

		Tries to identify which NBS solution could be applied => talks with community (citizens and others).	Display the potential NBS implementations to engage the community.
Step #4	-	<p>Launch a participatory budgeting campaign.</p> <p>Define eligibility criteria with municipality.</p> <p>Creates NBS scenarios for that location.</p> <p>Identify NBS solutions that would create citizen involvement.</p>	<p>Access the detailed documentation of the intervention and forecasted impact.</p> <p>Social cost / benefit estimation per scenario.</p> <p>Export a report about the intervention</p>
Step #5	-	<p>Outreach and communication of the campaign.</p> <p>Presents scenarios and estimation of costs and benefits to community.</p>	<p>Produce a blogpost based on the exported cost-benefit report.</p> <p>Publish the blogpost on a participatory platform (of the Municipality?)</p>
Step #6	-	<p>Collect ideas for the pilot site.</p>	<p>Vote in community about scenarios (preferred variant) [e-participation, community meetings].</p> <p>Access comments provided to the blogpost and stimulate discussions.</p>
Step #7	-	<p>Select best ideas based on votes and eligibility criteria and communicate.</p> <p>Communicate the results with the public.</p> <p>Create a plan or a vision for activities based on the user needs and location specifics.</p> <p>Inform the municipality with action plan.</p>	<p>Dashboard with diagrams showing results filtered by different criteria (age, etc.).</p> <p>Email people who vote for the different NBSs.</p>

Step #8	-	Include and engage them with implementation.	<p>Reports about work planned vs done.</p> <p>Collect information details of people willing to contribute.</p> <p>Publish informative reports (e.g. articles, blog post about the works) and get feedback.</p>
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Figure 6: Emilio Butragueño customer journey



**Main findings from Emilio Butragueño’s customer journey**

The main findings from Emilio Butragueño's customer journey can be summarised in three key aspects, that could be considered relevant for a community leader:

- Location identification and engagement:** identify the possible locations in the city areas where NBSs could play a relevant role in increasing the well-being of local communities. With this regard, digital tools (such as maps related to air pollution, age distribution, and local amenities) can support this activity; however, engagement of local communities is crucial. This includes analysis of the local needs (e.g. through interviews) and organisation of on-site events (also in collaboration with the Municipality). The use of innovative technologies, such as Generative AI can help engagement (e.g. to visualise how a city area could be regenerated).
- Participatory budgeting campaign:** the possibility to organise participatory budgeting campaigns can support the increase of awareness among local communities that are interested in NBSs and support their engagement. Collaboration with the Municipality is critical for the definition of the eligibility criteria of a budgeting campaign. With this regard, the possibility to access detailed documentation and forecasted impacts of the NBSs is crucial. Budgeting campaigns could be empowered by collecting and voting ideas about possible scenarios (such

as variants of an intervention). The possibility for people to comment can be an opportunity to stimulate discussions and improve proposals/interventions.

- **Feedback collection on NBS implementation:** the engagement of the local communities during the implementation of NBSs is a key point. Therefore, it is important to give the possibility to create and communicate reports about the planned versus completed works, and the collection of feedback from local communities.

## 2.2.6 Elizabeth Bennet - Citizen

Concerning the persona Elizabeth Bennet, the cocreation session explored the user journeys of two scenarios.

**Scenario #1:** Citizens receive information on current issues in a specific area and are offered the possibility to participate or follow the re-design ideas.

**Table 12: Elizabeth Bennet scenario #1 customer journey - summary<sup>7</sup>**

Step	Notes on steps (if any)	User Action	Touchpoints
Step #1	-	<p>Gather information via news or local plans (via hearings).</p> <p>Bring citizens together (physically) to start up the information/participation process and already offer digital means of info/part.</p> <p>Attends community forums and public hearings.</p>	<p>Email, Facebook, newsletters, etc.</p> <p>Press and official communications of the cities.</p>
Step #2	-	<p>Choose to participate on a digital platform (e.g., a Facebook group for locals).</p> <p>Consider the different channels citizens can use to receive information (e.g., Newsletter, classic “paper” info sheets, digital platform).</p>	<p>Some kind of (centralised) helpdesk.</p> <p>Make it possible for citizens to easily reach the digital environment.</p> <p>Platform should connect with existing communication platforms.</p>

<sup>7</sup> Steps #7 and #8 have been removed from the table since no input was provided by participants during the workshop.

		<p>Ask questions to inform/reveal concerns about something they heard about.</p> <p>Joins community group.</p>	
Step #3	-	<p>Engage in workshops.</p> <p>Offer a general info on the redesign on a digital way + a few physical meetings.</p> <p>A group of citizens that are interested in the participation process are detected and can receive extra info (push).</p> <p>Gather information by checking local websites, social media platforms for updates on project and future meetings. Maybe sign up for notifications.</p> <p>Reach out again, digitally towards the citizens that contacted the digital info/part environment.</p>	<p>A list of planned locations for changes, and different scenarios for NBSs.</p> <p>An environment where citizens can see what could happen.</p> <p>Platform should connect with a kind of portal where information of planned and finished workshops are kept.</p>
Step #4	-	<p>Solutions and layers of info are communicated with the active users.</p> <p>Attends open information sessions and events.</p> <p>Check what the different options for the NBS are.</p>	<p>No Touchpoints defined during the workshop.</p>
Step #5	-	<p>Propose solutions.</p> <p>Give feedback about the different options for the NBS.</p>	
Step #6	-	<p>Last scenarios are proposed to the whole group (active and non-active - digital and physical).</p>	



**Scenario #2:** Get a good view on existing NBS in the city.

**Table 13: Elizabeth Bennet scenario #2 customer journey - summary<sup>8</sup>**

Step	Notes on steps (if any)	User Action	Touchpoints
Step #1	-	<p>Inform what are NBS.</p> <p>Inform what NBS can do.</p> <p>Inform about the need for NBS.</p>	<p>Different sources will pop up in the platform.</p> <p>Need to address information and communication at different levels and channels and focus on not leaving anybody out; challenge may be due to the multicultural and diversity of the population.</p> <p>Definition and practical reference to NBS through engaging media.</p>
Step #2	-	<p>Providing overview NBS.</p> <p>Identify real needs of citizens as a starting point for urban planning and NBS application.</p>	<p>Interactions based on social networks (Instagram, Tik Tok).</p> <p>Search information on NBS projects from various sources (maps, lists).</p> <p>List of best practices and list of NBS open.</p>
Step #3	-	<p>Rethinking how the municipality interacts with citizens (analogic and digital).</p> <p>Transparency about strategy and on ongoing development project.</p> <p>To know about the project in the city - related to NBS.</p>	<p>Map with all the projects (ongoing and adopted) involving NBS of different types.</p> <p>AI that could answers to direct questions from citizens that explain municipality decisions (need to contextualize decision making processes).</p>

<sup>8</sup> Steps #7 and #8 have been removed from the table since no input was provided by participants during the workshop.

		<p>The users apply to NBS competitions: as example, a competition for the most beautiful balcony promoted by the administration inviting citizens to plant more plants - a competition at local level for the greening of balconies with photos and social media.</p>	<p>Inform about which NBSs have already been implemented.</p>
Step #4	-	<p>Map the needs of the citizen through the tool.</p> <p>Citizens want to know about their specific neighbourhoods.</p> <p>How citizens could help on implementing NBS at local level.</p>	<p>The proposed NBS actions to be displayed on a tool and users can add their comments and vote for their implementation.</p> <p>All the features of the selected neighbourhood will appear.</p> <p>“Blog” for citizens to express their impression, based on a list of “problems”.</p> <p>A link to apply for specific activities or tasks related to NBS (agenda with meetings, on-line and off-line activities).</p>
Step #5	-	<p>Provide real examples that are acquainted to the citizen.</p> <p>Involve the community in co-creating and design use cases finalized to develop NBS projects.</p> <p>Participate in public debates.</p>	<p>Show stories through engaging video or media.</p> <p>A pop-up notification will 'warn' you that there will be something going on in a specific day.</p> <p>Book the meeting, add to calendar and provision of an online meeting URL to attend public debate.</p>
Step #6	-	<p>Provides feedback on municipal consultations / projects through available channels (e.g., online forms, emails).</p>	<p>No Touchpoints defined during the workshop.</p>

**Figure 8: Elizabeth Bennet scenario #2 customer journey**



**Main findings from Elizabeth Bennet’s customer journeys**

The main findings from Elizabeth Bennet's customer journeys can be summarised in two key aspects, that could be considered relevant for a citizen:

- **Access to information and participation in the debate:** access to information related to local interventions (such as plans and issues) is a relevant aspect. This could be achieved through different channels (e.g. community forums, mailing lists, newsletters, social media, etc.). The possibility of having physical meetings is essential; however, not all citizens can have the opportunity to attend those meetings. In this case, the possibility to participate via digital platforms could offer a support.
- **Communication:** The possibility to access information layers is a plus to communicate effectively to active citizens, for instance, to allow them to check different options related to possible NBSs, propose solutions, and provide feedback. This would allow the municipality to integrate input from citizens into the redesign plan of city areas, also through the presentation of the final scenarios of the interventions, to ensure that everyone is informed.

**2.3 Service Blueprint**

This section provides a summary of the service blueprints the cities investigated during a dedicated cocreation session (held on 12<sup>th</sup> June 2024). During this cocreation session, representatives of the nine URBREATH cities together with the technical partners, had the chance to revise some of the customer journeys discussed in the previous session (Section 0) and to investigate the possible functionalities of a hypothetical IT system that can support the user (i.e. the persona) in each step (according to user actions and touchpoints). The outcomes of this cocreation session served as base for the identification of the URBREATH Toolbox (i.e. platform) requirements.

Sections from 2.3.1 to 2.3.6 detail the service blueprints as defined during the first cocreation session. Each section includes a table reporting the most relevant and pertinent contributions defined by the participants during the workshops (collected contributions have been reviewed to improve their readability, also considering the discussions held during the workshop that served clarify them), a picture of the customer journey resulted from the cocreation session, and the main findings.

It is important to underline that the aim of the cocreation session about the service blueprint was not to fill-in functionalities for each step of the customer journeys, but to identity relevant functionalities and collect important feedback coming from the discussions between participants.

### 2.3.1 Arantxa Sánchez - Urban planner / Policy Maker

**Table 14: Arantxa Sánchez Service Blueprint – summary of functionalities<sup>9</sup>**

Steps	Functionality
Step #1	<p><b>Data Visualisation</b></p> <ul style="list-style-type: none"> <li>• Data visualisation dashboard?</li> <li>• Getting information as overview like lists, dashboards.</li> </ul> <p><b>Data Access</b></p> <ul style="list-style-type: none"> <li>• The administration of Parma should change the plan based on NBS solutions proposed by URBREATH. To make urban planning modification is something hard in Italy.</li> <li>• Research public databases city plans/ urban planning regulations etc. perhaps Idra<sup>10</sup>?</li> <li>• Generative AI supported data accessing to make it easier to find what is relevant for Arantxa within all existing municipal data?</li> </ul> <p><b>Data Analysis</b></p> <ul style="list-style-type: none"> <li>• IOT and monitoring tools; find what tools/models are available.</li> <li>• Using models to make simulations.</li> <li>• The city council would like to use models to make simulations and comparisons.</li> <li>• Map local ecosystem actors? To identify associations / citizen orgs that are active in the area? (STEP 1 OR 2 - before working through scenarios so that relevant actors can be involved in co-design, selecting relevant KPIs etc).</li> </ul> <p><b>E-Participation</b></p>

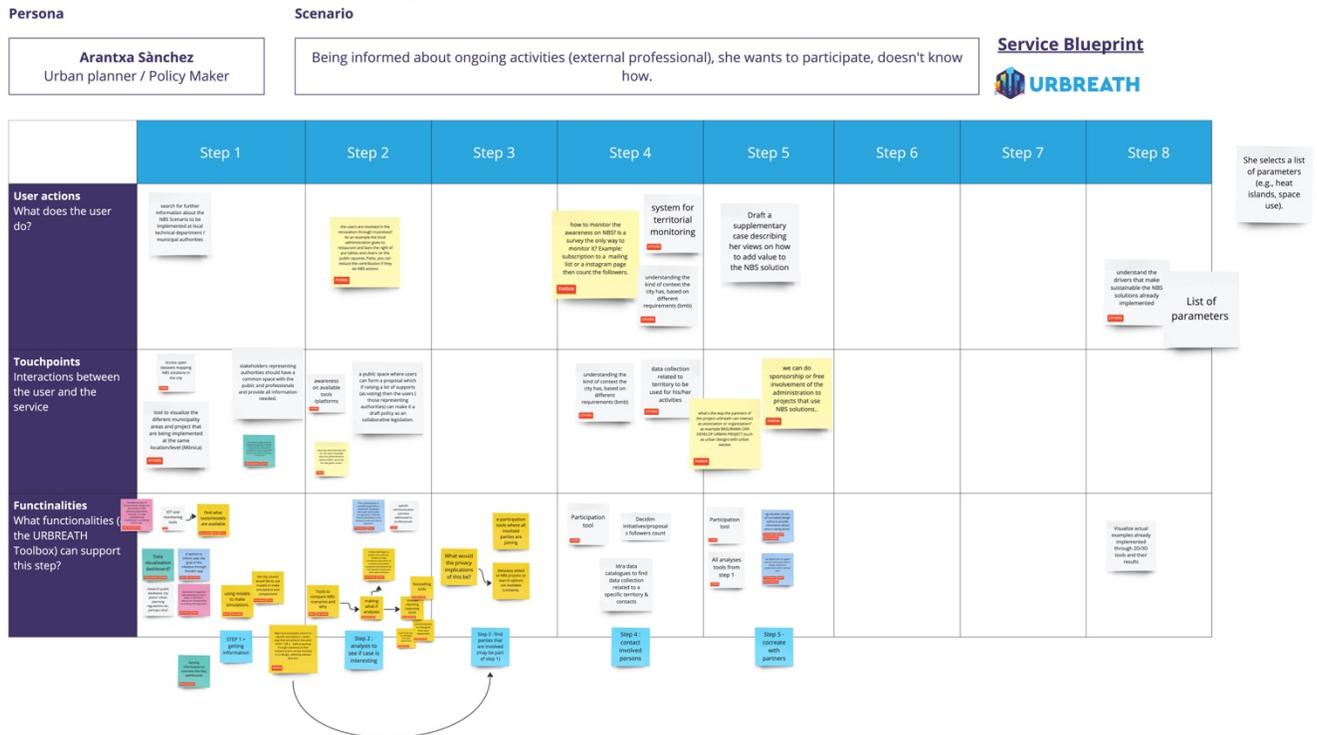
<sup>9</sup> Steps #7 and #8 have been removed from the table since no input was provided by participants during the workshop.

<sup>10</sup> Idra is one of the candidate tools presented during the cocreation session. More details about Idra are reported in Annex D - Initial Candidate tools of URBREATH Toolbox

	<ul style="list-style-type: none"> <li>• A section to inform user the goal of the initiative through Decidim<sup>11</sup> app.</li> </ul>
Step #2	<p><b>Data Analysis</b></p> <ul style="list-style-type: none"> <li>• Tools to compare NBS-scenarios and KPIs.</li> <li>• Making what-if analyses.</li> <li>• If she is working on a project, she could use models to make simulations with which to visualize and present proposed alternatives (incl. cost-benefit analysis etc.) and decide.</li> <li>• Storytelling tools.</li> <li>• Internal reporting (reporting tools).</li> <li>• Presenting data to colleagues from your department.</li> <li>• Presenting maps to colleagues from your department.</li> </ul> <p><b>E-Participation</b></p> <ul style="list-style-type: none"> <li>• The e-participation is something we would like to implement. Nowadays we have got social media (Instagram) to make the citizens participate to our initiatives, but we would like to improve it.</li> <li>• Specific communication activities addressed to professionals.</li> </ul>
Step #3	<p><b>Data Access</b></p> <ul style="list-style-type: none"> <li>• Metadata added to NBS projects so search options are available (contacts). What would the privacy implications of this be?</li> </ul> <p><b>E-Participation</b></p> <ul style="list-style-type: none"> <li>• E-participation tools where all involved parties are joining.</li> </ul>
Step #4	<p><b>Data Access</b></p> <ul style="list-style-type: none"> <li>• Idra data catalogues to find data collection related to a specific territory &amp; contacts</li> </ul> <p><b>E-Participation</b></p> <ul style="list-style-type: none"> <li>• Decidim initiatives/proposals followers' count.</li> </ul>
Step #5	<p><b>E-Participation</b></p> <ul style="list-style-type: none"> <li>• E.g. visualize results of co-created design online to provide information about what is being done?</li> <li>• Use digital tools to support scenario discussion and co-design sessions in combination within person work.</li> </ul>
Step #8	<p><b>Data Visualisation</b></p> <ul style="list-style-type: none"> <li>• Visualize actual examples already implemented through 2D/3D tools and their results.</li> </ul>

<sup>11</sup> Decidim is one of the candidate tools presented during the cocreation session. More details about Decidim are reported in Annex D - Initial Candidate tools of URBREATH Toolbox

Figure 9: Arantxa Sánchez Service Blueprint



**Main findings from Arantxa Sánchez’s service blueprint**

The most relevant functionalities for an Urban planner/Policy Maker are aimed at enhancing the overall urban planning process making use of detailed visualizations, comprehensive data access, robust impact analysis, and engagement of citizens for their active participation into decision making process. These functionalities are summarised in the following.

- **Data Visualization:** possibility to create data visualisation and dashboards to provide an overview of the current status concerning a specific area of the city of specific parameters to monitor. Dashboard could leverage 2D/3D tools (e.g. a Digital twin).
- **Data Access:** simplified access to scattered databases and data catalogues (including city plans, urban planning regulations, etc.) managed by different public bodies and /or department of the same municipality. The access should be facilitated by complete metadata to enhance search options. Search capabilities should offer also the possibility to find data collection related to specific territories and reference contacts (e.g. a specific office or department). Concerning the search functionalities, capabilities based on Generative AI could facilitate the identification of relevant datasets owned by the Municipality itself.
- **Data Analysis:** possibility to compare scenarios related to possible NBSs to be implemented. Comparisons could leverage including what-if analyses and definition (and calculation) of KPIs. Simulation models (e.g. to evaluate the effect of an NBS on a specific aspect, such as reduction of heat island effect) can offer a significant support in comparing the impact generated by an NBS, as well as the possibility to perform cost-benefit analysis and impact assessments (e.g. to

compare NBSs and identify the most suitable ones to solve a specific problem). With this regard, it is important to have access to solution that allow to identify the proper models to be used. Finally, once analysis and comparisons (e.g. between possible NBSs) are ready, availability of storytelling and reporting tools (e.g. for internal presentations and to support decision-making process) is considered a benefit.

- **E-Participation:** possibility to engage and involve stakeholders (e.g. citizens) into urban planning process, by offering online discussion and co-design sessions (that can be combined with in-person work) concerning possible scenarios (e.g. NBSs and redesign of city areas). The online sessions could be enhanced with digital visualization of co-created designs, also to offer updates about ongoing projects, and keep stakeholders engaged. With this regard, on-line participation tools could offer the possibility to implement communication activities (e.g. to address specific professionals) to improve their participation and to inform them about the goals of initiatives promoted by the Municipality.

### 2.3.2 Luigi Riva - Local Government Official

**Table 15: Luigi Riva Service Blueprint – summary of functionalities<sup>12</sup>**

Step	Functionality
Step #1	<p><b>Data Visualisation</b></p> <ul style="list-style-type: none"> <li>• VCS Viewer<sup>13</sup> (could be used by politician, managers, expert, to visualise plans and their developments, identify areas that need NBS interventions, etc.).</li> <li>• VCS Planner<sup>14</sup> (urban planner and designers could use it to design potential NBS plans and interventions).</li> <li>• Existing GIS system - planning in other tools (e.g., Autocad plans) could be imported and visualised.</li> </ul>
Step #2	<p><b>Data Visualisation</b></p> <ul style="list-style-type: none"> <li>• Simple analytics and visualisation of proposals.</li> <li>• Some designs will be made in professional tools of designers / architects (mostly outsourced).</li> </ul> <p><b>Data Analysis</b></p> <ul style="list-style-type: none"> <li>• Calculate impact and compare possible design with priorities defined by managers / politics; dashboard visualisations could support.</li> </ul>
Step #3	<p><b>Data Visualisation</b></p>

<sup>12</sup> Step #7 has been removed from the table since no input was provided by participants during the workshop.

<sup>13</sup> VCS Viewer is one of the candidate tools presented during the cocreation session. More details about VCS Viewer are reported in Annex D - Initial Candidate tools of URBREATH Toolbox

<sup>14</sup> VCS Planner is one of the candidate tools presented during the cocreation session. More details about VCS Planner are reported in Annex D - Initial Candidate tools of URBREATH Toolbox

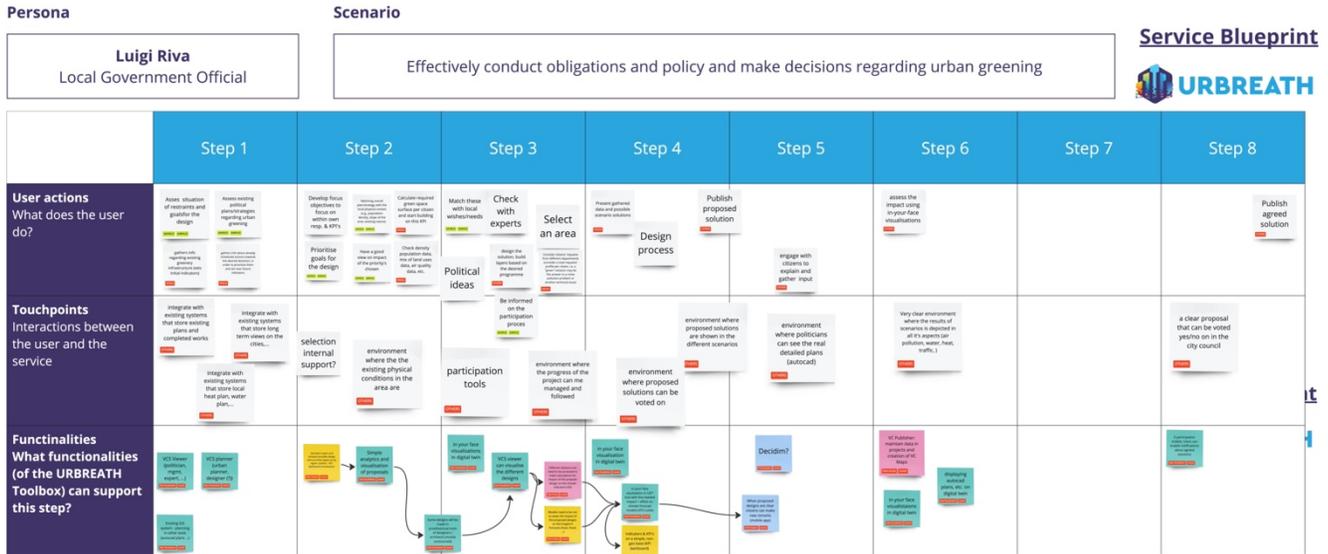
	<ul style="list-style-type: none"> <li>• In your face visualisations in digital twin.</li> <li>• VCS Viewer can visualise the different designs.</li> </ul> <p><b>Data Access</b></p> <ul style="list-style-type: none"> <li>• Different data sources need to be accessed to make calculations for impact of the proposed design on the chosen indicators.</li> </ul> <p><b>Data Analysis</b></p> <ul style="list-style-type: none"> <li>• Models need to be ran to assess the impact of the proposed designs on the long-term forecasts (heat, flood, etc.).</li> </ul>
Step #4	<p><b>Data Visualisation</b></p> <ul style="list-style-type: none"> <li>• In your face visualisations in digital twin.</li> <li>• In your face visualisation in UDT tool with the needed impact + effect on climate forecast models (VCS suite).</li> </ul> <p><b>Data Analysis</b></p> <ul style="list-style-type: none"> <li>• Indicators &amp; KPIs on a simple, non-geo base (KPI dashboard).</li> </ul>
Step #5	<p><b>E-Participation</b></p> <ul style="list-style-type: none"> <li>• Online participatory tool (e.g. Decidim) could offer a solution.</li> <li>• When proposed designs are clear, citizens can make new remarks (e.g. also using mobile app).</li> </ul>
Step #6	<p><b>Data Visualisation</b></p> <ul style="list-style-type: none"> <li>• Displaying Autocad plans, etc. on digital twin.</li> </ul> <p><b>Data Access</b></p> <ul style="list-style-type: none"> <li>• VC Publisher<sup>15</sup>: maintain data in projects and creation of VC Map<sup>16</sup>.</li> </ul>
Step #8	<p><b>E-Participation</b></p> <ul style="list-style-type: none"> <li>• E-participation mobile: users can enable notifications about agreed solutions</li> </ul>

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<sup>15</sup> VC Publisher is one of the candidate tools presented during the cocreation session. More details about VCS Publisher are reported in Section 11

<sup>16</sup> VC Map is one of the candidate tools presented during the cocreation session. More details about VC Map are reported in Section 11.

Figure 10: Luigi Riva Service Blueprint



**Main findings from Luigi Rivas’s service blueprint**

From information reported on Luigi Rivas’s service blueprint and collected during the cocreation session, the most relevant functionalities for a Local Government Official are very close to the ones identified for the Urban planner/Policy Maker. Similarly, in this case the identified functionalities are aimed at enhancing the overall urban planning making use of detailed visualizations, comprehensive data access, robust impact analysis, and engagement of citizens for their active participation into decision making process. These functionalities are summarised in the following.

- **Data Visualization:** visualisation capabilities allowing to explore and obtain a comprehensive view of different designs and proposals (e.g. concerning urban redesigns, NBSs, etc.) that integrates with existing GIS systems and tools like AutoCAD (e.g. to import and display on a map proposed designs). These capabilities should be based and leverage a Digital Twin environment to offer a clearer view of the potential impact and effects of proposed designs, include information (e.g. charts, graphs) concerning the related impacts on climate (e.g. obtained from forecast models).
- **Data Access:** possibility to access different data sources (e.g. to calculate the impact of proposed designs on chosen indicators) and to plot information on a map, to make it accessible also through a Digital Twin.
- **Data Analysis:** this point is connected to the previous one; solutions that allow to evaluate and the impact (e.g. heat island effect, reduction of flooding risk, etc.) of different proposed designs and compare them (e.g. to drive decisions with management and political priorities). Those solutions should offer the possibility to assess the long-term impact of proposed designs. This kind of solutions should include also the possibility to manage and monitors indicators (e.g. KPIs) offering user friendly functionalities.

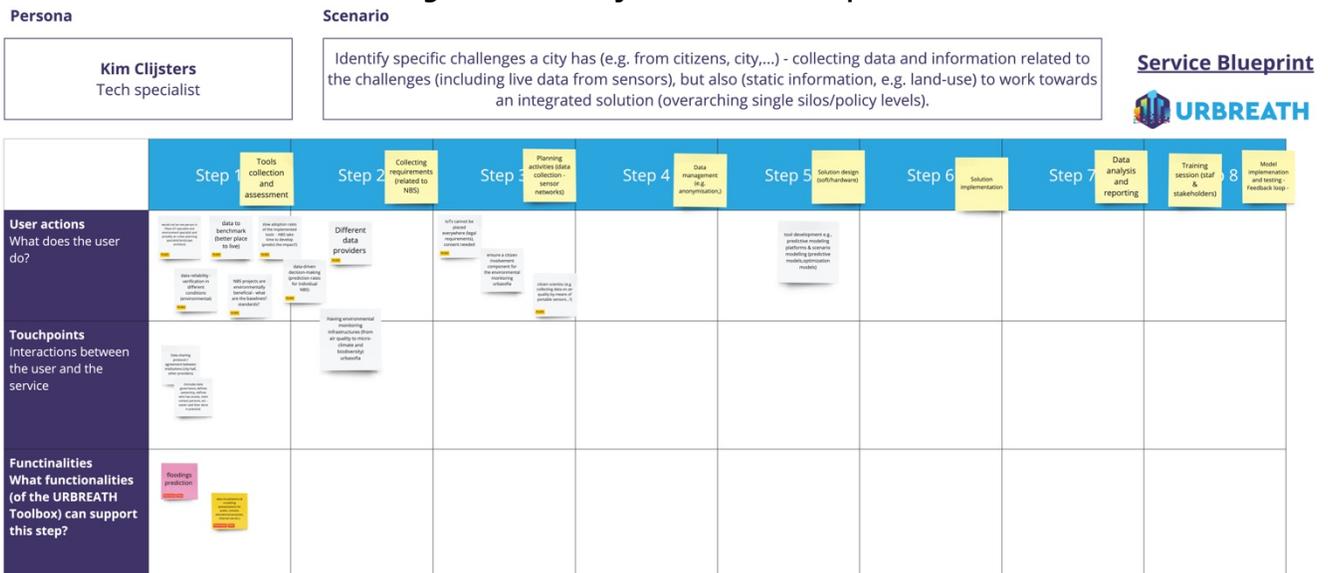
- **E-Participation:** possibility to engage citizens to get feedback using different communication and interaction channels that include both web-based and mobile solutions. Citizens should be allowed to access and provide feedback about the proposed designs. These solutions should also offer the possibility to set up participatory budgeting initiatives to investigate priorities of the citizens and to offer a notification system to inform about the agreed design and keep citizens informed and engaged.

### 2.3.3 Kim Clijsters - Tech specialist

Table 16: Kim Clijsters Service Blueprint – summary of functionalities<sup>17</sup>

Step	Functionality
Step #1	<p><b>Data Visualisation</b></p> <ul style="list-style-type: none"> <li>• Data visualisations &amp; modelling (presentations for public, schools, educational purposes, internal use etc.).</li> </ul> <p><b>Data Analysis</b></p> <ul style="list-style-type: none"> <li>• Floodings prediction.</li> </ul>

Figure 11: Kim Clijsters Service Blueprint



### Main findings from Kim Clijsters’s service blueprint

Even if during the co-creation session few information was reported on the service blueprint canvas, discussion among participants about the functionalities needed by Kim Clijsters allowed to collect useful hints, that are summarised in this section. In particular, the main functionalities needed by Kim Clijsters,

<sup>17</sup> Steps from #2 to #8 have been removed from the table since no input was provided by participants during the workshop.

should allow her to enhance data-driven decision-making by offering predictive modelling and forecast of possible impacts generated by NBSs. The implementation of such analytics would require access to environmental data. At the same time the results obtained by the same analytics could be helpful to foster community engagement in urban planning and environmental monitoring initiatives.

- **Data Visualization:** possibility to visualise and monitor environmental condition (such as air quality, micro-climate, and biodiversity) both leveraging historical data and real-time data (i.e. from sensor networks) represents a fundamental requirement; in this case the focus is more the possibility to visualise these data to build more robust analyses.
- **Data Access:** this point is connected to the previous one; to visualise data and build analysis it is essential to access data in an easy way. A centralised data repository would offer several benefits to reduce the time needed for the implementation of analytics (e.g. the possibility to deal with uniform data formats and standards). This includes the possibility to access comprehensive datasets built through the aggregation and fusion of data coming from various sources (to this aim, data-sharing protocols and agreements should be established among the different data providers to ensure both reliability and consistency of the data).
- **Data Analysis:** Kim Clijsters would benefit from functionalities that support her in the implementation of tools for predictive modelling and scenarios analysis. These would consist of solutions for forecasting the impact generated by NBSs, tools to model NBS scenarios, and to analyse tools to benchmark and predict the impact of NBSs under different environmental conditions.
- **E-Participation:** functionalities that support citizen science activities to collect useful data for monitoring actions and (as consequence) citizens engagement would represent a benefit. In this framework, solutions could be represented by dedicated IT web and mobile platforms/applications to promote citizen involvement and to spread environmental monitoring and citizen science initiatives, as well as to collect feedback. With this regard the same web and mobile platforms/applications could be used to publish simulation/analysis results and impact estimations to enhance citizens’ participation and gather feedback.

### 2.3.4 Gheorghe Hagi - Real Estate Developer / Investor

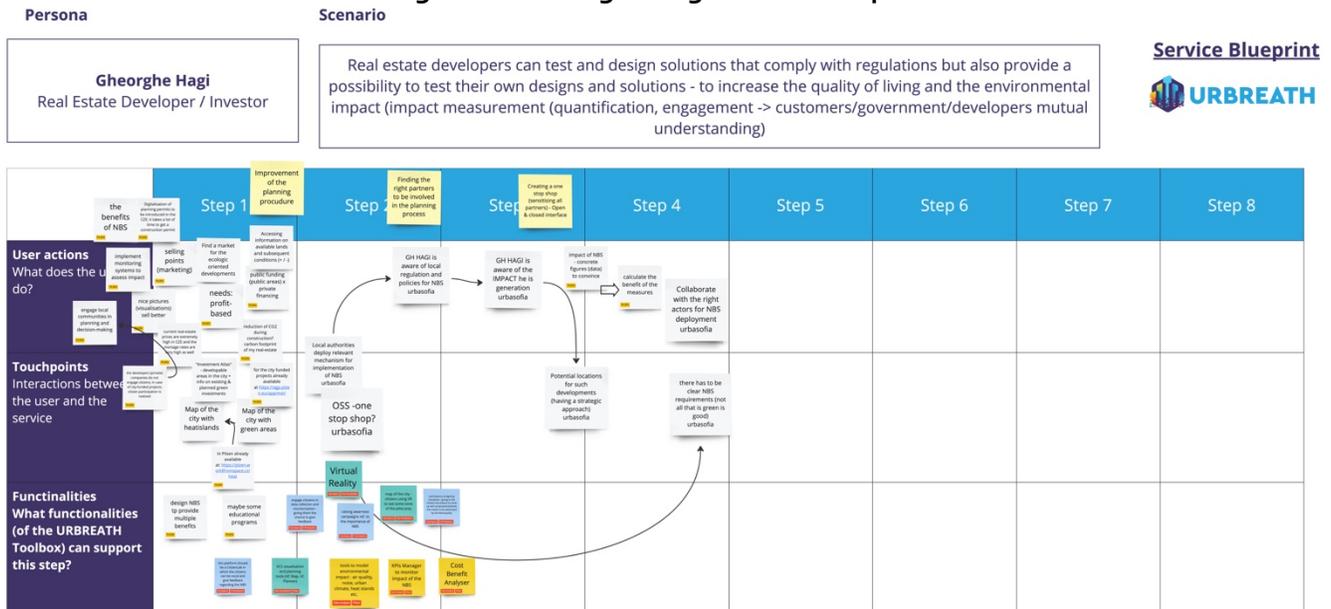
Table 17: Gheorghe Hagi Service Blueprint – summary of functionalities<sup>18</sup>

Steps	Functionality
Step #1	<p><b>Data Visualisation</b></p> <ul style="list-style-type: none"> <li>• VCS visualisation and planning tools (VC Map, VC Planner).</li> </ul> <p><b>E-Participation</b></p>

<sup>18</sup> Step #2 steps from #4 to #8 have been removed from the table since no input was provided by participants during the workshop.

	<ul style="list-style-type: none"> <li>This platform should be a CitizenLab in which the citizens can be vocal and give feedback regarding the NBS.</li> </ul>
Step #3	<p><b>Data Visualisation</b></p> <ul style="list-style-type: none"> <li>Virtual Reality.</li> <li>Map of the city - Citizens using VR to see some zone of the pilot area.</li> </ul> <p><b>Data Analysis</b></p> <ul style="list-style-type: none"> <li>Tools to model environmental impact: air quality, noise, urban climate, heat islands etc.</li> <li>Cost Benefit Analyser<sup>19</sup>.</li> <li>KPIs Manager<sup>20</sup> to monitor impact of the NBS.</li> </ul> <p><b>E-Participation</b></p> <ul style="list-style-type: none"> <li>Engage citizens in data collection and monitorization - giving them the chance to give feedback.</li> <li>Raising awareness campaigns ref. to the importance of NBS.</li> <li>Participatory budgeting initiatives - Giving to the citizens the chance to come up with proposals/initiatives that needs to be addressed by the Municipality.</li> </ul>

Figure 12: Gheorghe Hagi Service Blueprint



<sup>19</sup> Cost Benefit Analyser is one of the candidate tools presented during the cocreation session. More details about Cost Benefit Analyser are reported in Annex D - Initial Candidate tools of URBREATH Toolbox.

<sup>20</sup> KPI Manager is one of the candidate tools presented during the cocreation session. More details about KPI Manager are reported in Annex D - Initial Candidate tools of URBREATH Toolbox.

### Main findings from Gheorghe Hagi's service blueprint

Based on Gheorghe Hagi's service blueprint, the most relevant findings underline the need of functionalities to enhance community involvement, provide and access detailed information related to NBSs, and support data-driven decision-making in urban planning and greening initiatives. Below, a summary of the identified functionalities according to the four categories discussed during the workshop is reported.

- **Data Visualization:** tools to visualise (on a map) the status and the foreseen urban plans for specific areas of the city, creating awareness and improve comprehensions of the local conditions and expected impact. These tools could be enhanced with VR/AR capabilities to allow the users (such as citizens) to explore the area and the planned redesigns.
- **Data Access:** this point is strictly connected to the previous one; the possibility to visualise leveraging easy to use tools (e.g. a map) information related to the current status and the expected intervention on a specific area of the city, facilitate the access to knowledge, by offering a contextualised framework reporting the relevant information connected to the areas themselves. Information can be offered in different forms, such as dashboard combining charts and graphs, reports, 3D visualisation, map layers, etc.
- **Data Analysis:** concerning this category, the main needed functionalities can be grouped into three main kinds of tools: 1) tools offering capabilities to model the environmental impacts of NBS (e.g. improvement of air quality, reduction of noise, establishment of a more comfortable climate conditions for the citizens, mitigation of the heat islands effect, etc.); 2) tool that allow to manage (i.e. define and calculate) key performance indicators (KPIs) associated to city areas and monitor their condition in relation to parameters of interest (e.g. of air pollutants, noise levels, average temperature, etc.); 3) tool that offers functionalities to analyse and compare cost and benefit of different NBSs, supporting the identification of the most suitable solutions.
- **E-Participation:** solutions should consider functionalities to facilitate the engagement of citizens in data collection and monitoring (about city areas) and to increase awareness about the importance of NBS (for instance offering the chance to conduct online awareness campaigns). Furthermore, the possibility to implement participatory budgeting initiatives represent an important element, to citizens with the opportunity to propose and prioritize initiatives that need to be addressed (for instance by the municipality). All these functionalities should be enriched with the possibility for the citizens to provide feedback (e.g. regarding Nature-Based Solutions).

## 2.3.5 Emilio Butragueño - Community Leader

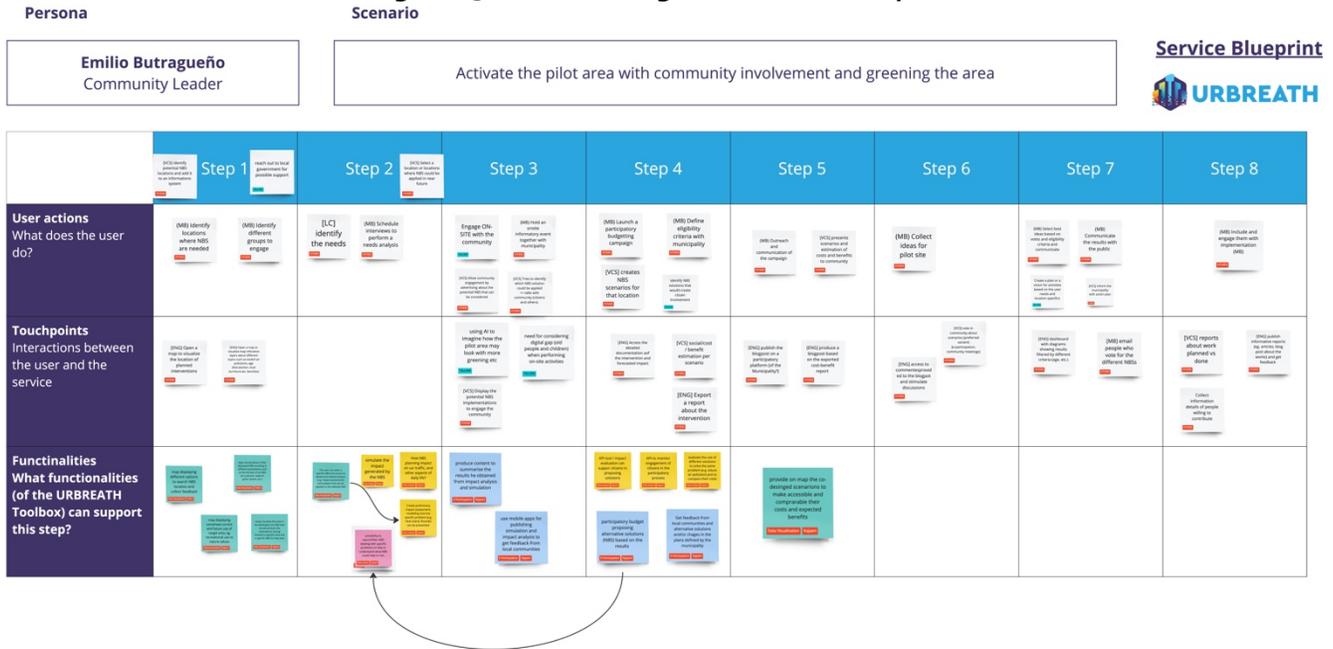
**Table 18: Emilio Butragueño Service Blueprint – summary of functionalities<sup>21</sup>**

Step	Functionality
Step #1	<p><b>Data Visualisation</b></p> <ul style="list-style-type: none"> <li>• Map should allow to filter displayed NBS according to different parameters such as the domain of an NBS (air pollution, water green spaces, etc.).</li> <li>• Map displaying different options to search NBS location and collect feedback.</li> <li>• Easily visualise the area to be developed, the NBS that should be built, the rationale for having chosen a specific area and a specific NBS for that area.</li> <li>• Map displaying somehow current and future use of target area, e.g. recreational use vs nature values.</li> </ul>
Step #2	<p><b>Data Visualisation</b></p> <ul style="list-style-type: none"> <li>• The user can select a specific NBS and access its details and related analysis (e.g. impact assessment) and analysis that can be applied to the selected NBS.</li> </ul> <p><b>Data Access</b></p> <ul style="list-style-type: none"> <li>• Possibility to search/filter NBS dealing with specific problems to help to understand what NBS could help or not.</li> </ul> <p><b>Data Analysis</b></p> <ul style="list-style-type: none"> <li>• How NBS planning impact on car traffic, and other aspects of daily life?</li> <li>• Simulate the impact generated by the NBS.</li> <li>• Create preliminary impact assessment, modelling how the specific problem (e.g. heat island, floods) can be prevented.</li> </ul>
Step #3	<p><b>E-Participation</b></p> <ul style="list-style-type: none"> <li>• Produce content to summarise the results he obtained from impact analysis and simulation.</li> <li>• Use mobile apps for publishing simulation and impact analysis to get feedback from local communities.</li> </ul>
Step #4	<p><b>Data Analysis</b></p> <ul style="list-style-type: none"> <li>• KPI tool/Impact evaluation can support citizens in proposing solutions.</li> <li>• KPI to monitor engagement of citizens in the participatory process.</li> <li>• Evaluate the use of different solutions to solve the same problem (e.g. reduce air pollution) and to compare their costs.</li> </ul> <p><b>E-Participation</b></p> <ul style="list-style-type: none"> <li>• Get feedback from local communities and alternative solutions and/or changes in the plans defined by the municipality.</li> <li>• Participatory budget proposing alternative solutions (NBS) based on the results.</li> </ul>

<sup>21</sup> Steps #6, #7 and #8 have been removed from the table since no input was provided by participants during the workshop.

<b>Step #5</b>	<p><b>Data Visualisation</b></p> <ul style="list-style-type: none"> <li>Provide on map the co-designed scenarios to make accessible and comparable their costs and expected benefits.</li> </ul>
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**Figure 13: Emilio Butragueño Service Blueprint**



**Main findings from Emilio Butragueño’s service blueprint**

The identified findings underline the need of tools to:

- Support search, identification and access to information of NBSs and their visualisation on maps.
- Simulate and evaluate the impact generated by NBSs on daily life of citizens.
- Interact with local communities by publishing content, getting feedback and present possible scenarios.

The identified needs move towards more inclusive, informed, and interactive participation of the citizens into redesign and improvement of their neighbourhoods, through the support of data-driven decision-making approaches.

Findings are summarized reported below according to the four categories that drove the co-creation session (i.e. Data Visualisation, Data Access, Data Analysis, and E-Participation).

- **Data Visualization:** tools offering maps to visualise information related to NBSs such as the area of interest and connected information (e.g. KPIs, documents, reports, graphs, etc.), that explain the rationale for choosing specific areas and a specific NBS. Maps should visualise also the current and future use of the areas of interest, for instance recreational use vs. nature values.
- **Data Access:** strictly connected to the previous point, the offered maps should allow to search and filter NBSs according to different parameters or (e.g. NBSs dealing with specific problems

or topics, such as air pollution, water, green spaces, etc.); the users should be able to select a specific NBS and access its details and related information.

- **Data Analysis:** tools that allow to simulate/estimate the impact generated by NBSs on daily life of citizens (e.g. car traffic, heat island effect, etc.). These tools should help to model possible solutions that help to prevent/reduce specific problems. Among these tools, technical solutions that allow to model KPIs can play a role, in relation to support citizens in understanding the current situation and the effects generated by possible solutions, as well as to help citizens in proposing solutions. With this regard, tools allowing to compare from different perspective (e.g. economic, effectiveness, etc.) how two or more solutions can solve the same problems (e.g., reducing air pollution) can offer a valuable support.
- **E-Participation:** tools allowing to produce and publish content (such as summary of impact analysis) to make it accessible from both the web and mobile and get feedback from local communities (e.g. about proposed solutions and alternative ones, plans defined by the municipality for a specific areas and possible changes/modifications, etc.). Also, the possibility to organise participatory budgeting and to co-design NBS scenarios on a map (making their costs and expected benefits accessible and comparable) represent important features (e.g. to propose alternative NBS solutions).

## 2.3.6 Elizabeth Bennet - Citizen

**Table 19: Elizabeth Bennet Service Blueprint – summary of functionalities<sup>22</sup>**

Steps	Functionality
Step #1	<p><b>E-Participation</b></p> <ul style="list-style-type: none"> <li>• User can connect to the project to stay informed = Decidim/Mobile participation tool.</li> <li>• Users can see upcoming events in the event calendar of the mobile app.</li> <li>• User can connect to our Go Vocal platform<sup>23</sup>.</li> </ul>
Step #2	<p><b>Data Visualisation</b></p> <ul style="list-style-type: none"> <li>• VC Planner allows for urban planning in 2D/3D environment =&gt; can be shared with a group/ makes it more interactive.</li> </ul> <p><b>Data Access</b></p> <ul style="list-style-type: none"> <li>• If the users are interested, they should be able to access more data (ASIS state, Framework in which the redesign is made, possible scenario's already existing from previous contact) - possibly GeoData Extractor<sup>24</sup>.</li> </ul>

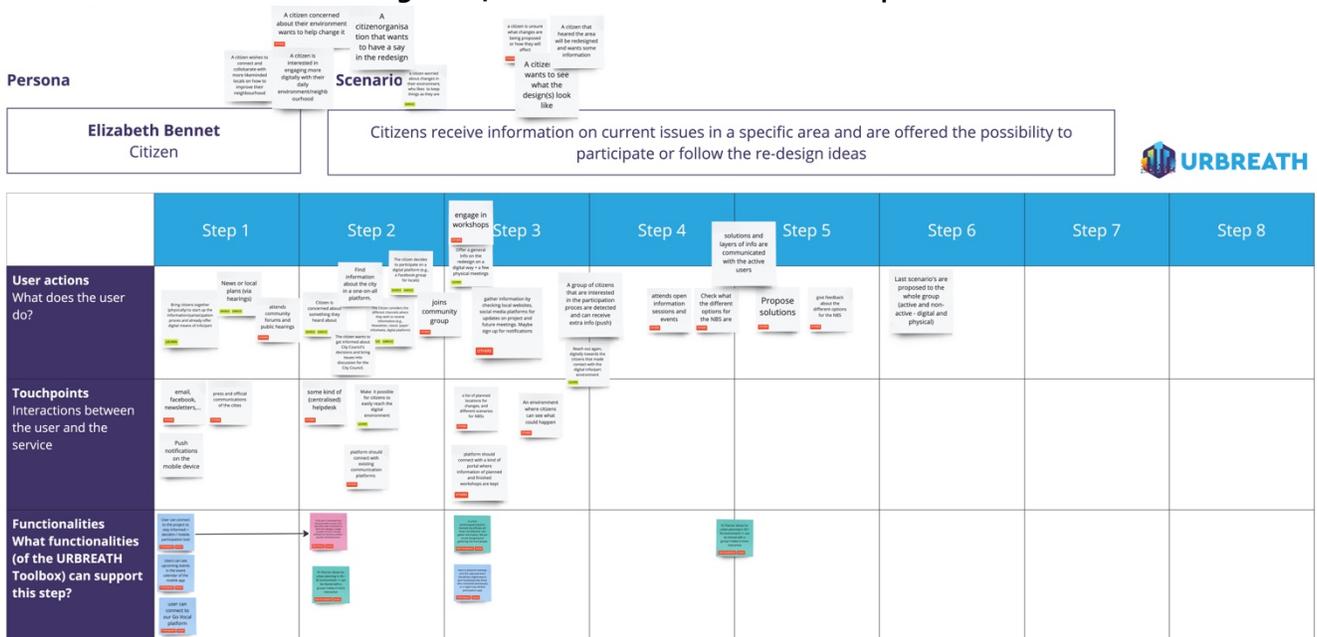
<sup>22</sup> Steps from #5 to #8 have been removed from the table since no input was provided by participants during the workshop.

<sup>23</sup> Go Vocal is a web platform for community engagement adopted by the City of Leuven (<https://www.govocal.com/>)

<sup>24</sup> GeoData Extractor is one of the candidate tools presented during the cocreation session. More details about GeoData Extractor are reported in Annex D - Initial Candidate tools of URBREATH Toolbox.

<p>Step #3</p>	<p><b>Data Visualisation</b></p> <ul style="list-style-type: none"> <li>In a first workshop/participation moment city officials will show “mood boards” and gather information. We are not yet designing but gathering info from people.</li> </ul> <p><b>E-Participation</b></p> <ul style="list-style-type: none"> <li>Next to physical meetings and info captured there should be a digital way to give input (especially those who connected previously on a digital way (Mobile participation app)).</li> </ul>
<p>Step #4</p>	<p><b>Data Visualisation</b></p> <ul style="list-style-type: none"> <li>VC Planner allows for urban planning in 2D/3D environment =&gt; can be shared with a group/ makes it more interactive.</li> </ul>

Figure 14: Elizabeth Bennet Service Blueprint



**Main findings from Elizabeth Bennet’s service blueprint**

The main findings from Elizabeth Bennet's service blueprint are summarised according to the four categories that drove the co-creation session (i.e. Data Visualisation, Data Access, Data Analysis, and E-Participation). The identified findings underline the need of inclusive, informed, and interactive participatory process for the citizens, which aim is to allow them to actively participate in the redesign and improvement of their neighbourhoods.

- Data Visualization:** Urban Planning Tools that offer 2D/3D visualisation environments and enable more interactive participation process; the possibility to make use of (online) “Mood Boards” (e.g. during workshops) would allow citizens to provide feedback.

- **Data Access:** the chance to access comprehensive data about the current state (AS-IS), the framework for redesign, and possible existing scenarios for intervention would allow citizens to obtain a clearer view of the city and its potential evolution, having so the opportunity to effectively contributing to participatory process.
- **Data Analysis:** Benchmarking and Predictive Tools, such as Scenario Modelling tools, provide the citizens with the possibility to predict the effect and impact (e.g. pros and cons) of different urban planning scenarios (such as NBSs) and evaluate their usefulness.
- **E-Participation:** web and mobile participation tools would help citizens to stay informed about city project, being engaged, and participating to debates digitally also. This would enable hybrid participation; alongside physical meetings, digital channels to participated into debates, would represent a further opportunity for citizens to provide their input and contribution (i.e. representing their viewpoints, needs, etc.). Furthermore, mobile participation tools could offer the chance to stay informed about upcoming events such as public debates (e.g. through a calendar or notifications).

### 3 Initial requirements of the URBREATH Toolbox

This section offers a brief recap of the initial requirements of the URBREATH Toolbox. The requirements have been identified leveraging two sources of information: the results collected during the workshops held with the cities (i.e. the customer journeys and the service blueprints) and the DoA (the detailed list of requirements is reported in Section 10).

Concerning the results collected during the workshops, these have been grouped in six categories.

- Unified Catalogue
- Dashboard and Reports
- Simulations and Analysis
- Scenarios Comparison
- Digital Twin, maps, and advanced 3D visualisations
- e-Participation

The high-level requirements of each category are reported in the following descriptions.

**Unified Catalogue:** unique point of access to knowledge, tools, models, sample/existing Nature-Based Solutions (NBSs), and datasets, that simplify the process of searching and accessing information needed for decision-making and participatory process.

- A searchable catalogue of available datasets (including data, documents, city plans, and urban planning regulations), tools, models, and sample/existing Nature-Based Solutions (NBSs).
- The catalogue should offer search options with parameters like keywords, tags, date ranges, and data sources.
- Concerning sample/existing Nature-Based Solutions search parameters should include criteria like air pollution, heat islands, etc.
- Search results include titles, descriptions, and associated files, with options to refine results by filters.
- Concerning provided details of sample/existing Nature-Based Solutions (from search results), these should include descriptions and images.

**Dashboards and Reports:** powerful tools for data visualization, analysis, and reporting made available for the end-users (e.g. decision-makers, urban planner, community leader, citizens, etc.); their aim is to allow the user to explore and understand relevant information.

- Dashboards should offer visualization options for real-time and historical data.
- Dashboards should include Key Performance Indicators (KPIs) and results from data analysis.
- It should be possible to create new KPIs and customize existing ones.
- It should be possible to create reports with text, images, charts, graphs, and map layers.

**Simulations and Analysis:** advanced tools for modelling, evaluating, and analysing environmental and urban planning solutions; Simulations and Analysis includes customizable simulation models, impact evaluation tools, and predictive model for specific issues (e.g. rainfall infiltration).

- Simulations and Analysis should include technical solutions for environmental impact modelling concerning different aspects (e.g. air quality, urban climate, heat islands, etc.).
- The users should be able to set parameters of simulations (e.g. target values) or use templates (e.g. pre-packaged configuration of simulations and models to simplify their use) that can be customised.
- Simulations and Analysis should offer What-if analysis capabilities.
- Simulations and Analysis should include impact evaluation capabilities concerning socio-economic and climate resilience aspects.

**Scenarios Comparison:** tool to define, evaluate, and compare urban planning scenarios, supporting urban planners and decision-makers towards informed decision-making and identification of the most effective and sustainable solutions.

- Scenarios Comparison should allow to define multiple scenarios by specifying their characteristics, e.g. type of intervention, associated costs, etc.
- The user should be able to compare scenarios and obtain summary reports.

**Digital Twin, Maps, and Advanced 3D Visualizations:** tools for exploring, visualising the urban environment and support the planning, monitoring and evaluation of interventions (e.g. NBSs):

- Maps to visualise urban areas, their infrastructural elements (e.g. road networks, buildings, green areas, etc.) as well as locations of urban interventions (e.g. NBSs) and associated relevant information.
- UI elements for searching and filtering urban interventions.
- Import and display designs from external applications (e.g., AutoCAD, BIM).

**e-Participation:** tools to enhance citizen engagement and participation in planning, monitoring, and evaluating urban interventions (e.g. NBSs). They aim to support municipalities in creating consensus and acceptance about urban interventions by empowering them to listen, understand, and address citizens' needs better.

- Tools for publishing content, including text, images, documents, and reports.
- Tools should offer access to educational materials and awareness campaigns (e.g. about the importance of NBSs).
- Tools should allow to implement and manage participatory budgeting campaigns.
- Tools should offer feedback mechanisms for citizens, allowing them to comment and provide input on published content.
- Tools should include a mobile app for accessing and interacting with content.

Concerning the requirements coming from the analysis of the DoA, these have been grouped in nine categories, that are briefly summarised below. The identified requirements prove to be complementary

to the ones identified from the analysis of the workshop. These further requirements (e.g. related to data management, climate analysis, and user interaction, etc.) are briefly summarised in the following.

### **Weather seasonal forecast and climate projections**

The URBREATH Toolbox should offer weather seasonal forecast and early warnings for extreme event based on climate change scenarios. These should include short-term anticipation to allow the implementation of protection strategies. Access to historical climate data and tailored climate information for specific areas of interest (i.e. for the pilots) should also be included. Climate projections should be designed to properly handle uncertainties (i.e. related to climate analysis) and consider extreme events also.

### **Nature-Based Solutions (NBS) Models**

The URBREATH Toolbox should include models for NBS to estimate their effects and impacts on various aspects (e.g. air quality, heat island effect, etc.). Spatial data such as 3D city morphology and vegetation distribution, represents key elements to implement these capabilities.

### **Socioeconomic analysis**

The URBREATH Toolbox should offer socioeconomic analysis to support the evaluation of the impact generated by NBSs (as well as climate change) on different socioeconomic groups and businesses. The generated results offer a support to both urban planners and policymakers in understanding the potential pros and cons of different solutions. Socioeconomic analysis should support also the identification of correlations between socioeconomic aspects and climate change effects (e.g. groups of population, business activities, etc. particularly impacted by climate changes).

### **Understandability and interpretability**

The URBREATH Toolbox should ensure interpretability of employed models (e.g. AI models) by adopting proper visualisations. Interactive visualizations should allow users to explore relationships between input features and predicted outcomes, that are used to feed decision-making process.

### **3D Digital Twin Models**

The URBREATH Toolbox should allow to implement 3D digital twin models by integrating geospatial data. Their aim is to support planning, monitoring and evaluation of NBSs. Digital Twins should allow scenarios planning and evaluation, as well as to export planning data, and visualise simulation results.

### **KPI Management**

The URBREATH Toolbox should offer technical solutions for the definition, management, calculation, and monitoring of KPIs. These solutions should be accessible through a user-friendly interface.

### **E-Participation Tools**

The URBREATH Toolbox should include ICT tools aiming to facilitate engagement of stakeholders into participatory process. These tools should offer user-friendly web and mobile interfaces and include features such as discussion forums and interactive maps, to enhance collaboration.

### **Data Management and Access**

The URBREATH Toolbox should offer technological solutions for data management and data interoperability, by offering simplified data access and reducing data silos. These solutions should allow to connect to diverse data sources, facilitating data exchange, as well as data spaces.

### **Access and Authentication**

The URBREATH Toolbox should include an ID manager, providing capabilities for user registration, authentication, and authorization.

The requirements reported in this document represent what the project recognised during the first year of activities and the base for the initial technical design of the URBREATH Toolbox (Section 4). These requirements, as well as the technical design of the URBREATH Toolbox and the related technological tools, will be revised during the implementation of the pilots.

## 4 Overview of URBREATH Toolbox

In collaborative projects involving Nature-Based Solutions (NBS), establishing a solid base architecture is critical for fostering coordination, integrating data, and ensuring the success of environmentally sustainable initiatives. Nature-Based Solutions often involve complex, interdisciplinary approaches that require input from engineers, urban planners, and local communities (as envisaged in Section 2). Given this complexity, a base architecture helps align these diverse stakeholders and their tools within a cohesive framework.

From the analysis of both customer journeys and service blueprints, as well as of the requirements derived from them, six characteristics have been identified as keys of the logical architecture of the URBREATH Toolbox.

- **Facilitating Cross-Disciplinary Collaboration:** NBS projects require the collaboration of various fields such as ecology, hydrology, urban planning, and civil engineering. A base architecture ensures that all participants are working on a shared platform, allowing seamless interaction between disciplines. It harmonizes methodologies, ensuring that environmental, social, and technical objectives are integrated into the project from the outset.
- **Centralizing and Standardizing Data:** In NBS projects, data such as ecological metrics, climate data, land-use information, and community input are crucial. A base architecture enables the creation of a centralized data environment where all parties can input, update, and access data in real-time. This ensures the accurate integration of scientific data with design and planning tools, avoiding errors or data silos.
- **Supporting Adaptive and Dynamic Project Management:** Nature-Based Solutions often need to adapt to changing environmental conditions or stakeholder inputs. A flexible base architecture allows for this adaptability by providing a structured yet modifiable framework where adjustments can be made efficiently. This is vital for ensuring that long-term environmental sustainability is met while allowing room for innovation or changes in project scope.
- **Enabling Scalability and Replication:** NBS projects are often part of larger regional or national efforts aimed at addressing climate change, water management, or urban resilience. A base architecture allows for scalability, enabling successful projects to be replicated in other regions or contexts. It also provides flexibility to incorporate local knowledge and conditions while maintaining a standardized approach for larger-scale replication.
- **Ensuring Stakeholder Engagement and Compliance:** A key aspect of NBS is the involvement of local communities and stakeholders. The base architecture should include platforms or tools for facilitating communication and input from these groups, ensuring that their needs and perspectives are incorporated into project design. Furthermore, it ensures that all participants adhere to national or international sustainability standards (e.g. UN's Sustainable Development Goals), as well as environmental regulations.
- **Enhancing Resilience and Long-Term Monitoring:** NBS projects are often long-term investments aimed at enhancing ecological and societal resilience. A robust base architecture

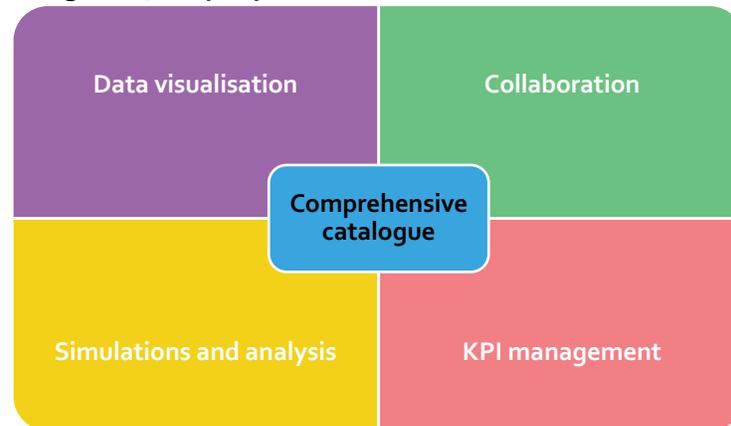
enables ongoing monitoring and data collection, allowing project managers and stakeholders to assess the success of the NBS over time and make necessary adjustments. This can include monitoring biodiversity, water quality, or carbon sequestration, ensuring that the solution continues to function effectively.

As suggested by the previous points, access and information sharing play a crucial role, since these capabilities pave the road to collaborations among stakeholders, implementation of data analysis, visualisation and data driven decision making. With this regard, a “comprehensive catalogue” is a central hub from where the other main capabilities originate, i.e. simulation and analysis, KPI management, data visualisation, and collaboration (Figure 15).

- The **comprehensive catalogue** should be able to capture a wide range of information, related to NBSs (including project descriptions, locations, implementation details, monitoring data, and performance indicators, as well as any relevant topic for the implementation of important activities, e.g. decision making, participatory process, co-creation, monitoring, etc.). Its primary aim is to enable informed decision-making, knowledge sharing, and effective evaluation of NBS effectiveness, by providing a solution for storing, organizing, and sharing information about various NBS projects, initiatives, and their associated data, also establishing a unified federation of existing scattered data sources at different levels (e.g. local, regional, national). With this regard, accessibility and user friendliness are essential, the catalogue should offer intuitive interfaces, ensuring that diverse stakeholders (e.g. researchers, policymakers, practitioners, etc.) can easily access and use the information contained within. This implies that information should include both the data and the associated metadata, which allows the users to better understand and discover the information they need.
- **Simulations and analysis** offer advanced models to assess the potential impacts and benefits of NBS projects. By simulating various scenarios and environmental conditions, stakeholders can gain valuable insights into the expected performance of NBS (e.g. in mitigating climate change, improving biodiversity, enhancing ecosystem services, etc.). Simulations allow for the exploration of different NBS implementation strategies and their potential outcomes under varying conditions (e.g. climate change projections). This enables informed decision-making regarding the most effective and sustainable NBS approaches.
- **KPI management** allows the definition, tracking, and reporting of key performance indicators (KPIs) associated with NBSs projects. This involves establishing relevant metrics to measure topics of interest (e.g. ecological, social, and economic benefits of NBSs), ensuring accountability, and facilitating continuous improvement.
- **Data visualisation** enables better understanding of knowledge and information (such as results of analysis and simulation, KPIs, etc.). Visualizing and exploring data (e.g. through charts, graphs, map layers, etc.) allow stakeholders to easily understand and communicate the effectiveness of NBS initiatives. This empowers decision makers to make data-driven adjustments and optimise NBSs’ implementation.

- **Collaboration** capabilities offer the chance to overcome barriers and improve decision making process, by allowing diverse actors involved in NBS planning and management (or interested in) to interact and exchange knowledge and feedback. The result is a shared view on NBSs, their role and advantages, as well as a participated planning of sustainable cities, that takes into account the needs of different segments of the population.

**Figure 15: Key capabilities of the URBREATH Toolbox**



The five main capabilities here identified are translated into a series of logical-technical building blocks, which are arranged into ten macro functional areas that are part of the initial logical architecture of the URBREATH Toolbox. Some of them can be directly linked to the key capabilities reported above, other are derived/implicit from them since represent enabling functionalities for their implementation (Figure 16 depicts the whole initial logical architecture of the URBREATH Toolbox).

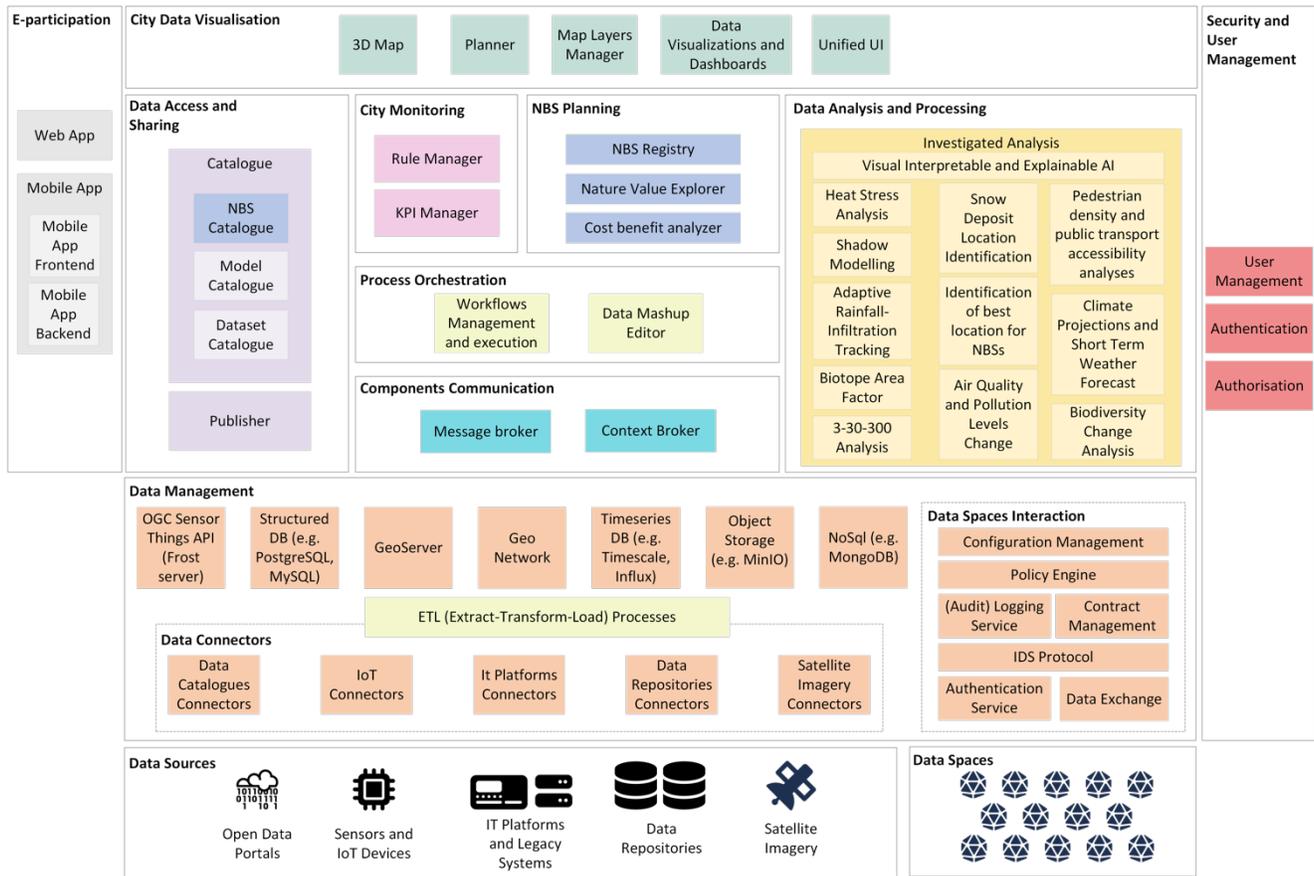
The ten macro functional areas of the initial logical architecture of the URBREATH Toolbox are:

- **Data Management:** this area includes the functionalities for the interconnection of the data sources and the management of the data collected from them, both static and real-time. These include data harmonisation and aggregation capabilities to properly treat data coming from heterogeneous sources that can be connected within a city (for this purpose, the Data Management area incorporates a sub element of the *Process Orchestration* area to take advantage of ETL processes). Examples of data sources are data repositories, such as databases, IoT devices, existing legacy IT platforms, and satellite imageries. Accordingly, the Data Management area offers the capabilities to manage diverse kind of data, structures, not structures, geo references, dynamic, etc. In addition, the Data Management includes the capabilities for the interconnection with data spaces.
- **Components Communication:** the macro area offers intercomponent communication channels between the different parts components of the URBREATH Toolbox and establishes a uniform way of interacting among them.
- **Process Orchestration:** this macro area includes capabilities to orchestrate complex processes within the URBREATH Toolbox that involve different components. The provided capabilities aim to support the definition of process and their executions, ensuring that interaction between the

involved components is properly executed. An element of this macro area (i.e. ETL processes) is incorporated into the Data Management area, to take advantages of these capabilities to implement data harmonisation and aggregation procedures concerning heterogeneous and scattered data.

- **Data Analysis and Processing:** this area includes specific data analytics and simulations, identified according to the needs and purposes of the URBREATH pilots. Their aim is to support decision-makers, urban planners and policymakers, in investigating specific aspects of the city. This area encompasses AI explainability tools, which ensure the interpretability and transparency of AI models. These tools provide interactive visualizations that allow users to explore relationships between input features and predicted outcomes, enhancing the decision-making process. By focusing on visual interpretability, these tools make complex AI systems more accessible and understandable for data scientists, domain experts, and non-expert users alike.
- **City Monitoring:** This macro area includes functionalities to monitor parameters of interest in the city (i.e. KPIs) to offers a comprehensive understanding of the status of the city and support decision and policy makers in planning activities (e.g. corrective activities) and interventions. Offered functionalities includes the possibility to implement complex rules that combine different KPIs (e.g. to raise warnings).
- **NBS Planning:** the NBS Planning macro area offers functionalities to support decision makers, planners, etc. in investigating, designing, and planning NBSs. Among the provided capabilities, it allows to define and design an NBS intervention by connecting it to simulations and scenario planning features, to investigate and evaluate the associated cost and benefits, as well as its socio-economic importance, considering aspects such as the impact of ecosystems on human well-being and the role of green spaces in recreation and health.
- **Data Access and Sharing:** this macro area provides a unique and uniform access point to information managed through the URBREATH Toolbox, such as datasets collected from connected systems (e.g. the connectors) and produced by the toolbox itself (e.g. results produced by analytics, simulations, etc.). For this purpose, among its capabilities, it allows also to publish datasets. The Data Access and Sharing macro-area integrates an element that is natively offered by the NBS Planning macro area, this is the NBS Catalogue, which offers the possibility to access information related to NBS projects.
- **City Data Visualisation:** this macro area offers the UIs of different components of the URBREATH Toolbox which require users' interaction and that offer data visualisation capabilities for them. Provided capabilities includes advanced data visualisation, DT visualisation (e.g. 3D maps), dashboards, etc.
- **E-Participation:** this macro area includes capabilities to support the engagement of stakeholders and their interaction within participatory process towards planning, monitoring and evaluation of interventions (such as NBSs projects).
- **Security and User Management:** this area includes the functionalities that allow to manage users, their role, access permissions, as well as the user authentication and authorisation.

Figure 16: Initial logical architecture of the URBREATH Toolbox



## 4.1 Data Management

This section provides details about the Data Management macro area of the URBREATH Toolbox, which main aim is to enable data collection, harmonisation, aggregation and management from heterogeneous and scattered data sources, both static (e.g. retrieved from data repositories) and dynamic (e.g. real-time data from IoT devices or legacy IT platforms).

To offer these capabilities, the Data Management macro area includes a set of logical/technical elements; the ones offering data storage capabilities are briefly summarised in Table 20.

**Table 20: Data Management logical/technical elements for data storage**

Logical/technical element	Description
OGC Sensor Thing API	OGC Sensor Thing API <sup>25</sup> is an open standard promoted by the Open Geospatial Consortium (OGC) which aim is to offer a unified approach to interconnect IoT devices, data they produce, and applications that consume that data. Since OGC Sensor Thing API is a standard, URBREATH identified an open-source implementation of that standard to be employed in the implementation of the Toolbox, which is the FROST Server <sup>26</sup> .
Structured DB	The Structured DB offers capabilities to store data in a predefined schema (structure). Its aim in the URBREATH Toolbox is to manage structured data collected from existing databases connected to the Toolbox, as well as structured data generated by the functionalities offered by the Toolbox itself (e.g. simulations and analysis). An example of Structured DB is PostgreSQL <sup>27</sup> , which offers the possibility to manage geographical and CityGML <sup>28</sup> compliant data through a dedicated extension (i.e. PostGIS <sup>29</sup> ).
Timeseries DB	The Timeseries DB offers functionalities that are dedicated for storing, managing and querying time-stamped data, that allow the implementation of monitoring and analysis capabilities concerning changes over the time about specific topics of interest (e.g. to monitor and analyse changes of the weather conditions in a city area through “series” of data collect form sensors). Examples of open-source Timeseries DB are InfluxDB <sup>30</sup> and TimescaleDB <sup>31</sup> .
NoSQL DB	The NoSQL DB (i.e. non-relational database) offers capabilities to store and manage data with flexible schemas (structures). An example of NoSQL DB is MongoDB <sup>32</sup> , which leverages BSON (Binary JSON <sup>33</sup> ) format to manage information.
Object Storage	The Object Storage offers capabilities to manage high volumes of data objects both structures (e.g. large CSV files) and unstructured such as multimedia files

<sup>25</sup> <https://www.ogc.org/publications/standard/sensorthings/>

<sup>26</sup> <https://github.com/FraunhoferIOSB/FROST-Server>

<sup>27</sup> <https://www.postgresql.org/>

<sup>28</sup> A standard data model promoted by the Open Geospatial Consortium to represent digital 3D models of cities and landscapes. <https://www.ogc.org/standard/citygml/>

<sup>29</sup> <https://postgis.net/>

<sup>30</sup> <https://github.com/influxdata/influxdb>

<sup>31</sup> <https://github.com/timescale/timescaledb>

<sup>32</sup> <https://github.com/mongodb/mongo>

<sup>33</sup> A binary-encoded serialization of JSON documents. <https://bsonspec.org/>

	(e.g. images, videos, etc.). Each file (i.e. object) is typically associated with a unique identifier and metadata. The Object Storage offers valuable functionalities to support the implementation of data analysis and simulation, allowing them to access large amount of data and to store produced results. An example of open-source object storage is MinIO <sup>34</sup> , which offers a set of API compatible with Amazon S3 services.
GeoServer	The GeoServer <sup>35</sup> is an open-source tool offering functionalities to manage geospatial data; it offers the possibility to publish geospatial data by supporting different formats (such as GeoTIFFs and Shapefiles, WMS, and WFS).
GeoNetwork	The GeoNetwork <sup>36</sup> is an open-source tool that allows to manage metadata of spatially referenced data (e.g. edit, search, etc.). Within the URBREATH Toolbox, it will work in combination with the GeoServer.

The Data Management area includes other two sets of elements, which belongs to Data Connectors and Data Spaces Interaction groups.

The first group (Data Connectors) represents the connection points between the URBREATH Toolbox and the data source it is connected to. This group includes connectors to interacts with different kind of data sources.

**Table 21: Data Management logical/technical elements for Data Connectors**

Logical/technical element	Description
Data Catalogues Connectors	The Data Catalogues Connectors allows to interact with heterogeneous and scattered data catalogues enabling the URBREATH Toolbox to collect metadata of datasets they manage and uniform those metadata according to a uniform format (i.e. DCAT-AP) and to establish a unique access point to search and discover the datasets (i.e. the Dataset Catalogue that is part of the Data Access and Sharing macro area). The candidate tool for the implementation of the Data Catalogues Connectors is Idra (see Section 11.2).
IoT Connectors	IoT Connectors offer capabilities to interact with IoT Devices and acquire data they produce. They support different protocols and translate IoT-specific protocols, making them compliant with the URBREATH Toolbox (e.g. according to OGC SensorThing API, NGSI-LD, etc.).
IT Platforms Connectors	The IT Platforms Connectors are custom components which aim is to allow the interconnection of legacy IT systems with the URBREATH Toolbox. These

<sup>34</sup> <https://github.com/minio/minio>

<sup>35</sup> <https://geoserver.org/>

<sup>36</sup> <https://github.com/geonetwork/core-geonetwork>

	connectors manage different activities to operate with IT legacy systems such as authentication and authorisation (to be authorised to interact with the connect IT system), and semantic adaptation (to adapt the exchanged data according to the data formats and models of the connect system and the URBREATH Toolbox).
Data Repositories Connectors	The Data Repositories Connectors allow to connect and perform SQL queries against heterogeneous data repositories. They enable to combine results obtained from scattered data repositories in a unique result, using a single query. The candidate tool to support the implementation of Data Repositories Connectors is Presto <sup>37</sup> , an open-source tool that already supports different technologies (e.g. Cassandra, Hive, Kafka, MongoDB, MySQL, PostgreSQL, etc.).
Satellite Connectors	The Satellite Connectors allow to connect and retrieve satellite imageries and observation (e.g. useful for the implementation of data analysis) from relevant hub, such as the Copernicus images repositories.

Between the Data Connectors and the elements of the Data Management macro area providing the data storage capabilities (OGC Sensor Thing API, Structured DB, Timeseries DB, etc.), an element of the Process Orchestration macro area is placed, the ETL Processes, which represents a logical perspective for the complex of transformation processes needed to adapt the data coming from the connectors according to the internal formats and standards adopted by the Toolbox (see Section 5).

The Data Management area includes other two sets of elements, which belongs to Data Connectors and Data Spaces Interaction groups.

The second group (Data Spaces Interaction) represents the connection points between the URBREATH Toolbox and the data source it is connected to. Its aim is to offer the capabilities that enables a seamless and trusted interaction and interoperability with the future European Data Spaces (such as Green Deal Data Spaces<sup>38</sup>), by taking into account the Data Spaces Blueprint [1] provided by DSSC<sup>39</sup> (Data Spaces Support Centre). The logical/technical elements belonging to this group are:

- **Configuration Management:** allows managing the configuration parameters connector (e.g. allowed protocols, etc.).
- **Policy Engine:** offers the capabilities allowing Usage Control policies.
- **Contract Management:** manages the contract negotiation between entities (e.g. users) involved in a data exchange process.

<sup>37</sup> <https://github.com/prestodb/presto>

<sup>38</sup> <https://green-deal-dataspace.eu/>

<sup>39</sup> <https://dssc.eu/>

- **The (Audit) Logging Service:** allows for the logging of relevant information during the execution of procedures implemented by the connector (e.g. changes of configuration, messages, data exchange, etc.).
- **IDS Protocol:** implements a specific communication protocol and interface for data exchange implements specific communication procedures for data exchange.
- **Authentication Service:** implements the authentication authorisation procedures of the connector from/to other platforms (i.e. inbound and outbound connections).
- **Data Exchange:** implements the interfaces for data exchange and communication/interaction with platforms participating in the data spaces (i.e. as data providers and/or consumers). As for the Protocol component, multiple instances of this component are allowed, so to enable multiple protocol bindings.

From a technological viewpoint, the open-source tool TRUE Connector<sup>40</sup>, is one of the candidate solutions for the implementation of elements of the Data Spaces Interaction group.

## 4.2 Components Communication

This section provides details about the Components Communication macro area of the URBREATH Toolbox, which main aim is to enable intercomponent communication between the tools composing the URBREATH Toolbox. It includes two components that are complementary: Context Broker and Message Broker.

The Context Broker manages the life cycle of context information and leverages a publish-subscribe mechanism to dispatch real-time updates about them. Users can create subscription to a specific piece of information or a set and be notified in case of update or if a new piece of information (that is compliance with specific criteria set by the user) is available. The candidate tool for its implementation is the Orion Context Broker LD<sup>41</sup>, which offers an implementation of both NGSI-LD APIs.

The Message Broker offers event streaming processing capabilities. It also leverages publish-subscribe mechanisms, that differently from the Context Broker, an application creates a subscription to a “topic” and receives updates only when another application writes on the same topic. The candidate tool for its implementation is the Apache Kafka<sup>42</sup>, which offers an open-source solution to support the implementation of high-throughput and low-latency data processing.

The Message Broker is more suitable for the implementation of event streaming and real-time data processing, whereas the Context Broker is more oriented to real-time information dispatching.

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<sup>40</sup> An IDS (International Data Spaces Association) certified connector for data sharing. <https://github.com/Engineering-Research-and-Development/true-connector>

<sup>41</sup> <https://github.com/FIWARE/context.Orion-LD>

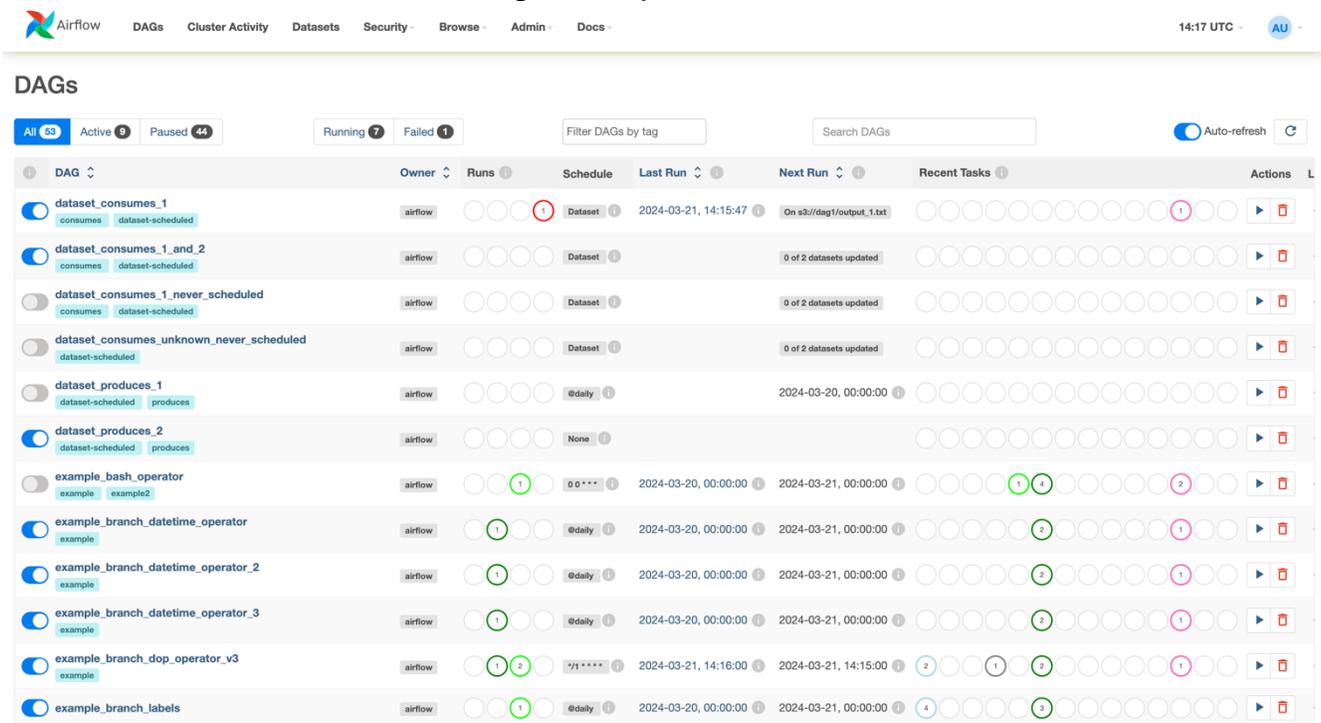
<sup>42</sup> <https://github.com/apache/kafka>

### 4.3 Process Orchestration

The Process Orchestration macro area allows the management and execution of complex process that involve different components and operations within the URBREATH Toolbox. Its purpose is to offer capabilities that enables the definition of process to be executed, the interconnections of the involved components, the execution of the process, as well as the monitoring of the executed process, making sure that under control.

This area includes two elements, Workflow Management and Execution and the Data Mashup Editor. The Workflow Management and Execution offer the proper functionalities for the definition, management and execution of workflow process. It also coordinates the interactions between different tools of the Toolbox to reach specific result. The candidate tool for its implementation is Apache Airflow<sup>43</sup>, an open-source solution which leverages Python scripts for the definition of workflows and includes scheduling and process monitoring capabilities, as well as a web-based UI to administer and monitor the executions of the workflows (e.g. their status, configuration parameters, logs, etc.).

Figure 17: Apache Airflow<sup>44</sup>

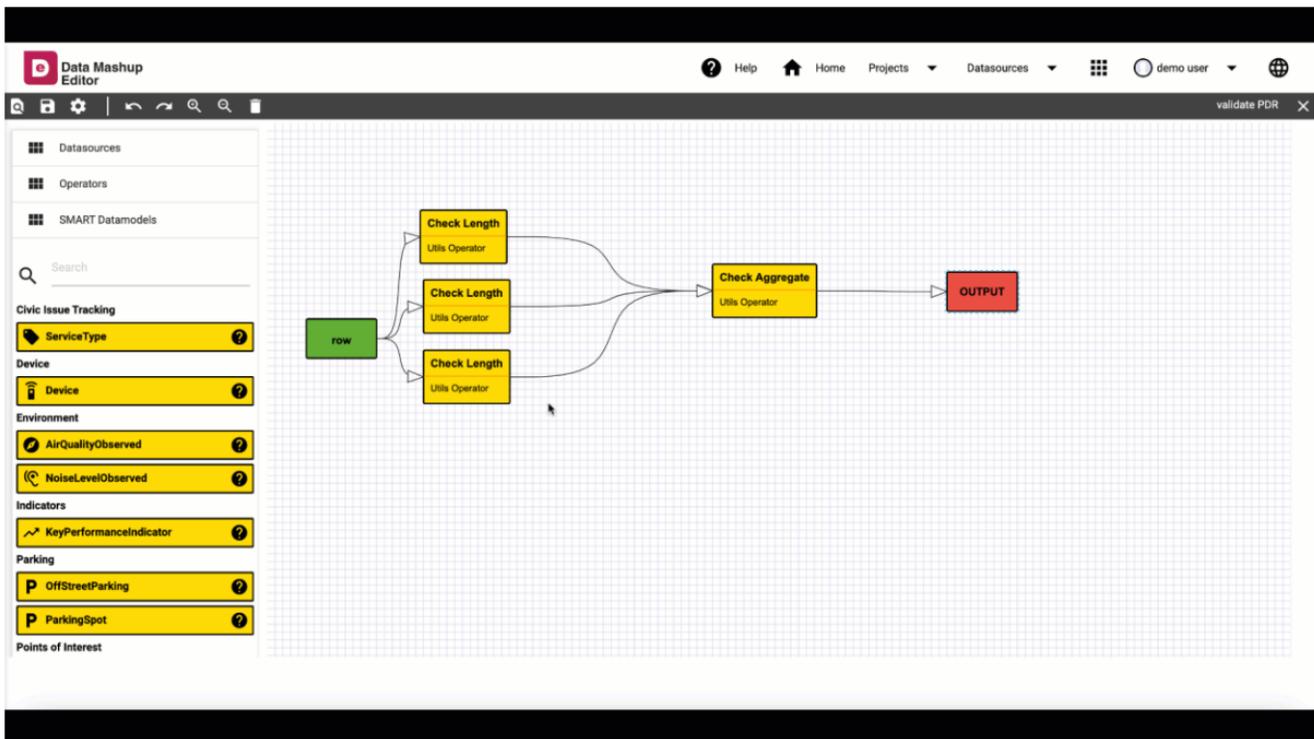


<sup>43</sup> <https://github.com/apache/airflow>

<sup>44</sup> Credits: The Apache Software Foundation - <https://airflow.apache.org/docs/apache-airflow/stable/ui.html>

The Data Mashup Editor offers capabilities more oriented to data processing for the implementation of data and transformation operation through the support of a graphical interface. The user is supported in the definition of the process; in contrast to Workflow Management and Execution (i.e. Apache Airflow) that requires a Python script, the Data Mashup Editor offers predefined operators to be involved in a process and connected each other within a canvas, offering a simplified approach for the end user. The Data mashup Editor is based on the homonymous tool that is part of the Digital Enabler<sup>45</sup>, a cloud native platform offering solutions to accelerate the discovery, collection, harmonisation, integration, analysis, and rendering of multi-dimensional and multi-source data.

Figure 18: Data Mashup Editor



## 4.4 Data Analysis and Processing

This section provides details about the Data Analysis and Processing macro area of the URBREATH Toolbox. Its main objective is to offer specific analysis based on the needs of the URBREATH's pilots. These analyses aim to provide urban planners and decision makers with support in the planning and design of NBSs. Currently eleven analyses have been identified, briefly summarised in Table 22.

<sup>45</sup> <https://www.eng.it/en/solutions/platforms/digital-enabler>

**Table 22: Summary of data analyses**

Data Analysis	Description
Heat Stress Analysis	Provides analysis capabilities of satellite images concerning a specific area of the city, aiming to evaluate heat exposure of urban infrastructures, heat exposure risk in relation to vulnerable segments of the population, the presence and number of green areas.
Shadow Modelling	Provides projections of the shadows casted by 3D objects (e.g. buildings, trees, etc.) at a certain hour of the day.
Adaptive Rainfall-Infiltration Tracking	An AI-based predictive model that uses precipitation, soil moisture measurements, weather conditions, and soil characteristics to estimate infiltration rates and predict soil moisture dynamics by analysing correlations between these variables.
Biotope Area Factor	Provide an implementation of the Biotope Area Factor; more details are provided in Section 11.3.
3-30-300 Analysis	Provide an implementation of the 3+30+300 rule defined by the Nature Based Solutions Institute (nbsi.eu) <sup>46</sup> , The 3+30+300 rule establishes that from a house people should be able to see at least 3 large trees, at least 30% of the neighbourhood where the house is located should be covered by tree canopy or vegetation, and that the house itself should be no more than 300 metres from the nearest public green space.
Snow Deposit Location Identification	Perform analysis of satellite images combined with models of meltwater infiltration into the soil (on preselected city areas coming from analysis of satellite images) and climate modelling (on preselected city areas coming from analysis of satellite images), to support the identification of potential areas of the city to be used as snow deposit.
Air Quality and Pollution Levels Changes	Provides estimation of air quality levels and related pollutant (e.g. due to traffic emission) as well as changes over time.
Pedestrian density and public transport accessibility analyses	The pedestrian density analysis estimates the number of people in a specific city area at a certain time, offering an indicator of the walkability of the area. On the other hand, public transport accessibility analysis provides an evaluation of how easily residents can access public transport services; to this aim, this analysis considers the proximity to transit stops, the frequency of service, and the network of the public transport.
Climate Projections and Short-Term Weather Forecast	Provide climate projections at different time scales of different parameters (e.g. temperature, humidity, rain levels, etc.) to estimate risk probability related to events of interest and critical weather situations (e.g. heat waves, droughts and extreme rainfall, etc.).

<sup>46</sup> <https://nbsi.eu/>

Biodiversity Change Analysis	Provide estimation about the impact of climate changes on local biodiversity at short-term and long term.
Identification of best location for NBSs	Provide combined information concerning the potential impact of an NBS (from previous analyses) in a specific area of the city.
Visual Interpretable and Explainable AI (VIE-AI)	The VIE-AI tool enhances AI model transparency by offering visualizations and interactive tools for understanding predictions. It supports feature importance visualization, SHAP values, and surrogate models, enabling users to explore data and make informed decisions.

Analyses reported in this section are preliminary and will be further investigated and validated according to the implementation activities of the pilots and their needs. Further details are provided in deliverables “D3.1 AI models for climate change vulnerability assessment and weather forecast - V1”, “D3.4 Numerical modelling for the NBSs - V1”, “D3.7 AI models for socioeconomic, community, organisational, and citizen well-being -V1”, and “D3.10 URBREATH Tools for AI-based algorithms and Data management and monitoring - V1”, as well as their updates.

## 4.5 City Monitoring

The City Monitoring macro area offers capabilities that enable the user to monitor and track specific aspects of the city, obtaining insights about their evolution and being aware if they reach critical conditions, as well as a comprehensive understanding of the status of the city, enabling informed decision-making and strategic planning. For these purposes, the City Monitoring macro area includes two solutions, the KPI Manager and the Rule Manager.

The KPI manager (Figure 19) offers capabilities to define tailored KPIs, set targets, and configure alerts (e.g. for deviations from desired performance levels). It tracks KPIs over time, allowing users to monitor performance trends and identify areas for improvement or intervention. This capability is supported by the possibility to graphically plot the evolution of KPIs. Collaboration among users is supported through the possibility to share KPIs, plots of the KPIs, and reports among them. Users can also combine existing KPIs, creating more complex ones.

The Rule Manager (Figure 20) offers functionalities that are complementary to the ones provided by the KPI Manager since it allows to create specific rules that follow the pattern “if-this-then-that”, to be executed in response to an event (e.g. an alert raised by the KPI Manager). Defined rules can include “AND” and “OR” Boolean operators.

Both KPI Manager and Rule Manager, are based on the homonymous tools that are part of the Digital Enabler.

Figure 19: KPI Manager

Figure 20: Rule Manager

## 4.6 NBS Planning

The NBS Planning macro area includes the functionalities providing support to decision makers and planners during the definition and evaluation of possible NBS interventions, giving them the chance to compare different alternatives to identify which one is the most suitable for their specific objectives.

To offer these capabilities, the NBS Planning macro area offers three technical elements, the Cost Benefit Analyzer, the Nature Value Explorer, and the NBS Registry.

The Cost Benefit Analyzer allows to compose possible scenarios of distribution of costs and benefits of an intervention, offering an estimation of their trend over the years. To facilitate user analysis, the results are shown both in tabular form and through interactive graphs. It is also possible to compare scenarios and export the results in PDF format.

The Nature Value Explorer offers functionalities to support the qualitative and quantitative evaluation of the impact of the ecosystems on human well-being, as well as its monetary quantification.

The NBS Registry allows to implement simulations and scenario planning of desired NBSs (e.g. by integrating analysis provided by the Data Analysis and Processing area into the defined scenarios). Its aim is to enable a data driven and evidence-based planning and design of NBS interventions that are sustainable and nature-driven.

In addition, the NBS Registry offers also capabilities to manage and share information about NBSs, allowing the users to explore, search, and analyse these solutions. From a logical perspective, these functionalities are part of the Data Access and Sharing macro areas where are represented by the NBS Catalogue.

Further information about the Cost Benefit Analyzer, the Nature Value Explorer, and the NBS Registry are reported in Section 11.

## 4.7 Data Access and Sharing

The Data Access and Sharing macro area aims to offer unified point to access, search and discover the information managed within the URBREATH Toolbox, both gathered from connected sources (e.g. data repositories, data catalogues, etc. connected to the URBREATH Toolbox through the connectors of the Data Management macro area) and generated by the toolbox itself (e.g. results produced by the data analyses that are part of the Data Analysis and Processing macro area).

This macro area comprises two main elements, that are the Catalogue and the Publisher. The Catalogue implements the functionalities to access, search and discover information that are main one of the Data Access and Sharing macro area. For this purpose, it comprises three sub elements, each devoted to the

management of a specific type of information: the NBS Catalogue, the Model Catalogue and the Dataset Catalogue.

The NBS Catalogue is dedicated to managing information related to NBS interventions. It is strictly related to the NBS Registry of the NBS Planning macro area, which aims to implement simulations and scenario planning for NBS interventions, supporting decision makers in selecting the most suitable according to their needs. Under this perspective, the NBS Catalogue offers the chance to easily access and discover examples of NBS interventions that can guide the decision-makers in selecting and designing the characteristics of the NBSs they would implement in the city.

The Model Catalogue offers a tailored solution to manage information concerning models and algorithms available within the URBREATH Toolbox. If the NBS Catalogue is intended to support mainly decision makers and planners in the identification of NBS solutions to be replicated or used as examples, the users of the Model Catalogue are mainly data analysts, data scientist, technology developers, that needs to obtain a clear view of what models, algorithms, etc, are already available and employed by the Municipality, to increase replication chance and reduce the time needed to implement new solutions (e.g. a data scientist employed in a department of the municipality can easily access models implemented by another department and cooperate following a win-win approach).

The Dataset Catalogue manages the datasets made available through the URBREATH Toolbox from connected sources (e.g. scattered and heterogeneous data catalogues) and the ones produced by data analyses offered by the Toolbox itself. To offer its capabilities, the Dataset Catalogue works in synergy with the Data Catalogues Connectors of the Data Management macro area (Table 21).

The NBS Catalogue, the Model Catalogue and the Dataset Catalogue, offers common functionalities that allow the users to search, filter, identify relevant information according to their needs (e.g. using keywords, data types, categories, etc.). In addition, the NBS Catalogue and the Dataset catalogue offer also the possibility to search and filter results using geo referenced attributes (e.g. by specifying an area of interest through a map).

Finally, the Publisher offers the possibility to publish new information (e.g. new datasets, 3D models of cities to feed the Digital Twin visualisations of the 3D Map that belong to the City Data Visualisation macro area, etc.) within the URBREATH Toolbox.

The candidate tools for the implementation of the NBS Catalogue, the Model Catalogue and the Dataset Catalogue, as well as of the Publisher are reported in Section 11.2.

## 4.8 City Data Visualisation

The City Data Visualisation macro area provides end user interactions capabilities to explore and visualise relevant information and make use of the advanced capabilities offered by the URBREATH Toolbox. It includes five main elements.

- **Unified UI** offers a harmonised “look & feel” for all the end user functionalities of the URBREATH Toolbox, as well as a comprehensive UI framework for the integration of diverse technological tools at the user interface level.
- **Data Visualisations and Dashboards** includes the end user functionalities to edit and manage dashboards able to combine different information (e.g. KPIs and related plots, map layers, results from data analyses, etc.). Its aim is to enable the user in representing useful information and build and share knowledge.
- **Map Layers Manager** offers a set of simplified functionalities for end users without technical skills to perform geo referenced queries and create map layers that can be then visualised on a map (e.g. the 3D Map) and exported as datasets and shared with other users.
- **3D Map** offers functionalities to access city related and geo referenced information through advanced 3D maps, that allow the user to obtain and explore in an intuitive and easy way complex data visualizations for urban planning, infrastructure management, and environmental monitoring.
- **Planner** provides the end users such as urban planners with functionalities to create and manage urban intervention projects leveraging realistic 3D models of the city and the possibility to integrate within them geo-referenced datasets (e.g. map layers), obtaining in a unified view the relevant information needed for decision-making.

The candidate tools for the implementation of the Map Layers Manager, 3D Map and Planner are reported in Section 11.

## 4.9 E-Participation

The E-Participation macro area provides the capabilities that enable stakeholders’ participation into decision making process of the Municipality. Its aim is to offer technical solution that foster engagement, participation, transparency and acceptance of intervention on public infrastructures (such as NBSs), as well as to enhance ability of the city to acquire a more realistic understanding of the needs of the citizens, the problems they face daily and what they would see in the city they live in.

This macro area includes two elements, a web application (Web App) and a mobile application (Mobile App), that are interconnected.

The Web application (based on Decidim<sup>47</sup> that is reported in Section 11.4) aims to offer the functionalities to manage participatory process and promote transparent and evidence-based participation and co-creation activities. Concerning the latter, the Web application will be integrated with other elements of the URBREATH Toolbox such as the Catalogue, the KPI Manager, the 3D Map, and the Map Layers Manager, to allow the user to reuse the information they manage into participatory and co-creation process, so to leverage evidence and data driven approaches when interacting with the other users (e.g. including references to NBS examples or to datasets within comments and proposals, or KPI plots and 3D maps and visualisation of NBSs into content they creates).

The Mobile App represents the mobile counterpart of the Web Application. It aims to offer a participatory and co-creation capabilities in mobility also leveraging geo localisation. To this aim, the mobile App includes two sub elements; the Mobile App Backend ensure the proper interaction with the Web App (i.e. Decidim), and the Mobile App Frontend offers the concrete end user functionalities accessible through a mobile device, such as a smartphone. The candidate tool for the implementation of the Mobile App is the e-Participation Mobile App reported in Section 11.4.

## 4.10 Security and User Management

The Security and User Management macro area aims to offer the capabilities that protect the URBREATH Toolbox from unauthorized and malicious access. To this aim, its functionalities allow to establish security measures to be adopted by the different elements that are part of the URBREATH Toolbox. These includes the definition of users' roles, their access rights to the functionalities of the Toolbox, as well as user management, unified login, etc. The candidate tool for the implementation of functionalities of the Security and User Management macro area is the open-source tool Keycloak<sup>48</sup>, which offers capabilities to implement centralized management and is compliant with standard protocols such as OAuth 2.0<sup>49</sup>.

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<sup>47</sup> Following the investigations performed by WP2 (that will be reported in the Deliverable "D2.1 URBREATH methodological framework for urban greening Living Labs and hybrid NBS interventions and adaptive pathways - V1"), Decidim has been selected among other e-participation platforms to be a potential candidate tool to implement the Web application. Roughly, Decidim has significant characteristics (e.g. the level of interaction with citizens, and the empowerment approach on which it is based; it's available as open-source software; the usability and employment from different territorial agencies and institutions; etc.) that allow a high level of flexibility and interoperability that could be effective in considering a the URBREATH platform to be used and deployed by other contexts while scaling out.

<sup>48</sup> <https://github.com/keycloak/keycloak>

<sup>49</sup> A protocol for the management of authentication procedures. <https://oauth.net/2/>

## 5 Concepts and principles for interoperability and replicability

URBREATH Toolbox aligns with EU initiatives to foster the digitalisation of European cities; among the different initiatives promoted by the EU Commission, the "Living-in.EU" declaration<sup>50</sup> is considered. Living-in.EU is an initiative aimed at transforming European cities into smart, sustainable, and citizen-centric communities. It encourages cities to commit to a common vision and approach for digital transformation. This initiative is built on principles like citizen engagement, ethical data usage, and interoperability, that are reported in a declaration<sup>51</sup>.

A particular emphasis is placed on principles such as "technologies as key enablers", "interoperable digital platforms based on open standards and technical specifications", as well as "Application Programming Interfaces (APIs) and shared data models.", whose aims are to avoid "Vendor Lock-In" and "City Lock-In" effects and to increase opportunities for replications and adoption of valuable solutions conceptualised, implemented and experimented among cities.

One of the main challenges URBREATH faces from the technological perspective is the integration of different technologies into a modular and customisable ICT toolbox (among them digital twins, artificial intelligence, simulations, digital visualization, such as 3D city models, etc.). The Toolbox is designed for the public sector to support data-driven decision-making in urban planning (taking into consideration Nature Based Solutions) exploiting also community participation, towards urban revitalisation, resilience and climate neutrality.

The main goal of the Toolbox is to offer cities interoperable software components that can be integrated into existing IT systems to foster their digital maturity towards ICT solutions able to monitor and analyse the urban areas and support the planning and implementation of urban revitalisation projects.

Table 23 briefly describes URBREATH's view concerning the six principles of the Living-in.EU declaration from the perspective of the URBREATH Toolbox.

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<sup>50</sup> <https://living-in.eu/>

<sup>51</sup> Declaration on joining forces to boost sustainable digital transformation in cities and communities in the EU | Living in EU, <https://living-in.eu/declaration>

**Table 23: URBREATH Toolbox viewpoint about Living-in.EU principles**

Living-in.EU principle	URBREATH's view
A citizen-centric approach.	URBREATH Toolbox will include functionalities and technical solutions to foster and facilitate connection and engagement of people in the planning of urban revitalisation projects (e.g. NBSs), allowing them to play a role in creating local solutions aimed at increasing wellbeing and towards more sustainable and resilient cities.
A city-led approach at EU level.	The identification of the functionalities of the URBREATH Toolbox has been based on a strong involvement of the nine URBREATH cities (Madrid, Parma, Athens, Leuven, Aarhus, Tallinn, Kajaani, Cluj-Napoca, and Pilsen) into a series of meetings and cocreation activities, leveraging cooperation between cities and project partners. This method aimed to employ strategic collaboration between involved parties to pave the road to the future scale-up of the digital solutions defined by the project, benefiting from a city-led approach.
The city as a citizen-driven and open innovation ecosystem.	As mentioned in the first point (a citizen-centric approach), the URBREATH Toolbox will include solutions to foster connection and engagement of people (i.e. E-Participation tools). These solutions aim to offer the opportunity to implement more efficient co-creation activities that involve local communities also in real-life testing of innovative digital solutions (e.g. Digital Twins) as part of Local Living Labs. The purpose is to make sure that local communities are involved in the creation and validation of local solutions, both digital (e.g. data analysis and visualisation) and not (e.g. local NBSs).
Ethical and socially responsible access, use, sharing and management of data.	The URBREATH Toolbox will include solutions to ensure security and prevent unauthorised access to data. These solutions will offer the possibility to manage user and associated roles and access rights. Concerning the decision-making process, the more advanced tools (such as those related to data analysis) will be documented to guarantee the needed transparency and the avoidance of potential biases, and where possible made available as open source.
Technologies as key enablers.	URBREATH Toolbox has been conceived as a set of modular technological solutions that can be combined and integrated with existing IT systems, to support cities in the path toward digital maturity. Each tool is designed to be as much as possible self-consistent and autonomous, but able to be combined with others to accomplish more and more advanced tasks. This approach aims to offer a wider range of applicability opportunities and to facilitate cities in the selection, customisation and integration of the components they need, without being forced to adopt "unnecessary" components.
Interoperable digital platforms based on open	Interoperability is a key element to ensure the replicability of technological solutions. The URBREATH Toolbox leverages European and

standards and technical specifications, Application Programming Interfaces (APIs) and shared data models.	internationally recognised standards (such as ETSI NGSI-LD, DCAT-AP, INSPIRE, and OGC SensorThing) to offer a wide range of possibilities for adopting provided technological solutions. These will be also complemented with documentation (also technical). The objective is to reduce barriers (e.g. vendor lock-in and non-interoperable proprietary protocols) that prevent the adoption of new technologies in the cities.
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Strictly connected with the Living-in.EU declaration, OASC<sup>52</sup> MIMs<sup>53</sup> and MIM Plus represent a relevant added value for the URBREATH Toolbox.

OASC MIMs are a set of guidelines designed to support cities and communities in achieving interoperability of data, systems, and services. These mechanisms address technical challenges and offer standardized data models and interfaces that facilitate seamless interaction between different platforms and services.

How is MIMs supporting Living-in.EU targets?

- **Common Standards:** MIMs provide the technical specifications and standards that cities need to implement the principles outlined in the Living-in.EU declaration. This includes guidelines on data sharing, system integration, and platform interoperability.
- **Scalability and Replicability:** By adopting MIMs, cities ensure that their digital solutions are scalable and replicable across different regions. This supports the Living-in.EU goal of creating a harmonized digital landscape where the best practices and innovations can be easily shared and adopted.
- **Enhanced Collaboration:** MIMs enable cities to collaborate more effectively by providing a common language and framework for data and system interaction. This fosters a sense of community and joint effort, aligning with the Living-in.EU vision of cities working together towards common goals.
- **Data-Driven Decisions:** MIMs ensure that cities can collect, analyse, and share data in a standardized way, leading to more informed and data-driven decision-making. This is crucial for achieving the sustainability and citizen-centric objectives of Living-in.EU.

MIMs support cities in implementing NBSs for carbon neutrality by ensuring seamless data sharing and integration across various platforms and systems. This interoperability is crucial for effectively managing and utilizing data related to natural resources, carbon emissions, and environmental impacts [2]. By facilitating the exchange of information, MIMs enable cities to:

- Identify and prioritize NBS interventions that maximize carbon sequestration and offset emissions.

<sup>52</sup> Open and Agile Smart Cities and Communities

<sup>53</sup> Minimal Interoperability Mechanisms - <https://oascities.org/minimal-interoperability-mechanisms/>

- Monitor and evaluate the effectiveness of NBS in real-time, allowing for adaptive management and continuous improvement.
- Integrate NBS into urban planning processes, ensuring that nature-based approaches are considered in all aspects of city development.

Currently, there are ten MIMs, some of them under definition. More detailed information about MIMs can be found on their dedicated web site<sup>54</sup>.

While MIMs strive to enable a global marketplace for data, systems and services, MIMs Plus provides this for the European market. The Living-in.EU movement and its Technical Working Group is responsible for moving this work forward with the guidance of OASC to ensure that MIMs and MIMs Plus remain in dialogue.

Furthermore, the URBREATH Toolbox will include technological solutions to enable interoperability with EU Data Spaces, i.e. the Data Space Connector. The aim of the Data Space Connector is to allow an IT platform to interoperate and exchange data with forthcoming European Data Spaces (such as the Green Deal Data Spaces). For this purpose, the Data Space Connector is aligned with relevant initiatives (such as IDSA<sup>55</sup>, SIMPL<sup>56</sup>, DSSC<sup>57</sup>, and DS4SSCC-DEP<sup>58</sup>) and GAIA-X to utilize frameworks for secure data handling and cloud services. In this case also, the objective is to offer cities a series of software components that are easy to use and integrate into their own IT system, enabling them to join Data Spaces and benefit from wider data access and exchange.

With this regard, it is important to underline the preparatory action for European data spaces for smart communities (DS4SSCC-DEP) published its blueprint in 2023. The blueprint aligns with the building blocks of the Data Space Support Centre building blocks<sup>59</sup> and elaborates upon it by mapping the MIMs onto the blocks [3].

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<sup>54</sup> <https://mims.oascities.org/>

<sup>55</sup> International Data Spaces Association - <https://internationaldataspaces.org/>

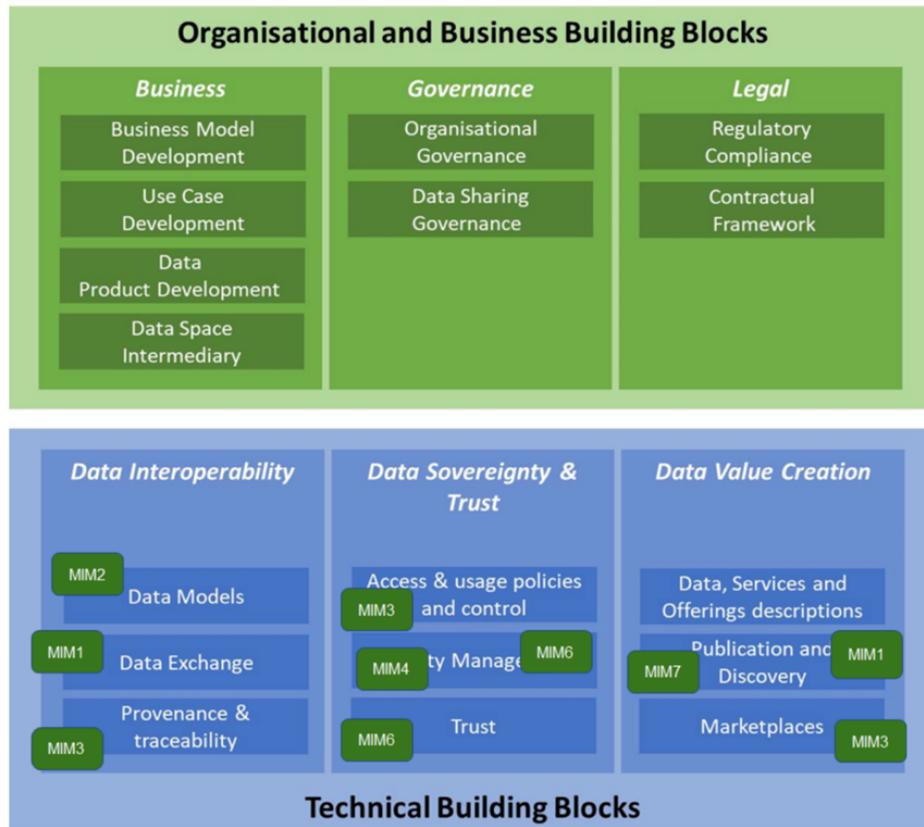
<sup>56</sup> A middleware platform funded by the EU Commission to support secure data exchange - <https://simpl-programme.ec.europa.eu/>

<sup>57</sup> Data Spaces Support Centre - <https://dssc.eu/>

<sup>58</sup> European data space for smart communities - <https://www.ds4sscc.eu/>

<sup>59</sup> <https://inventory.ds4sscc.eu/catalogue-of-specifications>

Figure 21: MIMs mapping on Data Space Support Centre building blocks<sup>60</sup>



<sup>60</sup> Edited image; original image from Data Spaces Support Centre - <https://dssc.eu/space/BBE/178421761/Building+Blocks+%7C+Version+0.5+%7C+September+2023>

## 6 Conclusions

This document reports the initial requirements and design of the URBREATH Toolbox, whose aim is to offer a comprehensive set of tools that can act as a whole solution to support municipalities in planning, steering, managing and monitoring NBS-related interventions, and enables users of the Toolbox (e.g. cities) to leverage the engagement participation and contributions of relevant stakeholders.

The initial design of the URBREATH Toolbox is based on the needs and problems of these stakeholders, which revolve around NBSs. From this, a series of personas was derived. The personas supported the definition of customer journeys and service blueprints. The analysis of the customer journeys and service blueprints produced a series of requirements enriched by a second set derived from the analysis of the DoA.

The final steps consisted of designing the initial version of the logical architecture of the URBREATH Toolbox, identification of its logical/technical elements, their roles and aggregation into macro functional areas, by considering uniformity in terms of provided capabilities and complementarities among the macro functional areas.

The work concerning the technical specifications of the URBREATH Toolbox does not conclude with this document.

The actual implementation of the technological components of the URBREATH Toolbox is performed in WP3 and WP4, where these activities already started in parallel and in synchronisation with the work carried out for the initial design of the URBREATH Toolbox (reported in this document) and will proceed following the identified requirements. At the same time, the design of the URBREATH Toolbox and its technical specifications will be further investigated. This activity will continue in WP4, where the undertaken actions will further detail the Toolbox, and how its components work together as a unique solution to provide different digital services for end-users (e.g., digital twins, e-participation tools, dashboards and maps, etc.). This process will also leverage feedback collected during the implementation of the pilots, in WP5, where the Toolbox components will be selected and put into operations according to their needs.

## 7 References

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## 8 Annex A - Cities' use case scenarios

Below a summary table with the complete list of cities' use cases as outlined thanks to the data collection performed (for more details please refer to the deliverable D2.4 "Use case scenarios and baselines"). In total, they are 54 use case scenarios, around six per each of the nine URBREATH pilot cities. The use cases highlighted with a star are the ones identified as top priorities by the cities.

**Table 24: Summary of cities' use cases scenarios**

Climatic Zone	City	Use case scenarios
Atlantic	Leuven - LEU Front Runner City	To monitor environmental effects and ecosystem services resulting from the redesign of the square. ★
		To monitor if the planned NBS implementation impact traffic.
		To monitor if there is a modal shift (after the NBS implementation).
		To monitor social justice and wellbeing. ★
		To get input and interaction with stakeholders to shape their case (using living lab and LDT). ★
		To get input and interaction with stakeholders to evaluate the NBS implementation (using LL and LDT).
	Aarhus - AA Follower City	To understand the reduction of <b>motorized mobility</b> in the area after the increased number of pedestrians sqm. ★
		To understand the reduction of water flooding in the area after the intervention of a subterranean path for the rainwater.
		To understand the reduction of noise pollution in the area (after the NBS implementation).
		To understand the evolution of residents' livability in the area (after the NBS implementation). ★
		To simulate the reorganization of the main square in the LDT to support the communication with residents and local community. ★
		To measure the above parameters (mobility and livability) in different scenarios, using LDT.
Boreal	Tallinn – TLN Front Runner City	To explore possibilities of location of specific NBSs for snow meltwater solutions on site. ★
		To understand the effectiveness of the selected NBS for snow meltwater infiltration. ★
		To assess habitat, biodiversity restoration (after the NBS implementation).

		To understand the changes in accessibility in the area (after the NBS implementation), i.e. visitors' number/more vulnerable users (e.g. children). ★
		To estimate the potential change of cars driving in the area (after the NBS implementation).
		To engage residents and local community in co-planning process.
		To assess residents' satisfaction with the re-designed area (after the NBS implementation). ★
	Kajaani – KA Follower City	To design potential ideas for NBSs for better water management to achieve flood-proof city. ★
		To estimate potential costs-benefits of such NBSs. ★
		To assess habitat, biodiversity restoration (after the NBS implementation).
		To understand biodiversity support mechanisms related to NBSs. ★
		To engage citizens/youth in the co-planning process.
Continental	Cluj-Napoca – CLUJ Front Runner City	To integrate greening simulations in the LDT. ★
		To understand the changes (increase?) in shaded areas (after the NBS implementation). ★
		To demonstrate the value of green pockets for multi-family housing areas. ★
		To understand CO2 emissions reduction (after the NBS implementation). ★
		To understand the reduction in traffic (after the NBS implementation).
		To raise awareness.
		To involve community in co-creation (i.e. trees selection and planting). ★
		To understand the sense of wellbeing (after the NBS implementation).
	Pilsen – PILS Follower City	To investigate if there is an impact on traffic (size and modal shift) using a LDT.
		To see if there is an impact on air quality, noise, heat and shadow impact using a LDT.
		To understand the perception of residential Quality and safety of public space (after the NBS implementation).
		To visualise designs in a LDT.
		To visualise designs using generative AI-driven tools.

		To investigate the social impact on well-defined target groups (i.e. pedestrians and cyclists?).
Mediterranean	Madrid – MAD Front Runner City	To organise training and codesign sessions. ★
		To measure the success level of collaboration initiatives.
		To offer LDT-visualisation of datasets, simulations to district officials to get a better knowledge and insights. ★
		To centralise past/ongoing studies, plans, interventions for the Villaverde district. ★
		To centralise existing information about potential NBS for the Villaverde district. ★
	Athens – AT Follower City	To monitor the improvement in air quality in the Neos Kosmos area and to investigate the correlation with traffic in particular
		To invest potential candidates for pocket parks, green walls, and other NBS. ★
		To investigate the accessibility of NBS.
		To analyse the changes (improvement) in stormwater management.
		To analyse the changes (reduction) of urban heat islands. ★
		To increase awareness, engagement, participation and cocreation with stakeholders (local governments, residents, investors). ★
	Parma – PA Follower City	To engage technicians and administrators in co-creation of NBSs. ★
		To test green renovations actions in the local digital twin (technicians can model the LDT). ★
		To understand the changes in mobility, i.e. reduction in traffic and modal shift and/or increase in soft mobility (after the NBS).
		To understand the changes in climate resilience of the area (after the NBS, i.e. unsealing the area).
		To collect the information related to the green strategy and show results to local communities. ★

## 9 Annex B – Initial stakeholders’ mapping

This section reports the initial stakeholders’ mapping performed by the nine cities involved in the URBREATH project considering an IT perspective. The mapping is summarised in Table 25; for each city, stakeholders are arranged in two groups: internal stakeholders of the Municipality and external stakeholders of the Municipality. Information reported in this section represents the base for initiating discussion within the cities to investigate the IT functionalities of the URBREATH Toolbox and to support the definition of the personas used to guide the workshops about the customer journeys and service blueprints.

Table 25: Initial stakeholders’ mapping

Name, short description and role	What does it want to obtain (gains)? & Gain creators	What problems does it encounter in doing so (pains)? & Pain relievers
<b>Madrid – Internal stakeholders of the Municipality</b>		
<p><b>Madrid City council Urban planning.</b></p> <p>Strategic planning team, public realm and parks and green areas teams. In charge of NBSs and urban regeneration project planning and implementation.</p> <p>Connected to the team's mandate and goals.</p>	<p><b>Gains:</b> Criteria to intervene, from an inter-sectorial approach to design and launch projects of NBS. Access organised, practical and concise information to guide their work.</p> <p><b>Gain creators:</b> Obtain a comprehensive view of the different aspects to be considered for the design of suitable NBSs; current status criteria to be considered and their spatial distribution within the city and specific areas (e.g. through map layers, such as heatmaps). Possibility to combine in a single view 2 or more criteria and explore (at a high level) their mutual relations (correlation vs causation).</p>	<p><b>Pains:</b> 1) Lack of common criteria to cross-cut NBS in projects; 2) Lack of accessible information to guide the work on NBS; 3) Disconnection between departments; 4) Lack of inter-sectorial approach (crossing social data with urban, economic and environmental).</p> <p><b>Pain relievers:</b> A unique point to access scattered information related “planned / under implementation / implemented” NBSs and managed by different departments of the Municipality.</p> <p>Establish a common communication/collaboration process among departments (internal communication) supported by tools (also digital), defining the role the tools play within the process and</p>

	<p>A unique point to access scattered information related “planned / under implementation / implemented” NBSs and managed by different departments of the Municipality. Information could be provided as dataset enriched with metadata (e.g. for search purposes) and cross references (where needed/useful).</p>	<p>the way they should be used, as well as the expected goals to be reached through their use.</p> <p>Allow smoother interaction between departments through a clearer view of the NBS-related procedures and processes, contact points and relative responsibilities/roles in the process.</p> <p>Facilitate communication and knowledge exchange among departments, e.g. easy to build and share reports/dashboards and feedback/comments.</p>
<p><b>Madrid City council Climate change and energy team.</b></p> <p>Municipal teams - Climate change and energy - in charge of climate adaptation and resilience strategies.</p> <p>Connected to the team's mandate and goals.</p>	<p>Same above</p>	<p>Same above</p>
<p><b>Other relevant Madrid City Council teams</b></p> <p>Other departments: housing, social services, economy. Not involved in NBSs planning, implementation or maintenance directly but with decision making processes that</p>	<p>Same above</p>	<p>Same above</p>

<p>need to be considered and integrated.</p> <p>Indirectly connected to mandate and goals.</p>		
<p><b>Madrid City Council Data and Digital teams.</b></p> <p>Can connect process to broader mandate and goals, needs to input for successful outcome.</p>	<p>Same above</p>	<p>Same above</p>
<p><b>Madrid – External stakeholders of the Municipality</b></p>		
<p><b>San Cristóbal Community Board</b></p> <p>Working group made up of all the associations that work in the San Cristóbal neighbourhood.</p> <p>Within the neighbourhood’s aesthetics and beautification commission, this group cares for the improvement of the neighbourhood’s green spaces, which although they are abundant, their state of conservation is poor.</p> <p>In a neighbourhood where the quality of housing is very low, the importance of NBS is essential so that the neighbourhood’s public</p>	<p><b>Gains:</b> General improvement of the neighbourhood’s public spaces, given that it is an area where the homes have poor construction quality and in some cases more than one family lives on each floor, which makes it essential to have a quality public space that meet the needs for climatic comfort that homes cannot provide.</p> <p><b>Gain creators:</b> Obtain an estimation of the climate and well-being conditions of the area of interest (e.g. heat island, exposure to extreme weather events, availability of indoor/outdoor recreation facilities/furniture).</p>	<p><b>Pains:</b> Higher quality public spaces generate greater attraction for the diverse cultural profiles that inhabit the neighbourhood, which can generate conflictive situations derived from a lack of a culture of coexistence.</p> <p>Some profiles may be more clearly excluded in these spaces, such as older people and children.</p> <p><b>Pain Relievers:</b> Not IT related pain relievers were identified.</p>

<p>spaces meet the comfort needs during heat waves.</p>		
<p><b>Navas de Tolosa and Sagunto public schools</b></p> <p>Management team, teaching team, parents' association and students from both schools.</p> <p>More and more schools are worrying about modifying their playgrounds to make them more comfortable and adapted to high temperatures, which among other things includes the introduction of NBS. Specifically, the playground of the Navas de Tolosa school is being transformed so that its playground can be opened outside of school hours and serve as public infrastructure for the entire neighbourhood.</p> <p>The playgrounds of public schools in Madrid are basically concrete surfaces with little presence of vegetation. Around the month of May, with the arrival of the first</p>	<p><b>Gains:</b> Improvement of the climatic conditions of the schoolyard in the school period where heat waves already occur (in Madrid this can begin as early as April or May). Possibility of serving as public infrastructure adapted to climatic conditions at times and dates where the building does not function as an educational space.</p> <p><b>Gain creators:</b> Obtain an estimation of the climate and well-being conditions of the area of interest (e.g. heat island, exposure to extreme weather events) over different periods of the year. Establish communication (offline + online) with local communities to identify (co-create) potential usage opportunities of the building during school closures.</p>	<p><b>Pains:</b> In some cases there may be a certain resistance (minor, in any case) on the part of some students when the space available for classic sports practices (football and basketball, in the case of Spain) is reduced. In cases where it is decided to open the playground publicly outside of school hours, it is necessary to plan for the management and maintenance of the space.</p> <p><b>Pain Relievers:</b> Not IT related pain relievers were identified.</p>

<p>heat waves, these patios begin to become uninhabitable.</p>		
<p><b>Educación Cultura y Solidaridad (ECYS) - NGO Education, Culture and Solidarity</b></p> <p>NGO whose objective is that the residents of San Cristóbal have a dignified life, being able to enjoy opportunities to know, participate and collaborate in the construction of our neighbourhood.</p> <p>ECYS is located in one of the areas of the neighbourhood where it is most necessary to regenerate green spaces through the introduction of NBS. ECYS can collaborate in the mediation process with the residents of that area, since it is a place with high social conflict.</p> <p>This organization carries out numerous activities in outer space. In fact, its headquarters are located in an area with various garden spaces in poor condition that would be in its interest to recover.</p>	<p><b>Gains:</b> This organization is based in a particularly degraded green space, so the introduction of NBS in the surrounding green spaces would expand the range of activities they can organize.</p> <p><b>Gain creators:</b> Obtain a map of current available indoor/outdoor recreation facilities/furniture (benches, playgrounds, public spaces, etc.) and the expected ones as potential results from the implementation of the NBS.</p>	<p><b>Pains:</b> The type of people with whom this organization works are not always liked by the neighbours who live in the blocks attached to these green spaces, so increasing the possibility of using these spaces can lead to confrontation.</p> <p><b>Pain Relievers:</b> Not IT related pain relievers were identified.</p>

<p><b>Continuing Care Program (PAC, in Spanish)</b></p> <p>Service of the Villaverde District Board made up of social workers who provide support in the schools of San Cristóbal. They also do street work with young people outside of school hours.</p> <p>Due to its direct contact with young people from the neighbourhood, PAC has a high capacity to generate mediation processes in the public space that Favor the implementation, care and good management of the NBS.</p> <p>Outside of school hours, PAC does street work with young people. As long as public spaces are better equipped for stay, it will Favor the development of their activities.</p>	<p><b>Gains:</b> From April to approximately October, having a green space adapted to the climatic conditions allows us to greatly expand the range of activities that this organization can carry out with its young people.</p> <p><b>Gain creators:</b> Obtain an estimation of the climate and well-being conditions of the area of interest over different periods of the year.</p>	<p><b>Pains:</b> In some cases, the improvement of these spaces can become an attracting element for various people with inappropriate behaviour, especially if they happen in front of the young people with whom this organization works.</p> <p><b>Pain Relievers:</b> Not IT related pain relievers were identified.</p>
<p><b>Parma – Internal stakeholders of the Municipality</b></p>		
<p><b>Departments of the Municipality</b></p> <p>Maintenance and green spaces, Urban Planning, Civil protection, Public works and infrastructures,</p>	<p><b>Gains:</b> Create an effective strategy on NBS</p> <p><b>Gain creators:</b> Ability to compare scenarios in which different NBS are evaluated (e.g.</p>	<p><b>Pains:</b> Lack of knowledge of the strategic role of NBS. Too fragmented process and poor interaction among departments, no strategy at Admin level</p>

<p>Mobility, Digital Transition, Public companies (ATES, ADE, ASP, ACER, Parma Infanzia)</p> <p>Co-planning of NBS, realisation of NBS realisation and maintenance of NBS</p>	<p>concerning their potential contributions in solving problems affecting the city).</p>	<p><b>Pain Relievers:</b> Simple to understand case studies about NBSs and their role (e.g. to face climate change) made accessible in different forms, e.g. videos, slides, online interactive manual, etc. Availability of webinar (or pre-recorded one), class, etc.</p> <p>Establish a common communication/collaboration process among departments; the communication/collaboration process could be supported by tools (also digital), defining the role they play within the process and the way they should be used, as well as the expected goals to be reached through their use.</p>
<p><b>Parma – External stakeholders of the Municipality</b></p>		
<p><b>University of Parma</b></p> <p>Urban regeneration, adaptation to climate change and quality of public space</p> <p>Research, planning of NBS in urban areas.</p>	<p><b>Gains:</b> urban regeneration applied to adaptation</p> <p><b>Gain creators:</b> Availability of on-line tools through which provide feedback about intervention for engagement, to support co-creation activities, etc.</p>	<p><b>Pains:</b> difficulties in obtaining comprehensive information about impact of NBSs.</p> <p><b>Pain relievers:</b> Obtain information about the impact NBSs generates (e.g. socio-economic aspects, well-being, environment, biodiversity, etc.) through reports, KPIs, map layers, etc.</p>
<p><b>KMVerde Parma</b></p> <p>Consortium aimed to create permanent green areas and woods in Parma and its province.</p>	<p><b>Gains:</b> Increase local well-being; involvement of the community (citizens, enterprises, etc) in green areas realisation</p>	<p><b>Pains:</b> difficulties in obtaining comprehensive information about impact of NBSs.</p> <p><b>Pain relievers:</b> Obtain information about the impact NBSs generates (e.g. socio-economic aspects, well-</p>

<p>Realisation of green spaces &amp; urban forests</p> <p>Provide support in the planning stage.</p>	<p><b>Gain creators:</b> Availability of on-line tools for engagement, to support co-creation activities, etc.</p> <p>Access to reports and KPIs about the impact generated by NBSs (e.g. about environment, biodiversity, climate resilience, etc.).</p>	<p>being, environment, biodiversity, etc.) through reports, KPIs, map layers, etc.</p>
<p><b>CEA – Environmental Ethics Centre</b></p> <p>Adaptation to climate change.</p> <p>Training and communication activities; participation of adaptation measures.</p> <p>Provide support in the planning stage.</p>	<p><b>Gains:</b> increase skills and competences/know how</p> <p><b>Gain creators:</b> Availability of a knowledge base comprising case studies and best practices about NBSs (documents, online material, videos, webinar, etc.)</p> <p>Availability of on-line tools for engagement, to support co-creation activities, etc."</p>	<p><b>Pains:</b> difficulties in obtaining easy to understand and accessing information about NBSs</p> <p><b>Pain relievers:</b> Simple to understand case studies about Digital Twins and NBSs made accessible in different forms, e.g. videos, slides, online interactive manual, etc. Availability of webinar (or pre-recorded one), class, etc.</p> <p>Availability of a "Digital Twin Sandbox/Playground"</p>
<p><b>Athens – Internal stakeholders of the Municipality</b></p>		
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<p><b>Athens – External stakeholders of the Municipality</b></p>		
<p><b>DAEM S.A.</b></p> <p>Organization for local development (Municipality of Athens) focused on ICT.</p> <p>Has already developed a Digital Twin for Athens.</p>	<p>Not IT related gains and gain creators were identified.</p>	<p>Not IT related pains and pain relievers were identified.</p>

<p>Can capitalize on the outcome of URBREATH in terms of data and ICT tools.</p>		
<p><b>Elliniko Metro SA</b></p> <p>State-owned company for developing new metro lines</p> <p>Mobility network.</p> <p>MoU regarding Metro Line 4, currently under construction (Anaplassis SA, Municipality of Athens, Elliniko Metro SA and Ministry of Transport)</p>	<p>Not IT related gains and gain creators were identified.</p>	<p>Not IT related pains and pain relievers were identified.</p>
<p><b>Ministry of Transport and Infrastructure</b></p> <p>Mobility network.</p> <p>MoU regarding Metro Line 4, currently under construction (Anaplassis SA, Municipality of Athens, Elliniko Metro SA and Ministry of Transport)</p>	<p>Not IT related gains and gain creators were identified.</p>	<p>Not IT related pains and pain relievers were identified.</p>
<p><b>OASA S.A.</b></p> <p>The operator for Public Transport in Athens.</p>	<p>Not IT related gains and gain creators were identified.</p>	<p>Not IT related pains and pain relievers were identified.</p>

Mobility network.  MoU regarding Metro Line 4, currently under construction (Anaplassis SA, Municipality of Athens, Elliniko Metro SA and Ministry of Transport)		
<b>Tallinn – Internal stakeholders of the Municipality</b>		
<b>Spatial planning and design department</b> Project leading experts	Not IT related gains and gain creators were identified.	Not IT related pains and pain relievers were identified.
<b>Urban Environment and Public Works Department</b>  Technical consultation	Not IT related gains and gain creators were identified.	Not IT related pains and pain relievers were identified.
<b>Urban Planning Department</b>  Technical consultation	Not IT related gains and gain creators were identified.	Not IT related pains and pain relievers were identified.
<b>Tallinn – External stakeholders of the Municipality</b>		
<b>Local community (visitors)</b>	Not IT related gains and gain creators were identified.	Not IT related pains and pain relievers were identified.
<b>Winter swimmers in the area</b>	Not IT related gains and gain creators were identified.	Not IT related pains and pain relievers were identified.
<b>NGO Kuum ja Külm</b>	Not IT related gains and gain creators were identified.	Not IT related pains and pain relievers were identified.
<b>Kajaani – Internal stakeholders of the Municipality</b>		
<b>Environmental-technical department</b>	<b>Gains:</b> fluent and resilient city operations in all conditions.	<b>Pains:</b> lacking resources for gaining expertise about possibilities and funding for investments

<p>Responsible for operations concerning land use, infra planning &amp; operational maintenance. Holds local authority role for infrastructure-related issues.</p> <p>The department is the main responsible actor for planning and implementing NBS or other solutions related to city infra or city property.</p> <p>The department is the main responsible actor for NBS or other solutions for adding city infra resilience.</p>	<p><b>Gain creators:</b> Not IT related gains and gain creators were identified.</p>	<p><b>Pain relievers:</b> Not IT related pains and pain relievers were identified.</p>
<p><b>City infrastructure maintenance department.</b></p> <p>Responsible for infra maintenance operations. Part of environmental-technical department.</p> <p>Responsible for maintenance operations for implemented solutions. Participates on planning in order to ensure compatibility</p>	<p><b>Gains:</b> operational model on how to include new solutions into city maintenance operations</p> <p><b>Gain creators:</b> Not IT related gains and gain creators were identified.</p>	<p><b>Pains:</b> tight resources for all maintenance operations, challenges to resource on co-creation related to new NBS and related planning</p> <p><b>Pain relievers:</b> Not IT related pains and pain relievers were identified.</p>

<p>with city resources concerning long-term maintenance.</p> <p>This department will be the holding the main responsibility for long-term maintenance.</p>		
<p><b>Regional planning department.</b></p> <p>Responsible for land use planning and infrastructural planning operations. Part of environmental-technical department.</p> <p>The department will review and accept the forthcoming NBS plans in order to ensure compatibility with other city infrastructures.</p> <p>The <b>department</b> has the main responsibility for all infra-related initiatives.</p>	<p><b>Gains:</b> ensure coherent development of city infra</p> <p><b>Gain creators:</b> Access information about the location and design of the proposed/planned NBSs (e.g. 3D render, materials to be used to build the NBS, plant species, etc.).</p>	<p><b>Pains:</b> tight personnel resources</p> <p><b>Pain relievers:</b> Not IT related pains and pain relievers were identified.</p>
<p><b>Spatial &amp; building centre</b></p> <p>Responsible for city-owned building use, maintenance and related planning. Responsible for new building construction operations. Part of the</p>	<p><b>Gains:</b> ensure coherent use and maintenance of buildings and spaces owned or hosted by city</p> <p><b>Gain creators:</b> Access information about the location and design of the proposed/planned NBSs (e.g. 3D render, materials to be used to build the NBS, plant species, etc.).</p>	<p><b>Pains:</b> core business is only loosely related to NBS, no resources for co-creation</p> <p><b>Pain relievers:</b> Not IT related pains and pain relievers were identified.</p>

<p>environmental-technical department.</p> <p>Participates on planning in case new NBS solutions are located within the property hosted by spatial planning + building centre</p> <p>New initiatives for NBS might be implemented within the properties hosted by spatial planning &amp; building centre</p>		
<p><b>Kajaani – External stakeholders of the Municipality</b></p>		
<p><b>KAMK University of Applied Sciences</b></p> <p>Collaboration partner for several new projects and/or other planning initiatives.</p> <p>Collaboration partner in URBREATH project and other planning for new NBS solutions.</p> <p>KAMK is interested to develop further expertise to increase resilience and ensure environmentally aware aspects in new planning.</p>	<p><b>Gains:</b> wants to support both long-term resilience and related new business/research initiatives</p> <p><b>Gain creators:</b> Obtain information about the impact NBSs generates (e.g. socio-economic aspects, well-being, environment, biodiversity, etc.) through reports, KPIs, map layers, etc.</p>	<p><b>Pains:</b> lacking human resources to ensure early stage/continuous co-creation with city</p> <p><b>Pain relievers:</b> Not IT related pains and pain relievers were identified.</p>

<p><b>Regional council of Kainuu</b></p> <p>Regional authority for hosting EU funding and generic regional development activities.</p> <p>Forms regional strategies and hosts use of ERDF funding in Kainuu region. Current regional strategies have strong value for sustainability and environmentally aware actions. NBS solutions support regional strategies for sustainable and resilient operations.</p>	<p><b>Gains:</b> wants to ensure that all region develops both economically and ecologically</p> <p><b>Gain creators:</b> Obtain information about the impact NBSs generates (e.g. socio-economic aspects, well-being, environment, biodiversity, etc.) through reports, KPIs, map layers, etc.</p>	<p><b>Pains:</b> lacking adequate resources to ensure high-level expertise related to sustainability issues</p> <p><b>Pain relievers:</b> Not IT related pains and pain relievers were identified.</p>
<p><b>ELY-centre - Center for Economic, transport and environment.</b></p> <p>Regional authority for environmental protection and recovery, transport-related issues and financial incentives for business support</p> <p>Responsible for e.g. endangered species protection and invasive species control operations. Supports waterbody protection initiatives. Responsible for</p>	<p><b>Gains:</b> wants to ensure environmental sustainability of all industrial and municipal operations. wants to support company development with funding.</p> <p><b>Gain creators:</b> Obtain information about the impact NBSs generates (e.g. socio-economic aspects, well-being, environment, biodiversity, etc.) through reports, KPIs, map layers, etc.</p>	<p><b>Pains:</b> role as an author is limited and sometimes hinders them to participate actively in some discussions.</p> <p><b>Pain relievers:</b> Not IT related pains and pain relievers were identified.</p>

<p>environmental permit control and environmental impact assessment.</p> <p>New expertise in NBS is closely related to ELY responsibilities as a regional authority for environmental issues</p>		
<p>Commercial infrastructure planning companies</p> <p>Provides detailed planning for new initiatives as subcontracted service</p> <p>Selected commercial partner provide detailed structural planning, cost estimations or other issues related to NBS solutions as subcontracted service</p> <p>Selected commercial partner provide detailed structural planning, cost estimations or other issues related to NBS solutions as subcontracted service</p>	<p><b>Gains:</b> wants to develop business and provide support for city infra renewals</p> <p><b>Gain creators:</b> Obtain information about the impact NBSs generates (e.g. socio-economic aspects, well-being, environment, biodiversity, etc.) through reports, KPIs, map layers, etc.</p>	<p><b>Pains:</b> dependent on received subcontracting</p> <p><b>Pain relievers:</b> Not IT related pains and pain relievers were identified.</p>
<p><b>Leuven – Internal stakeholders of the Municipality</b></p>		
<p><b>SOW</b></p> <p>Dept public works</p>	<p><b>Gains:</b> More public support in projects implementing NBS / insight and better communication in ecosystem impact of NBS.</p>	<p><b>Pains:</b> No data available. No communication approach.</p>

<p>Design public domain</p> <p>Driving the 'Let it sink in' program of depavement and greening.</p>	<p><b>Gain creators:</b> Access to reports and KPIs about the impact generated by NBSs (e.g. about socio economic aspects, well-being, etc.).</p>	<p><b>Pain relievers:</b> Unique point to search and access documents/datasets owned by different departments of the Municipality. Tools that facilitate connection and data collection from heterogeneous systems. Establish a common communication/collaboration process among departments (internal communication) and towards stakeholders such as local associations, citizens, etc (external communication); the communication/collaboration process should be supported by tools (also digital), defining the role they play within the process and the way they should be used, as well as the expected goals to be reached through their use.</p>
<p><b>Green department</b></p> <p>City Green department/landscapers</p> <p>Design &amp; maintenance of NBS</p> <p>Owner of green in the public domain</p>	<p><b>Gains:</b> More NBS / more insight on impact</p> <p><b>Gain creators:</b> Obtain information about the impact NBSs generates (e.g. socio-economic aspects, well-being, etc.) through reports, KPIs, map layers, etc.</p>	<p><b>Pains:</b> Not identified</p> <p><b>Pain relievers:</b> Not identified</p>
<p><b>GGW</b></p> <p>Dept of participation, liveability.</p> <p>Lead the participation and co-creation process.</p>	<p><b>Gains:</b> More digital and data driven support of participation processes.</p> <p><b>Gain creators:</b> Enable participants into participatory process to produce content (e.g. comments, proposals, etc.) "based on / linked to" data (e.g. collected / managed /</p>	<p><b>Pains:</b> Lack of tools / experience in digital and data driven support of participation processes.</p> <p><b>Pain relievers:</b> Access to digital tools that as much as possible simple to use, and well documented (e.g. online user guides, videos, training material, etc.).</p>

<p>Experiment with more digital and data driven ways of participation and co-creation.</p>	<p>produced) by digital platforms (e.g. Digital Twins).</p>	
<p><b>Smart city Leuven</b></p> <p>Smart city program of Leuven using innovative technology in the public space.</p> <p>Experimenting with the set-up, functionalities and usage of digital twin software.</p> <p>Interested in the possibilities of digital twin tools</p>	<p><b>Gains:</b> Experiences in using digital twin technology for internal and external use.</p> <p><b>Gain creators:</b> "Simple to understand case studies about the use of Digital Twins made accessible in different forms, e.g. videos, slides, online interactive manual, etc. Availability of webinar (or pre-recorded one), class, etc. Availability of a "Digital Twin Sandbox/Playground"</p>	<p><b>Pains:</b> Limited experience with digital twin tools / technical legacy and debt.</p> <p><b>Pain relievers:</b> Access to support for advanced technologies and ICT solutions (e.g. Digital Twins). Opportunity to make use of tools enabling interoperability with legacy system, which allows data interoperability (e.g. ETL operations), API adaptation, application integration, etc.</p>
<p><b>Leuven – External stakeholders of the Municipality</b></p>		
<p><b>Leuven 2030</b></p> <p>An association of all relevant quadruple helix players in the field of sustainability.</p> <p>Providing quick access to all member.</p> <p>Coordinating all engagements of non-city participants in the Climate City Contract.</p>	<p><b>Gains:</b> Better understanding in use of digital twin technologies.</p> <p><b>Gain creators:</b> Simple to understand case studies about the use of Digital Twins made accessible in different forms, e.g. videos, slides, online interactive manual, etc. Availability of webinar (or pre-recorded one), class, etc.</p>	<p><b>Pains:</b> Not identified.</p> <p><b>Pain relievers:</b> Not identified.</p>
<p><b>Aarhus – Internal stakeholders of the Municipality</b></p>		

<p><b>Aarhus City's Office for Urban Spaces</b></p> <p>City planning and green spaces.</p> <p>Responsible for city's parks, trees, and urban greening, where NBS will often take place.</p> <p>Will be working with NBS in public spaces</p>	<p><b>Gains:</b> Not identified.</p> <p><b>Gain creators:</b> Not identified.</p>	<p><b>Pains:</b> Not identified.</p> <p><b>Pain relievers:</b> Not identified.</p>
<p><b>Aarhus City's Office for Water Management</b></p> <p>Climate adaption measures</p> <p>Will be working with NBS with regards to e.g. rainwater management.</p> <p>Will be working with NBS in public spaces.</p> <p>Have access to advanced, digital flood mapping.</p>	<p><b>Gains:</b> Not identified.</p> <p><b>Gain creators:</b> Not identified.</p>	<p><b>Pains:</b> Not identified.</p> <p><b>Pain relievers:</b> Not identified.</p>
<p><b>Chief Architect of Aarhus</b></p> <p>Aarhus has a chief architect, responsible for the city</p>	<p><b>Gains:</b> Not identified.</p> <p><b>Gain creators:</b> Not identified.</p>	<p><b>Pains:</b> Not identified.</p> <p><b>Pain relievers:</b> Not identified.</p>

<p>architectural and aesthetic development.</p> <p>NBS within architecture politics.</p> <p>Ensuring that the NBS is in line with aesthetic principles and architectural goals.</p>		
<p><b>Aarhus City's Office of Digitalisation</b></p> <p>Responsible for current 3D-model UrbanCityPlanner.</p> <p>Working with the developing the 3D model to become a digital twin with data on multifunctional NBS.</p> <p>Responsible for the City's data management.</p>	<p><b>Gains:</b> Not identified.</p> <p><b>Gain creators:</b> Not identified.</p>	<p><b>Pains:</b> Not identified.</p> <p><b>Pain relievers:</b> Not identified.</p>
<p><b>Aarhus City's Office for Sport &amp; Leisure</b></p> <p>Responsible for creating recreational spaces and options in the city.</p>	<p><b>Gains:</b> Not identified.</p> <p><b>Gain creators:</b> Not identified.</p>	<p><b>Pains:</b> Not identified.</p> <p><b>Pain relievers:</b> Not identified.</p>

<p>Ensuring multifunctionality in NBS, so that it can have recreational use.</p> <p>They are tasked ensuring that NBS stimulates active and/or recreational use.</p>		
<p><b>Aarhus – External stakeholders of the Municipality</b></p>		
<p>Local civic associations.</p> <p>Citizens are often organised locally in civic associations.</p> <p>Provide input to the local plans and/or NBS that will take place in their immediate surroundings.</p> <p>The NBS will affect their neighbourhood and community.</p>	<p><b>Gains:</b> Not identified.</p> <p><b>Gain creators:</b> Not identified.</p>	<p><b>Pains:</b> Not identified.</p> <p><b>Pain relievers:</b> Not identified.</p>
<p>Joint citizen councils.</p> <p>In Aarhus, citizens have official access to the politicians and municipal staffers through various joint councils for several.</p> <p>Can present concerns/cases/solutions to the city hall and/or civil servants.</p>	<p><b>Gains:</b> Not identified.</p> <p><b>Gain creators:</b> Not identified.</p>	<p><b>Pains:</b> Not identified.</p> <p><b>Pain relievers:</b> Not identified.</p>

<p>They represent citizens living in areas where NBS can be planned.</p>		
<p><b>Cluj-Napoca – Internal stakeholders of the Municipality</b></p>		
<p><b>City Municipality of Cluj-Napoca</b></p> <p>Cluj-Napoca has been focusing in recent years on deploying flagship projects. Thus, the current strategy prioritises local efforts and reduces social discrepancies, empowering residents through sustainable interventions and regenerating local landscapes.</p> <p>Managing the investments: procurement, permits, technical documentation / Collaborating with local actors and residents for the NBS design. Cluj-Napoca has plans to introduce green walls-, roofs and accessible corridors to improve access to nature in the city. The city aims to introduce community-based urban farms and gardens and local environmental compensation processes.</p>	<p><b>Gains:</b> a step towards climate neutrality / improving life quality of citizens / testing new green solutions that can be upscaled in other parts of the city/ authorisation.</p> <p><b>Gain creators:</b> Access to reports and KPIs about the impact generated by NBSs.</p>	<p><b>Pains:</b> Limited resources (funding, technical expertise and community engagement)/ Ensuring the sustained effectiveness of NBS solutions.</p> <p><b>Pain relievers:</b> Not identified.</p>

<p>NBS subject is considered a priority for Cluj-Napoca. City Motto is Green Cluj. This has to translate also into smart and tailor-made green solutions for blue-green corridors and derelict green areas, as well as nature-oriented approaches contributing at achieving climate neutrality by 2030.</p>		
<p><b>European funds Department</b></p> <p>The European Funds Department plays a crucial role in maximizing the impact of EU funds on regional development and promoting sustainable growth and prosperity in the areas it serves.</p> <p>Managing the investments: procurement, permits, technical documentation / Collaborating with local actors and residents for the NBS design.</p> <p>NBS subject is considered a priority for Cluj-Napoca. City Motto is Green Cluj. This has to translate also into smart and tailor-made</p>	<p><b>Gains:</b> data collection.</p> <p><b>Gain creators:</b> Tools facilitating connection to heterogeneous data source, harmonise collected data according to well know data formats and standards; tools that support and facilitate data integrations and offer easy to implement ETL.</p>	<p><b>Pains:</b> communication across departments, procedure (administrative requirements).</p> <p><b>Pain relievers:</b> Reduce uncertainties, e.g. a clearer view of the procedures and related processes, contact points and related responsibilities/roles in the process. Facilitate communication and knowledge exchange among departments, e.g. easy to build and share reports/dashboards and feedback/comments. Unique point to search and access documents/datasets owned by different departments.</p>

<p>green solutions for blue-green corridors and derelict green areas, as well as nature-oriented approaches contributing at achieving climate neutrality by 2030.</p>		
<p><b>Urban Strategies Department</b></p> <p>The Bureau of Urban Strategies is the specialized structure subordinate to the Chief Architect whose main mission is to promote and manage urban planning and land use documentation, ensuring compliance with the provisions contained in the approved land use and land use planning documents.</p> <p>Ensuring an integrated approach of the URBREATH NBS investments with the rest of work which is in progress or in planning /</p> <p>Taking into account good practices and how to replicate them in other key areas in the city and Somes Corridor</p>	<p><b>Gains:</b> upscaling tested solutions in other strategic areas of the city, according to the city strategy/ authorisation.</p> <p><b>Gain creators:</b> support in identifying potential areas in which replicate experimented/implemented NBSs (e.g. matches needs - NBSs capabilities).</p>	<p><b>Pains:</b> communication across departments, procedure (administrative requirements).</p> <p><b>Pain relievers:</b> Reduce uncertainties, e.g. a clearer view of the procedures and related processes, contact points and related responsibilities/roles in the process. Facilitate communication and knowledge exchange among departments, e.g. easy to build and share reports/dashboards and feedback/comments. Unique point to search and access documents/datasets owned by different departments.</p>
<p><b>Urban ecology and green spaces Department</b></p>	<p><b>Gains:</b> data collection.</p>	<p><b>Pains:</b> communication across departments, procedure (administrative requirements).</p>

<p>Organization, verification and reception of the activities of: street sanitation; snow removal; household sanitation; loaded and transported waste from recreational areas; extermination, and disinfection; treatment and maintenance of stray dogs; neutralization of animal corpses; unclogging watercourses; dressing; maintenance and unclogging street containers; development of action plans regarding air protection, air quality, noise plan; maintenance of public toilets; placement and emptying of ecological toilets.</p> <p>Contribute to the mapping of derelict sites for adapting NBS</p> <p>Taking into account good practices and how to replicate them in other key areas in the city and Somes Corridor</p>	<p><b>Gain creators:</b> Tools facilitating connection to heterogeneous data source, harmonise collected data according to well know data formats and standards; tools that support and facilitate data integrations and offer easy to implement ETL.</p>	<p><b>Pain relievers:</b> Reduce uncertainties, e.g. a clearer view of the procedures and related processes, contact points and related responsibilities/roles in the process. Facilitate communication and knowledge exchange among departments, e.g. easy to build and share reports/dashboards and feedback/comments. Unique point to search and access documents/datasets owned by different departments.</p>
<p><b>Public events and citizen information Department</b></p>	<p><b>Gains:</b> data collection.</p> <p><b>Gain creators:</b> Tools facilitating connection to heterogeneous data source, harmonise</p>	<p><b>Pains:</b> communication across departments, procedure (administrative requirements).</p>

<p>Responsibilities include organizing and promoting all events held under the auspices of the Cluj-Napoca City Hall and the Local Council; supporting public events where the City Hall or the Local Council are partners; promoting among the partners of the City Hall and the Local Council events that meet the objectives set out in the Development Strategy of Cluj-Napoca Municipality 2014-2020; receiving, recording, and distributing within the institution all requests, complaints, petitions, and official documents according to established procedures; issuing and sending all documents issued or sent from the institution to citizens or other institutions, as well as related activities according to established procedures;</p> <p>Contribute to the organization of co-creation activities / Keeping contact with residents and ensuring the transfer of ownership to local communities / Involvement of marginalized groups</p>	<p>collected data according to well know data formats and standards; tools that support and facilitate data integrations and offer easy to implement ETL.</p>	<p><b>Pain relievers:</b> Reduce uncertainties, e.g. a clearer view of the procedures and related processes, contact points and related responsibilities/roles in the process. Facilitate communication and knowledge exchange among departments, e.g. easy to build and share reports/dashboards and feedback/comments. Unique point to search and access documents/datasets owned by different departments.</p>
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<p>Citizens in the Cluj-Napoca LL area have engaged in informal greening activities (planting fruit trees in the area, landscaping the green strips along the street). There is the need for more coherent interventions, and improved accessibility of residents towards the river corridor</p>		
<p><b>Civic Imagination and Innovation Center.</b></p> <p>The Center is coordinated by a Board comprising community representatives from academia, the private and public sectors, and NGOs. Additionally, it has integrated a subdivision focused on urban innovation to enhance collaborative and innovative projects with stakeholders and further promote participatory governance.</p> <p>CIIC is a communication, research and promotion tool, as well as an open place for debates at the disposal of experts from different</p>	<p><b>Gains:</b> feedback from citizens.</p> <p><b>Gain creators:</b> Facilitate communication with citizens, e.g. publish clear reports/documents about interventions (NBS) and the expected impact (e.g. social, economic, well-being, etc.); enable citizens to provide "informed" feedback collection (comments, ideas, proposals) based on data/evidence.</p>	<p><b>Pains:</b> Not identified.</p> <p><b>Pain relievers:</b> Not identified.</p>

<p>fields and any citizen willing to participate.</p> <p>Public debates and participatory governance to activate the local community/Cooperation with academia and the private sector to co-design solutions</p>		
<p><b>Cluj-Napoca – External stakeholders of the Municipality</b></p>		
<p><b>Somes Delivery NGO</b></p> <p>"Someş Delivery" is an independent project that challenges and tests the community's ideas for integrating the Someş River into the life of the city of Cluj-Napoca.</p> <p>Contribute to the organization of co-creation activities</p> <p>Action plans/policies</p>	<p><b>Gains:</b> improving life quality of citizens.</p> <p><b>Gain creators:</b> Possibility to evaluate the impact of potential NBSs according to different aspects, such as environment, pollutions, resilience of urban environment, economic developments, etc.</p>	<p><b>Pains:</b> Building community support and addressing social acceptance.</p> <p><b>Pain relievers:</b> Easier communication with citizens offering support in understanding reports/documents (e.g. provided by the Municipality) about interventions such as NBS and the expected impact (e.g. social, economic, well-being, etc.); help citizens to provide "informed" feedback collection (comments, ideas, proposals) based on data/evidence.</p>
<p><b>Order of Romanian Architects</b></p> <p>The Romanian Order of Architects is a professional, non-profit, apolitical, public interest, autonomous and independent</p>	<p><b>Gains:</b> data collection.</p> <p><b>Gain creators:</b> Not identified.</p>	<p><b>Pains:</b> Integrating NBS solutions with traditional built infrastructure.</p> <p><b>Pain relievers:</b> Access information about the location and design of the proposed/planned NBSs (e.g. 3D render, materials to be used to build the NBS, plant species, etc.).</p>

<p>organisation, structured through branches in the territory.</p> <p>Responsible for analytical documents, urban planning and studies, development studies, and policy.</p> <p>Strategic &amp; Action plans/policies</p>		
<p><b>Metapolis Architects</b></p> <p>Metapolis based on practice working on the confluence of city and nature across scales. Their projects are staged as identifiable designs that develop into symbiotic systems, at once embedded in, revealing of and enriching for their respective environments. With background in architecture, urbanism and constructed landscape, Metapolis designs clear and open living environments, rooted in a precise reading and a critical interrogation of their physical and socio-economical context.</p>	<p><b>Gains:</b> data collection.</p> <p><b>Gain creators:</b> Not identified.</p>	<p><b>Pains:</b> Integrating NBS solutions with traditional built infrastructure.</p> <p><b>Pain relievers:</b> Access information about the location and design of the proposed/planned NBSs (e.g. 3D render, materials to be used to build the NBS, plant species, etc.).</p>

<p>Metapolis can contribute to the development of vibrant, resilient, and sustainable urban environments that integrate seamlessly with nature and enhance the well-being of residents and ecosystems alike.</p> <p>Strategic &amp; Action plans/policies</p>		
<p><b>Transilvania IT Cluster</b></p> <p>Transilvania IT Cluster works at the intersection between entrepreneurship, researchers, innovators, and public administration, pushing forward discussion and action around digital transformation and thus enhancing community development through digitisation.</p> <p>The IT Cluster can support the collection, analysis, and visualization of environmental data to inform decision-making and promote evidence-based policymaking. The IT Cluster can provide training and capacity-</p>	<p><b>Gains:</b> data collection/ Digital Twin.</p> <p><b>Gain creators:</b> Tools facilitating connection to heterogeneous data source, harmonise collected data according to well know data formats and standards; tools that support and facilitate data integrations and offer easy to implement ETL.</p>	<p><b>Pains:</b> Gathering and integrating data from natural environments/ Developing accurate and reliable models for natural systems.</p> <p><b>Pain relievers:</b> Not identified.</p>

<p>building programs on NBS concepts, tools, and best practices.</p> <p>Strategic &amp; Action plans/policies.</p>		
<p><b>Cluj Metropolitan Area – CMA</b></p> <p>Cluj Metropolitan Area association operates around Romania’s second-largest city, Cluj-Napoca. This is the largest urban center of Transylvania, considered Romania’s most forward-looking region, and playing the role of its informal capital. The city and its peri-urban area are located northwest of Romania, not far from the border with Hungary. The population of the metro area is about 450.000 inhabitants.</p> <p>They already have people that were part of Local Groups regarding the NBS topic, and it will be helpful to have their expertise.</p> <p>CMA acts like a support partner for Cluj-Napoca Municipality when needed, especially in projects that</p>	<p><b>Gains:</b> testing new green solutions that can be upscaled in other parts of the city/ improving life quality of citizens.</p> <p><b>Gain creators:</b> Access to reports and KPIs about the impact generated by NBSs (e.g. about socio-economic aspects, well-being, etc.).</p>	<p><b>Pains:</b> Building community support and addressing social acceptance/ Ensuring the sustained effectiveness of NBS solutions.</p> <p><b>Pain relievers:</b> Easier communication with citizens offering support in understanding reports/documents (e.g. provided by the Municipality) about interventions such as NBS and the expected impact (e.g. social, economic, well-being, etc.); help citizens to provide "informed" feedback collection (comments, ideas, proposals) based on data/evidence.</p>

<p>can be replicated in the metropolitan area.</p>		
<p><b>CCC- Cluj Cultural Center</b></p> <p>The Cluj Cultural Center is a non-governmental organization focused on culture and sustainable development.</p> <p>They are concerned about the well-being of individuals and communities, and about building a sustainable society.</p> <p>They contribute to the development of an equitable society where art and culture are accessible to all.</p>	<p><b>Gains:</b> improving life quality of citizens.</p> <p><b>Gain creators:</b> Not identified.</p>	<p><b>Pains:</b> Building community support and addressing social acceptance.</p> <p><b>Pain relievers:</b> Easier communication with citizens offering support in understanding reports/documents (e.g. provided by the Municipality) about interventions such as NBS and the expected impact (e.g. social, economic, well-being, etc.); help citizens to provide "informed" feedback collection (comments, ideas, proposals) based on data/evidence.</p>
<p><b>Cluj Youth Federation</b></p> <p>The Cluj Youth Federation aims to invest in youth for sustainable and responsible urban development.</p> <p>Contribute to the organization of co-creation activities.</p> <p>Action plans/policies.</p>	<p><b>Gains:</b> improving life quality of citizens.</p> <p><b>Gain creators:</b> Not identified.</p>	<p><b>Pains:</b> Building community support and addressing social acceptance.</p> <p><b>Pain relievers:</b> Easier communication with citizens offering support in understanding reports/documents (e.g. provided by the Municipality) about interventions such as NBS and the expected impact (e.g. social, economic, well-being, etc.); help citizens to provide "informed" feedback collection (comments, ideas, proposals) based on data/evidence.</p>

<p><b>The Urban Scene/ "Scena Urbana"</b></p> <p>"Scena Urbană" is an initiative of the Romanian Order of Architects, Transylvania Branch, aimed at revitalizing urban spaces and returning them to the community.</p> <p>"Scena Urbană" pursues its goal by exemplifying the cultural and educational potential of underutilized urban spaces, reintroducing them onto the map of Cluj's cultural and active objectives.</p> <p>They consult residents of the area regarding their relationship with the river, involves them in project activities, and challenges the neighbouring institutions to get involved.</p>	<p><b>Gains:</b> improving life quality of citizens.</p> <p><b>Gain creators:</b> Not identified.</p>	<p><b>Pains:</b> Building community support and addressing social acceptance.</p> <p><b>Pain relievers:</b> Easier communication with citizens offering support in understanding reports/documents (e.g. provided by the Municipality) about interventions such as NBS and the expected impact (e.g. social, economic, well-being, etc.); help citizens to provide "informed" feedback collection (comments, ideas, proposals) based on data/evidence.</p>
<p><b>Pilsen – Internal stakeholders of the Municipality</b></p>		
<p><b>SVSMP (Správa veřejného statku města Plzně)</b></p> <p>Public Property Administration of the City of Pilsen.</p>	<p><b>Gains:</b> implementation + maintenance.</p> <p><b>Gain creators:</b> A clear view of the (NBS) implementation and maintenance plan, its status (e.g. actual vs planned), identified and occurred issues and involved actors (e.g.</p>	<p><b>Pains:</b> communication across departments, procedure (administrative requirements).</p> <p><b>Pain relievers:</b> Reduce uncertainties, e.g. a clearer view of the procedures and related processes, contact points and related responsibilities/roles in</p>

<p>management and maintenance of publicly accessible city property.</p> <p>Strategic &amp; Action plans/policies</p>	<p>delay from providers and or other departments). frequently updated data.</p>	<p>the process. Facilitate communication and knowledge exchange among departments, e.g. easy to build and share reports/dashboards and feedback/comments. Unique point to search and access documents/datasets owned by different departments.</p>
<p><b>Municipality of Pilsen</b></p> <p>Performs tasks in the field of territorial self-government and state administration delegated to the City of Pilsen.</p> <p>Decision-making.</p> <p>Strategic &amp; Action plans/policies</p>	<p><b>Gains:</b> obtain public consensus, feedback from citizens, reduce problems on traffic generated by the NBS implementation.</p> <p><b>Gain creators:</b> Facilitate communication with citizens, e.g. publish clear reports/documents about interventions (NBS) and the expected impact (e.g. social, economic, well-being, etc.); enable citizens to provide "informed" feedback collection (comments, ideas, proposals) based on data/evidence. Obtain information about the impact on mobility due to the implementation (phase) of NBS (e.g. reduced capacity of roads, needs to establish LTZ, reduced offer of public transport such as suppressed bus stops, etc.).</p>	<p><b>Pains:</b> communication across departments, procedure (administrative requirements).</p> <p><b>Pain relievers:</b> Reduce uncertainties, e.g. a clearer view of the procedures and related processes, contact points and related responsibilities/roles in the process. Facilitate communication and knowledge exchange among departments, e.g. easy to build and share reports/dashboards and feedback/comments. Unique point to search and access documents/datasets owned by different departments.</p>
<p><b>UKRMP (Útvar Koncepce a Rozvoje Města Plzně)</b></p> <p>Urban Planning and Development Institute of the City of Pilsen.</p>	<p><b>Gains:</b> obtain public consensus, feedback from citizens, reduce problems on traffic generated by the NBS implementation.</p> <p><b>Gain creators:</b> Facilitate communication with citizens, e.g. publish clear reports/documents about interventions (NBS) and the expected</p>	<p><b>Pains:</b> communication across departments, procedure (administrative requirements).</p> <p><b>Pain relievers:</b> Reduce uncertainties, e.g. a clearer view of the procedures and related processes, contact points and related responsibilities/roles in the process. Facilitate communication and knowledge</p>

<p>In charge of analytic documents, urban planning&amp;studies, development studies and policy.</p> <p>Strategic &amp; Action plans/policies.</p>	<p>impact (e.g. social, economic, well-being, etc.); enable citizens to provide "informed" feedback collection (comments, ideas, proposals) based on data/evidence. Obtain information about the impact on mobility due to the implementation (phase) of NBS (e.g. reduced capacity of roads, needs to establish LTZ, reduced offer of public transport such as suppressed bus stops, etc.).</p>	<p>exchange among departments, e.g. easy to build and share reports/dashboards and feedback/comments. Unique point to search and access documents/datasets owned by different departments.</p>
<p><b>SITMP (Správa Informačních Technologii Města Plzně)</b></p> <p>Administration of IT services for the city.</p> <p>3D model of the city, digital twin.</p> <p>Contribute to live in a better city.</p>	<p><b>Gains:</b> data collection</p> <p><b>Gain creators:</b> Tools facilitating connection to heterogeneous data source, harmonise collected data according to well know data formats and standards; tools that support and facilitate data integrations and offer easy to implement ETL.</p>	<p><b>Pains:</b> communication across departments, procedure (administrative requirements).</p> <p><b>Pain relievers:</b> Reduce uncertainties, e.g. a clearer view of the procedures and related processes, contact points and related responsibilities/roles in the process. Facilitate communication and knowledge exchange among departments, e.g. easy to build and share reports/dashboards and feedback/comments. Unique point to search and access documents/datasets owned by different departments.</p>
<p><b>Department of Heritage Protection (MMP)</b></p> <p>Heritage protection department of the city of Pilsen.</p> <p>Advisory.</p>	<p><b>Gains:</b> heritage protection (heritage protected zone).</p> <p><b>Gain creators:</b> Access information about the location and design of the proposed/planned NBSs (e.g. 3D render, materials to be used to build the NBS, plant species, etc.).</p>	<p><b>Pains:</b> communication, procedure, administrative and legal requirements, cultural heritage - protected zone.</p> <p><b>Pain relievers:</b> Not identified.</p>

Heritage protection.		
<b>Pilsen – External stakeholders of the Municipality</b>		
<p><b>Pestuj Prostor, Plzeň má na víc etc.</b></p> <p>Expert NGOs / citizen organisations active in public space design.</p> <p>Co-design NBSs with public space experts and citizens.</p> <p>Contribute to live in a better city.</p>	<p><b>Gains:</b> feedback from citizens.</p> <p><b>Gain creators:</b> Not identified.</p>	<p><b>Pains:</b> communication.</p> <p><b>Pain relievers:</b> Facilitate communication and knowledge exchange, e.g. easy to build and share reports/dashboards and feedback/comments. Unique point to search and access public documents/datasets owned by departments of the Municipality.</p>

## 10 Annex C – Detailed list of the initial URBREATH Toolbox requirements

This section reports the initial requirements of the URBREATH Toolbox identified from the analysis of the results collected during the workshop with the cities about customer journeys and service blueprints (Table 26), and from the analysis of the DoA (Table 27).

**Table 26: Initial requirements of the URBREATH Toolbox from workshops with cities**

ID	Description	Linked requirements
<b>Unified catalogue</b>		
WS2-MED-UJ1-MADRID-STEP1-01-R01	The toolbox should include a catalogue of available tools and models	
WS2-MED-UJ1-MADRID-STEP1-01-R02	The user can search among available tools and models available in the catalogue using keywords, etc.	
WS2-MED-UJ1-PARMA-STEP1-02-R01	The toolbox should include a catalogue of sample/existing NBSs to be used as reference (e.g. for internal discussion in the municipality).	
WS2-BOR-UJ1-KAJAANI-STEP2-05-R02	The catalogue of sample NBSs must allow the user to search NBSs according to criteria such as the problems NBSs can deal with (e.g. air pollution, heat islands, etc.)	
WS2-BOR-UJ1-KAJAANI-STEP2-05-R03	The catalogue of sample NBSs must display the list of NBSs matching the criteria the user specifies	
WS2-BOR-UJ1-KAJAANI-STEP2-05-R04	The user can select one of the identified NBSs to access its details (e.g. full description, images, etc.)	
WS2-MED-UJ1-OTHERS-STEP1-02-R01	The toolbox should include a catalogue of available datasets (data, documents, city plans, urban planning regulations, etc.)	
WS2-MED-UJ1-OTHERS-STEP1-02-R02	The data catalogue should allow the user to search among different datasets repositories	
WS2-MED-UJ1-OTHERS-STEP4-02-R01	Through the data catalogue the user should be able to search/filter results according to specific geographic area of interest or contacts (if public)	
WS2-CON-UJ2-OTHER-STEP1-01-R01	Enable filtering, sorting, and searching of datasets with advanced options, allowing users to specify parameters such as keywords, tags, date ranges, and data sources for more precise and efficient data retrieval.	

WS2-CON-UJ2-OTHER-STEP1-02-R01	The user should be able to search datasets by specifying different parameters, including title keywords, description keywords, tags, release date range, update date range, and catalogue of provenance, ensuring comprehensive and targeted search results.	
WS2-CON-UJ2-OTHER-STEP2-01-R01	On the data catalogue, search results are provided in a list; each result includes the title, a preview of the description, catalogue of provenance, and associated files, giving users a clear and concise overview of the dataset contents.	
WS2-CON-UJ2-OTHER-STEP2-02-R01	The user can further refine results by selecting one or more filters, such as type of NBS, domain, climatic areas, and more, allowing for more targeted and relevant search outcomes.	
WS2-CON-UJ2-OTHER-STEP3-01-R01	If the result of a search on the data catalogue is an NBS, from the related details the user can press a dedicated button (or link) to visualize a map providing detailed information about the selected NBS, including its location and key characteristics.	WS2-CON-UJ2-OTHER-STEP2-01-R01
WS2-CON-UJ2-OTHER-STEP3-02-R01	When the user presses the button, a map with visualization of 2D/3D data appears, displaying the location of the selected NBS along with its relevant information, such as project details, environmental impact, and progress status.	WS2-CON-UJ2-OTHER-STEP3-01-R01
WS2-ATL-UJ2-LEUVEN-STEP3-03-R01	The toolbox should include a catalogue of the available data sources	
WS2-ATL-UJ2-LEUVEN-STEP3-03-R02	The user can search among available data sources (categories of provided data, location, etc.)	
WS2-ATL-UJ2-LEUVEN-STEP3-03-R03	The user can obtain a list of possible data sources matching the performed search	
<b>Dashboards and reports</b>		
WS2-MED-UJ1-MADRID-STEP1-02-R01	Dashboards could include a selection of KPIs and results obtained from data analysis (e.g. weather forecast, etc.)	
WS2-MED-UJ1-MADRID-STEP1-02-R02	The dashboard could offer visualisation options	
WS2-MED-UJ1-OTHERS-STEP1-01-R01	Possibility to visualise real-time and/or historical data from an IOT source	
WS2-MED-UJ1-OTHERS-STEP1-03-R01	The user should be able to select KPIs to compose a dashboard	

WS2-CON-UJ1- CLUJNAPOCA-STEP2- 07-R01	The user can create a new KPI (e.g. title, description, mathematical formula, geographic areas) or customise a KPI already defined.	
WS2-CON-UJ1- CLUJNAPOCA-STEP2- 07-R02	User can associate the data needed to calculate the KPI.	
WS2-CON-UJ1- CLUJNAPOCA-STEP2- 07-R03	User can select the KPI of interest and access its details (e.g. description, charts, etc.)	
WS2-MED-UJ1- ATHENS-STEP2-03-R01	The user should be able to create reports (e.g. text and images, charts graphs, and map layers created through the use of data analysis)	
WS2-MED-UJ1- ATHENS-STEP2-04-R01	The user should be able to create his/her own data visualisation starting from available datasets	
WS2-ATL-UJ2-LEUVEN- STEP2-02-R01	The Municipality should be able to create short reports enriched with charts, graphs, images, etc.	
WS2-ATL-UJ2-LEUVEN- STEP2-02-R02	The Municipality should be able to publish created reports (e.g. as static documents and/or web pages) to make them accessible to the relevant stakeholders (e.g. citizens, local associations, etc.	
WS2-ATL-UJ2-LEUVEN- STEP2-02-R03	The stakeholders should be able to search and visualize the reports published by the Municipality	
WS2-CON-UJ2-PILSEN- STEP1-02-R02	Provide data visualization and modelling tools that allow users to create and share presentations for various audiences, including the public, schools, and internal use, featuring customizable charts, graphs, and interactive models to enhance understanding and engagement.	
<b>Simulations and Analysis</b>		
WS2-MED-UJ1- MADRID-STEP2-01-R01	Simulation models' should offer a set of options the user can choose or set values.	
WS2-MED-UJ1- MADRID-STEP2-01-R02	Simulation models should offer templates the user can customise (e.g. setting parameters).	
WS2-MED-UJ1- ATHENS-STEP2-02-R01	Simulation models would offer the opportunity to perform what-if analysis	
WS2-CON-UJ1-PILSEN- STEP1-01-R01	Impact evaluation of possible NBSs should cover different aspects (e.g. socio economic, climate resilience, etc.).	
WS2-CON-UJ2-PILSEN- STEP1-01-R01	Flooding prediction tool that uses real-time data and predictive modelling to forecast potential flooding events, allowing users to visualize risk	

	areas, receive alerts, and plan mitigation strategies.	
WS2-BOR-UJ1-KAJAANI-STEP2-02-R01	Offer one or more tools able to estimate the potential impact of a possible NBS concerning different aspects (e.g. economic, air quality, resilience to extreme/ordinary weather events)	
WS2-BOR-UJ1-KAJAANI-STEP2-02-R02	The tool(s) must be able to publish as datasets the produced results both in machine readable and human readable formats (e.g. CSV and JSON files, tables, map layers, pdf documents, etc.)	WS2-BOR-UJ1-KAJAANI-STEP2-02-R01
WS2-CON-UJ1-CLUJNAPOCA-STEP2-06-R01	Tools to model environmental impacts such as air quality, noise, urban climate, and heat islands, enabling users to input data and visualize potential outcomes through interactive simulations and predictive models.	
WS2-CON-UJ1-CLUJNAPOCA-STEP2-06-R02	The user can visualize impact estimation through chart, graph and map layers.	
<b>Scenarios comparison</b>		
WS2-MED-UJ1-ATHENS-STEP2-01-R01	The user can define one or more NBS scenarios and related information (e.g. building costs)	
WS2-MED-UJ1-ATHENS-STEP2-01-R02	The user can select two NBS scenarios to be compared	
WS2-MED-UJ1-ATHENS-STEP2-01-R03	The user obtains a report which includes the comparison of the selected NBS scenarios	
WS2-BOR-UJ1-KAJAANI-STEP4-05-R01	The user must be able to define multiple (at least 2) scenarios (e.g. solutions) to solve a certain problem in an area of the city.	
WS2-BOR-UJ1-KAJAANI-STEP4-05-R02	When building a scenario, the user must be able to define its characteristics, such as the of interventions, the costs related to the activities to build the foreseen solution (e.g. unit cost for planting and maintaining a tree, to build a wall, etc.).	
WS2-BOR-UJ1-KAJAANI-STEP4-05-R03	Once defined a scenario, the user must be able to obtain the expected total costs for the foreseen intervention.	
WS2-BOR-UJ1-KAJAANI-STEP4-05-R04	The user can select two or more scenario to be compared and obtain summary report describing the selected scenarios and their comparison.	

WS2-CON-UJ1- CLUJNAPOCA-STEP3- 01-R01	Support the user to understand the economic feasibility of NBS projects comparing costs and expected economic benefits of NBSs	
<b>Digital Twin, maps, and advanced 3D visualisations</b>		
WS2-CON-UJ1- CLUJNAPOCA-STEP1- 02-R01	Map to visualise relevant information and support urban planning.	
WS2-CON-UJ1- CLUJNAPOCA-STEP1- 02-R02	Allow users to map out and plan various aspects of NBS projects, including visual representations and detailed planning.	
WS2-ATL-UJ1-LEUVEN- STEP2-02-R03	Allow users to share among them planning hypothesis to work together in an interactive manner.	
WS2-BOR-UJ1- KAJAANI-STEP1-01-R01	Offer a map to display locations of NBS	
WS2-BOR-UJ1- KAJAANI-STEP1-01-R02	The map must include UI elements to search available NBS (e.g. text box to input keywords, list of NBSs organised per category such as park, green roof, flower bed, etc.)	
WS2-BOR-UJ1- KAJAANI-STEP1-01-R04	The user must be able to select an NBS and access the related details (e.g. description).	
WS2-BOR-UJ1- KAJAANI-STEP1-01-R05	When the user accesses the details of an NBS, also a textbox to provide feedback about the selected NBS must appear.	
WS2-BOR-UJ1- KAJAANI-STEP1-01-R06	The user can submit feedback about the selected NBS through the text box available with the details of the NBS (e.g. type text and press submit button)	
WS2-BOR-UJ1- KAJAANI-STEP1-02-R01	The map must display a list of domains related to the NBS (air pollution, water, green spaces, etc.), e.g. checkboxes	WS2-BOR-UJ1- KAJAANI-STEP1-01- R01
WS2-BOR-UJ1- KAJAANI-STEP1-02-R02	The user can select the domains to be considered to filter (display/hide) NBSs on the map (e.g. by selecting one or more checkboxes)	
WS2-BOR-UJ1- KAJAANI-STEP1-02-R03	The map updates the displayed NBs according to the domains the user selects (e.g. checked checkboxes)	
WS2-BOR-UJ1- KAJAANI-STEP1-03-R01	The map must allow to visualise the areas interested by the NBS interventions	WS2-BOR-UJ1- KAJAANI-STEP1-01- R01
WS2-BOR-UJ1- KAJAANI-STEP1-03-R02	For each area the user must be able to access its related information (current use and future use)	

WS2-BOR-UJ1-KAJAANI-STEP1-04-R01	Among the provided information, the user must be able to access information about the NBS to be implemented/under implementation/implemented such as a report (e.g. text + charts) that explain the rationale for having chosen the specific area and a specific NBS.	WS2-BOR-UJ1-KAJAANI-STEP1-01-R04
WS2-BOR-UJ1-KAJAANI-STEP1-04-R02	The report can be in the form of a document (e.g. a PDF) and or a web page	
WS2-BOR-UJ1-KAJAANI-STEP2-01-R01	Among the provided information, the user must be able to access the related analysis, such as impact assessment.	WS2-BOR-UJ1-KAJAANI-STEP1-01-R04
WS2-BOR-UJ1-KAJAANI-STEP2-01-R02	Analysis related to the selected NBs must be provided as reports (e.g. text + chart) made accessible as a document and/or web page	
WS2-BOR-UJ1-KAJAANI-STEP5-01-R01	A map must allow the user to display the location of co-designed scenarios.	
WS2-BOR-UJ1-KAJAANI-STEP5-01-R02	The user can navigate the map and select a co-designed scenario to access its details.	
WS2-BOR-UJ1-KAJAANI-STEP5-01-R03	Once the user selects a co-designed scenario the map shows the related details (e.g. by opening a pop-up window, a side bar, etc.).	
WS2-BOR-UJ1-KAJAANI-STEP5-01-R04	Among the details of the selected co-designed scenario, its costs and expected benefits must be reported (e.g. text description, images, charts. etc.)	
WS2-ATL-UJ2-LEUVEN-STEP2-03-R01	A map able to display 3D/2D objects	
WS2-ATL-UJ2-LEUVEN-STEP2-03-R02	The user should be able to import designs produced by external applications (AutoCAD, BIM, etc.)	
WS2-ATL-UJ2-LEUVEN-STEP2-03-R03	The user should be able to visualise on the map the imported designs	
WS2-ATL-UJ2-LEUVEN-STEP3-02-R01	The user can navigate the map and city areas.	WS2-ATL-UJ2-LEUVEN-STEP2-03-R01
WS2-ATL-UJ2-LEUVEN-STEP3-02-R02	The user can access alternative proposed designs and visualise them on the map (e.g. of NBSs).	
WS2-ATL-UJ2-LEUVEN-STEP4-02-R04	Once the user selects a proposed design, the map shows (e.g. in a pop-up window, a side bar, etc.) the estimated impact of the NBS, for instance climate model.	WS2-ATL-UJ2-LEUVEN-STEP3-02-R02

WS2-ATL-UJ2-LEUVEN-STEP4-03-R01	Once the user selects a proposed design, the map provide access to a detailed dashboard (e.g. through a link to a dedicated web page in the pop-up window, side bar, etc.). (Linked to)	WS2-ATL-UJ2-LEUVEN-STEP4-02-R04
WS2-ATL-UJ2-LEUVEN-STEP4-03-R02	The dashboard shows the detailed KPIs, and indicators calculated (e.g. for the area where the NBS is planned)	“Dashboards and reports” requirements
<b>e-Participation</b>		
WS2-BOR-UJ1-KAJAANI-STEP3-01-R01	The e-participation tool must allow the user to publish content such as text, images, documents, reports, and integrate or add references to external web pages (e.g. maps, KPI dashboards, etc.) to document results obtained from impact analysis and simulation.	
WS2-CON-UJ1-CLUJNAPOCA-STEP2-02-R01	Possibility to implement awareness campaigns about the importance of NBS by creating a dedicated sections (in e-participation tool) with educational materials, infographics, videos, and webinars, encouraging users to learn and spread awareness within their communities.	
WS2-CON-UJ1-CLUJNAPOCA-STEP2-02-R02	Citizens can navigate different sections and discover NBS related content.	
WS2-CON-UJ1-CLUJNAPOCA-STEP2-03-R01	Launch participatory budgeting initiatives that allows citizens to submit proposals and initiatives for municipal consideration.	
WS2-CON-UJ1-CLUJNAPOCA-STEP2-03-R02	Offer the possibility to set and manage participatory budget campaigns	
WS2-CON-UJ1-CLUJNAPOCA-STEP2-03-R03	The “administrator” must be able to set the total budget of the participatory budget campaign and possible alternatives solutions (e.g. build a bike lane, deploy new benches, plant trees, etc.) with their related costs	
WS2-CON-UJ1-CLUJNAPOCA-STEP2-03-R04	Citizens can choose among the proposed alternative solutions and their combination until the total cost does not exceed the total budget.	
WS2-BOR-UJ1-KAJAANI-STEP4-02-R01	The “administrator” must be able to setup campaign to collect ideas (alternative solutions) from the local communities concerning a specific	

	topic (e.g. changes in the plans defined by the municipality).	
WS2-BOR-UJ1-KAJAANI-STEP4-02-R02	Citizens must be able to access the campaigns promoted by the Municipality, select a campaign and access its details.	
WS2-BOR-UJ1-KAJAANI-STEP4-02-R03	Citizens must be able to submit a proposal for the selected campaign.	
WS2-BOR-UJ1-KAJAANI-STEP4-03-R01	The e-participation tool should allow the user to access KPIs and impact evaluations related to topics of interest (e.g. promoted by the Municipality)	“Dashboards and reports” requirements
WS2-ATL-UJ1-LEUVEN-STEP1-01-R01	The e-participation tool offers the list/map of the NBS related initiatives/projects planned/under implementation/implemented by the Municipality	“Digital Twin, maps, and advanced 3D visualisations” requirements
WS2-ATL-UJ1-LEUVEN-STEP1-01-R02	The user can select one the of available initiatives/projects and access its details (e.g. full description, location, expected impact, etc.)	
WS2-ATL-UJ1-LEUVEN-STEP2-01-R01	Among the details of the selected NBS, the user must be able to access information such as ASIS state, Framework in which the redesign is made, possible scenario's already existing.	WS2-ATL-UJ1-LEUVEN-STEP1-01-R02
WS2-ATL-UJ1-LEUVEN-STEP2-01-R02	The user should be able to access report (e.g. documents and/or web pages that includes charts graph, may layers, etc.).	WS2-ATL-UJ1-LEUVEN-STEP1-01-R02
WS2-MED-UJ1-MADRID-STEP5-01-R01	e-Participation toll should allow the user to publish and integrate 3D visualisation of possible NBS (e.g. co-created) together with content such as text, images, documents, reports, etc.	“Digital Twin, maps, and advanced 3D visualisations” requirements
WS2-MED-UJ1-MADRID-STEP5-02-R01	Stakeholders (e.g. citizens) can access published content.	WS2-MED-UJ1-MADRID-STEP5-01-R01
WS2-MED-UJ1-MADRID-STEP5-02-R02	Stakeholders (e.g. citizens) can add comment, feedback, etc.to published content.	
WS2-CON-UJ1-CLUJNAPOCA-STEP1-01-R01	Citizens can discover published content and interact (e.g. post comment, reply, etc.)	
WS2-CON-UJ1-CLUJNAPOCA-STEP1-01-R02	Citizens can comment, provide feedback, debate and propose solutions to topics of intertest.	

WS2-CON-UJ1- CLUJNAPOCA-STEP2- 01-R02	Enable users to submit observations, track progress, and give feedback through dedicated feedback forms and real-time data dashboards.	
WS2-ATL-UJ1-LEUVEN- STEP3-02-R01	Enable users to submit observations, track progress, and give feedback through a mobile app.	WS2-CON-UJ1- CLUJNAPOCA-STEP2- 01-R02
WS2-BOR-UJ1- KAJAANI-STEP3-02-R01	e-Participation tool should allow to make accessible content to summarise the results obtained from impact analysis and simulation also through a mobile app	
WS2-ATL-UJ2-LEUVEN- STEP5-02-R01	The Municipality can publish informative material (e.g. reports including charts, graphs, images, etc.) explaining the proposed design of an NBS	
WS2-ATL-UJ2-LEUVEN- STEP5-02-R02	Citizens can navigate the proposed NBSs and access the related informative material, also from a mobile application.	
WS2-ATL-UJ2-LEUVEN- STEP5-02-R03	Citizens can provide feedback, comments about the proposed NBSs, also from a mobile application.	
WS2-BOR-UJ1- KAJAANI-STEP3-02-R02	Citizens can access the list of published content	
WS2-BOR-UJ1- KAJAANI-STEP3-02-R03	Citizens can select a content and access its details	
WS2-BOR-UJ1- KAJAANI-STEP3-02-R04	Citizens can provide feedback to the access content through a text box and submit the feedback through a dedicated button	
WS2-ATL-UJ1-LEUVEN- STEP1-02-R01	The e-Participation tool must offer a calendar reporting the events scheduled by the Municipality.	
WS2-ATL-UJ1-LEUVEN- STEP1-02-R02	The administrator of the Municipality must be able to create a new event (e.g. by editing the title, description, date, time, location if physical event or link to online meeting) to be included in the calendar.	
WS2-ATL-UJ1-LEUVEN- STEP1-02-R03	On his/her side, the user should be able to access the calendar and the planned events on the mobile app.	
WS2-ATL-UJ1-LEUVEN- STEP1-02-R04	On the mobile app the user can select an event and access its details (e.g. by title, description, date, time, location if physical event or link to online meeting).	

WS2-CON-UJ1- CLUJNAPOCA-STEP2- 01-R01	e-Participation tool should offer user friendly tools to engage citizens in data collection and monitoring	
WS2-BOR-UJ1- KAJAANI-STEP4-04-R01	The e-participation tool should offer metrics (such as number of participants, number of submitted, number of provided comments, etc.) to monitor engagement of citizens in the participatory process	
WS2-ATL-UJ2-LEUVEN- STEP8-01-R01	The user can turn on notifications about the solutions (e.g. NBSs).	
WS2-ATL-UJ2-LEUVEN- STEP8-01-R02	When the Municipality selects an agreed solution (e.g. the most voted) a notification is sent to the users.	
WS2-ATL-UJ2-LEUVEN- STEP8-01-R03	The user receives the notification about the agreed solution.	

**Table 27: Initial requirements of the URBREATH Toolbox from DoA**

ID	Description
DOA-T3.1-R01	Feature Importance: implement techniques to visualize the importance or contribution of different input features (e.g., traffic volume, weather conditions, etc.) to the model's predictions of air quality or noise levels. This could be done through feature importance plots, bar charts, or interactive visualizations.
DOA-T3.1-R02	SHAP (SHapley Additive exPlanations): calculate and visualize SHAP values, which provide an interpretable way to attribute the model's predictions to individual features.
DOA-T3.1-R03	Surrogate Models: train interpretable surrogate models (e.g., decision trees, linear models) to copy the behaviour of complex AI models. These models can then be visualized and interpreted more easily.
DOA-T3.1-R04	Interactive Feature Exploration: develop interactive visualizations that allow users to explore the relationships between different input features and the predicted air quality or noise levels. This could include scatter plots and other visual analytics tools.
DOA-T3.1-R05	Decision Support Dashboard: create a dashboard that integrates various visualizations and interpretability tools, allowing stakeholders such as city managers, domain experts, and non-expert users to explore the data, understand model predictions, and make informed decisions based on the insights provided.
DOA-T3.2-R01	Easy access to historical climate data (either from weather stations or from a reanalysis).
DOA-T3.2-R02	Offer tailored climate information for each location based on CMIP6 Models
DOA-T3.2-R03	Handling uncertainties associated with climate projections
DOA-T3.2-R04	Offer Climate projections of extreme events associated with different sectors like Hydraulic, NBS, Health etc.
DOA-T3.2-R05	Verification and validation of statistical downscaling methodologies.
DOA-T3.2-R06	Offer assessment for adaptation measures for NBS and the city itself.
DOA-T3.2-R07	Offer characterisation of current local climate and CC most probable scenario.
DOA-T3.2-R08	Offer assessment of climate change local vulnerability to extreme events and hazards.
DOA-T3.2-R09	Offer facilities for long term assessment updates of climate change scenarios evolution.
DOA-T3.3-R01	Offer tailored weather and seasonal data and specific indices for each location.
DOA-T3.3-R02	Based on the best assessed and statistically corrected models.
DOA-T3.3-R03	Offer early warning system for co-defined flags for anticipation purposes.
DOA-T3.3-R04	Offer daily-monthly automatic updates thorough WMS protocol.
DOA-T3.3-R05	Identify extreme event warning on corresponding CC scenario.
DOA-T3.3-R06	Offer assessment for protection measures for NBS and the city itself (seasonal forecast).

DOA-T3.3-R07	Offer short term anticipation for developing protection measures to safeguard the city's elements of interest.
DOA-T3.4-R01	Offer NBS models for the cities.
DOA-T3.4-R02	Calculate the effect of the selected NBS on various KPIs.
DOA-T3.4-R03	Take into account the following elements in NBS models: radiative heat transfer, aerosol physics, evaporation-transpiration by vegetation as the emission, transport, reaction and deposition of biogenic volatile organic compounds and pollen, etc.
DOA-T3.4-R04	Read and process various spatial data sources used as input for the NBS models (3D city morphology, vegetation and water elements, etc.).
DOA-T3.5-R01	Gather socioeconomic data such as census data, population density, income levels, and active businesses.
DOA-T3.5-R02	Correlate socioeconomic data with effects of climate change, using remote sensing data to quantify changes in temperature, precipitation, and extreme weather events.
DOA-T3.5-R03	Develop models to analyse the impact of climate change on different socioeconomic groups and businesses.
DOA-T3.5-R04	Provide tools for visualizing the correlation between socioeconomic factors and climate change effects for urban planners and policymakers.
DOA-T3.5-R05	Ensure data integration from various sources, maintaining data accuracy and consistency for reliable analysis.
DOA-T3.6-R01	Simplify access to the data.
DOA-T3.6-R02	Manage varying data formats.
DOA-T3.6-R03	Offer a single access point to the data (vs "absence of a single access point to the data")
DOA-T3.6-R04	Increase data interoperability (vs "lack of data interoperability").
DOA-T3.6-R05	Overcome isolation of data ("data silos").
DOA-T3.6-R06	Offer data anonymization functions while allowing the data to be used for analysis or processing.
DOA-T3.6-R07	Offer data encryption functionalities.
DOA-T3.6-R08	Offer access control functionalities.
DOA-T3.6-R09	Offer capabilities to guarantee data confidentiality.
DOA-T3.6-R10	Offer capabilities to guarantee data integrity
DOA-T3.6-R11	Adopt shared data models to enable data interoperability.
DOA-T3.6-R12	Offer capabilities to connect to satellite and EO data source and manage the retrieved data.
DOA-T3.6-R13	Offer capabilities to connect to open data and information from public entities and managed the retrieved data.
DOA-T3.6-R14	Offer capabilities to collect crowdsourcing/sensing and survey data.
DOA-T3.6-R15	Based on open and standardised interfaces such as NGSI-LD, DCAT-AP, SensorML, and others.
DOA-T3.6-R16	Offer capabilities to interact with data spaces.

DOA-T4.1-R01	Initiation of one / multiple 3D digital twin models for the pilots
DOA-T4.1-R02	Integration of geospatial data into the viewer.
DOA-T4.1-R03	Minimum a terrain dataset is required.
DOA-T4.1-R04	Minimum a CityGML LOD 2 model for buildings is required.
DOA-T4.1-R05	Extension via URBREATH plugins to be able to connect to NBS modelling modules and to be able to integrate simulation results.
DOA-T4.1-R06	Users are empowered to use a NBS planning tool in 3D (using a 3D viewer) and save their plannings in individual planning scenarios (VC PLANNER).
DOA-T4.1-R07	Plannings can be exported (several formats will be supported) to be used in NBS simulation tools.
DOA-T4.1-R08	Results of T3.3 NBS simulations will be integrated and visualised in the 3D viewer.
DOA-T4.1-R09	Comparisons between before and after applying NBS measures.
DOA-T4.1-R10	Support e-participation process by comparison methods of NBS.
DOA-T4.2-R01	Release of ICT tools to facilitate e-participation.
DOA-T4.2-R02	Provide user-friendly web and mobile, open-source based toolset.
DOA-T4.2-R03	Include discussion forums to support communication among stakeholders.
DOA-T4.2-R04	Involve interactive maps and geolocation features.
DOA-T4.2-R05	Offer social media integration for users to share on social media platforms.
DOA-T4.2-R06	Explore ways to enhance collaboration by linking outputs from other tools of the framework.
DOA-T4.2-R07	Explore ways to enhance stakeholder engagement by mobile interaction/visualisation capabilities.
DOA-T4.2-R08	Tools to include a mobile-based application available for both OS platforms (Android & iOS) as well as the web (web progressive app).
DOA-T4.2-R09	Facilitate e-participation using a friendly, easy to use, interface to support communication.
DOA-T4.2-R10	Embedded geolocation features.
DOA-T4.2-R11	Build on the outputs obtained by the other tools of the framework.
DOA-T4.3-R01	Allow the definition of KPIs.
DOA-T4.3-R02	Creation, management, calculation, and monitoring of KPIs.
DOA-T4.3-R03	User-friendly interface for easy end-user interaction.
DOA-T4.3-R04	Allow to compare KPIs (to identify areas for improvement and develop strategies).
DOA-T4.4-R01	Offer an ID manager to enable user registration, authentication, and authorisation (related to T3.6 "Offer access control functionalities").
DOA-T4.4-R02	Offer a unique point to access, explore and test the tools composing the Toolbox.

## 11 Annex D - Initial Candidate tools of URBREATH Toolbox

This section offers a brief overview of the main initial candidate tools composing the URBREATH Toolbox. The tools here reported are organised in four groups:

- **City data visualization:** the tools reported under this group offer functionalities to enable the user to visualize and understand data and information.
- **Data access & sharing:** tools being part of these groups offer capabilities to simplify the discovery and access to scattered data and information.
- **Data analysis and processing:** tools belonging to this group offer data analysis capabilities, to allow the implementation of analytics that are of interest for the cities (e.g. estimation of heat island effect, air quality assessment, etc.)
- **E-participation:** this group includes tools devoted to supporting stakeholders' engagement and participation in a participatory process.

The tools part of the URBREATH Toolbox will be made available on a dedicated online GitHub repository<sup>61</sup>, which will be constantly updated.

### 11.1 City data visualization

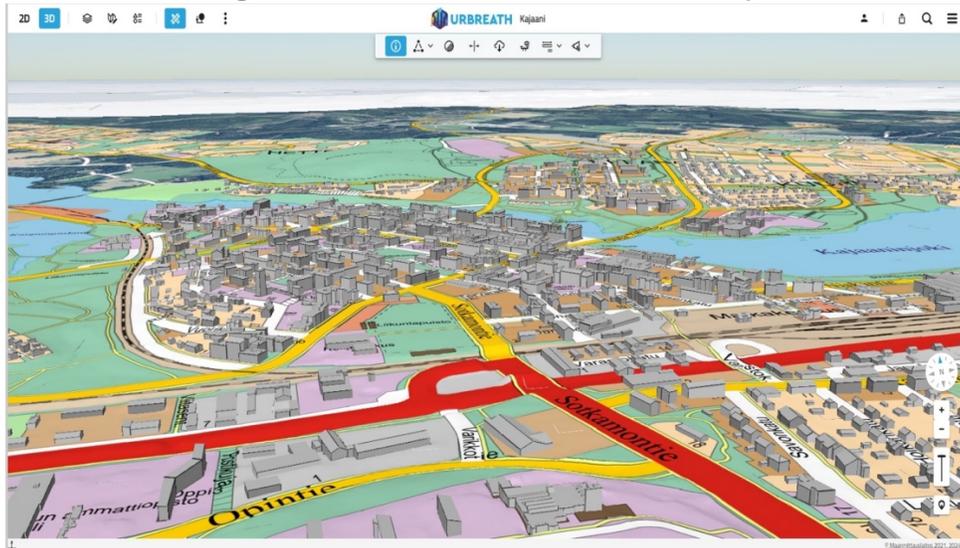
#### VC Map

VC Map is an open-source platform designed for visualizing 2D and 3D geospatial data on the web, providing a powerful yet accessible tool for creating interactive maps and local digital twins. Built on CesiumJS, a popular JavaScript library for 3D geospatial visualization, VC Map combines the high-performance 3D rendering of CesiumJS with additional features tailored for complex data visualizations in urban planning, infrastructure management, and environmental monitoring. VC Map's architecture allows it to incorporate various map data sources, supports diverse data formats like GeoJSON, KML, and 3D Tiles, and enables users to easily switch between 2D and 3D views, enhancing the flexibility and utility of its mapping capabilities.

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<sup>61</sup> <https://github.com/orgs/URBREATH/repositories>

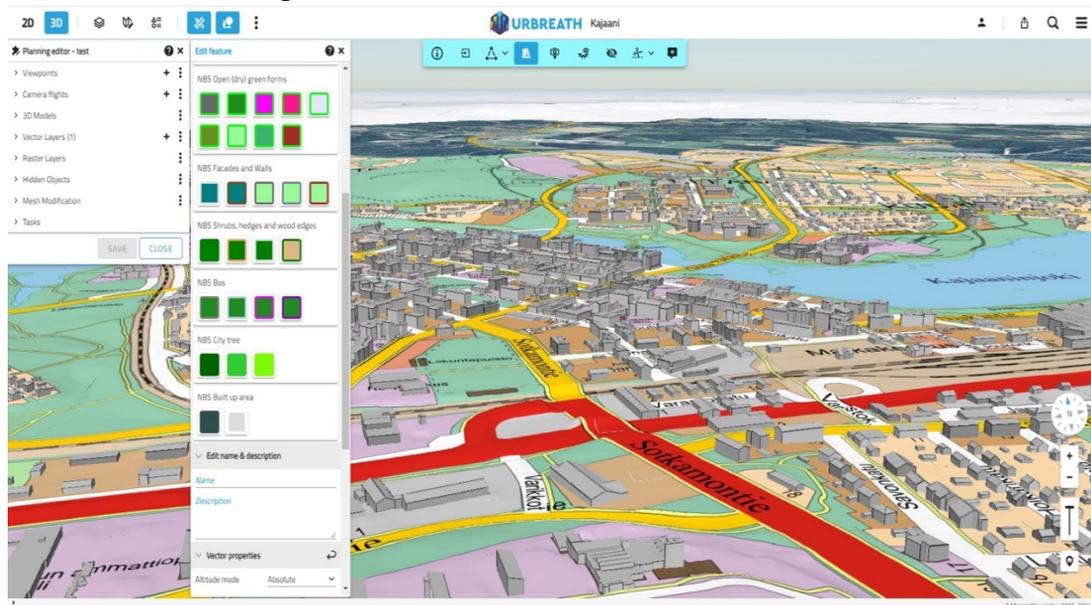
Figure 22: URBREATH Initial tools – VC Map



### VC Planner

The VC Planner empowers urban planners and city developers with a comprehensive suite of tools to create, analyse, and manage complex urban projects. Start by structuring project goals, phases, and milestones in a high-level overview, then leverage detailed 3D city modelling to visualize realistic urban environments. Integrate diverse spatial datasets, including GIS layers and BIM models, for a unified view that enhances data management and informed decision-making. The VC Planner supports the import of a wide range of data formats, including DWG, DXF, Shape, IFC, 3DS, OBJ, DAE, KML, KMZ, and GeoTIFF. Additionally, it integrates object libraries to enhance planning with features such as 3D tree libraries, 3D city furniture, 3D houses, and especially for URBREATH - the NBS catalog.

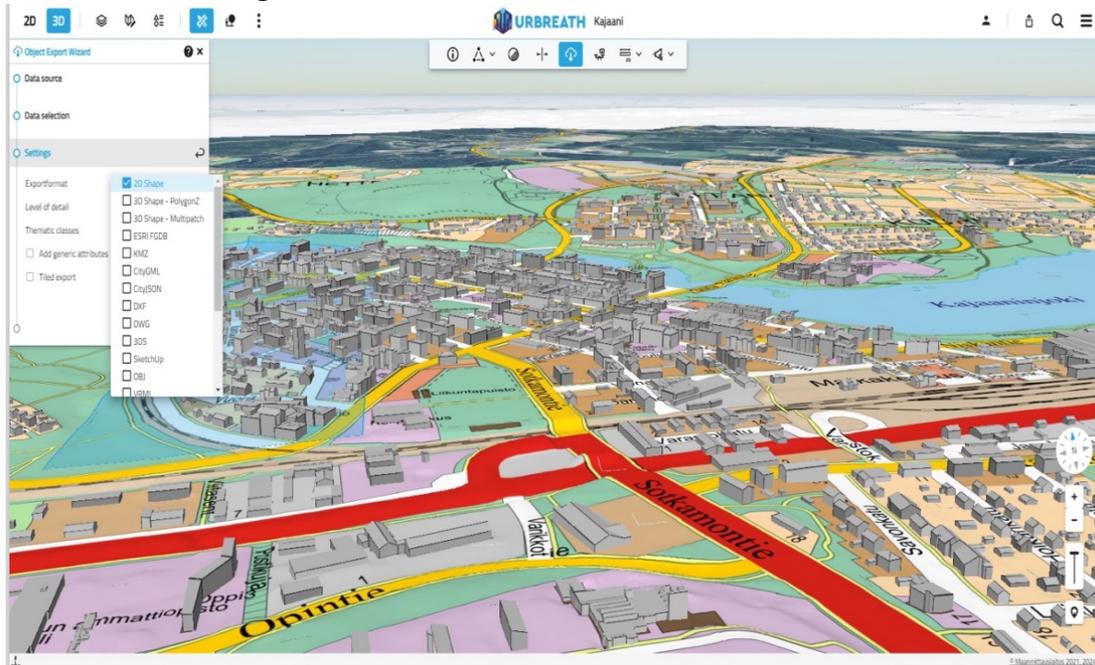
Figure 23: URBREATH Initial tools – VC Planner



## VC Warehouse

VC Warehouse allows the scene export from LDT and all visible objects including drawn and newly planned features into several output formats such as Shapefiles, OBJ, 3DS, STL and more. By using the VC Planner together with VC Warehouse an export of planning data alongside the 3D scene is supported. The export supports both single-object selection and polygon-based selection for exporting specific areas.

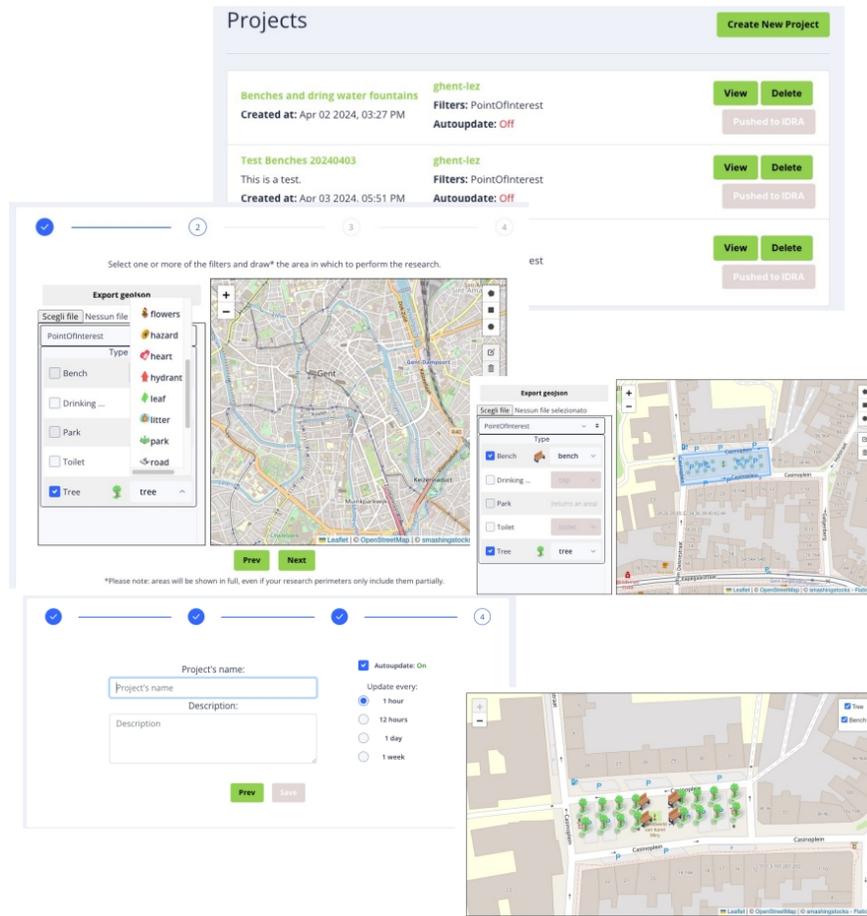
Figure 24: URBREATH Initial tools – VC Warehouse



## GeoCacher

GeoCacher is designed to support the user in exploring geospatial data. The solution combines a flexible backend with a user-friendly graphical interface, enabling users to query and visualise geo referenced data. For this purpose, the GeoCacher interfaces with the ORION context broker, which is the primary source to retrieve geo referenced information derived from NGSI-LD entities. Among its capabilities, the GeoCacher, allows the user to manage map layers (GeoJson format) built with retrieved information, their periodic update and publication as datasets leveraging Idra's functionalities (see section 11.2 where the Idra tool is reported), ensuring they are readily available for broader access and use.

**Figure 25: URBREATH Initial tools – Geodata Extractor**

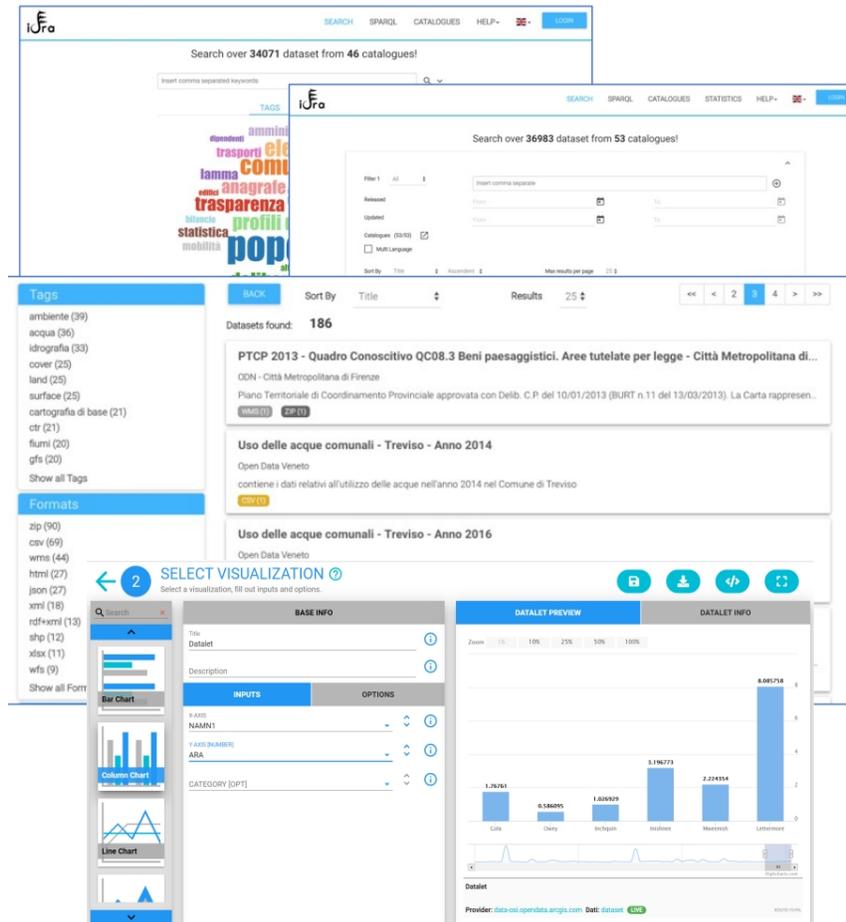


## 11.2 Data access & sharing

### Idra

Idra is a web application designed to integrate and federate a wide variety of existing Open Data Management Systems (ODMS), regardless of the underlying technology. By offering a single access point, it enables users to search and discover open datasets from diverse, heterogeneous sources. The application ensures consistency in data representation through the adoption of international standards (i.e. DCAT-AP), promoting interoperability across different platforms. To further enhance its functionality, Idra offers a suite of RESTful APIs that can be leveraged by third-party applications. Natively, Idra supports popular ODMS such as CKAN, DKAN, Socrata, as well as other technologies, such as and Orion Context Broker (NGSI v2), while also providing additional APIs to integrate with systems that are not natively supported. For open data portals that lack APIs, Idra includes features like web scraping or the ability to process dataset dump files in the DCAT-AP format. The platform also facilitates the creation of visualizations such as charts, based on the collected open data, providing powerful tools for data analysis and presentation.

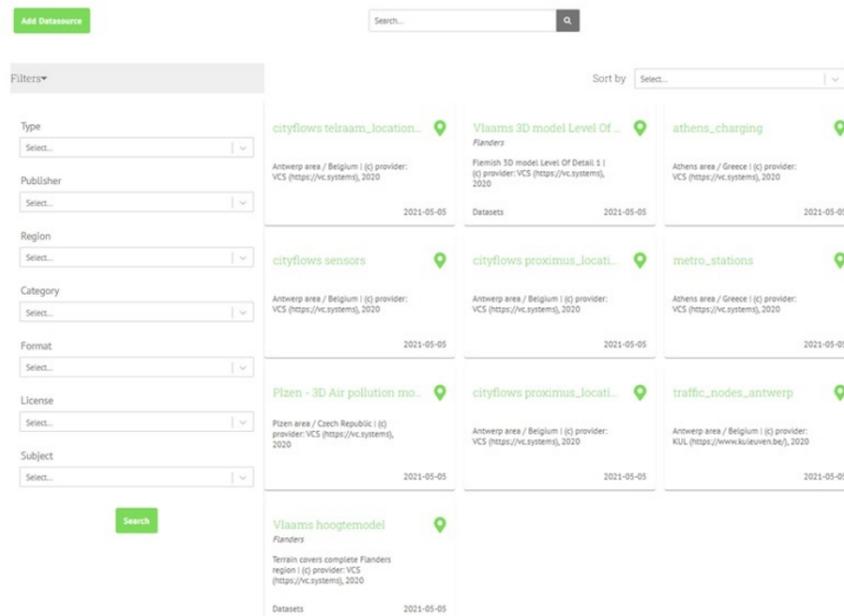
Figure 26: URBREATH Initial tools – Idra



## Model Catalogue

On the Data Catalogue page, users can search for registered data sources within the system or add new ones. The same process applies to the Model Catalogue for managing models. The Data Catalogue allows users to easily search for registered data sources by using filters like keywords, data types, categories, and metadata. Users can add new datasets by uploading files or connecting to external data sources, providing essential metadata like descriptions, formats, and ownership. The catalogue promotes efficient data discovery, encourages reuse, and ensures data governance by allowing users to manage access, document data lineage, and track quality metrics. This system enhances collaboration by making data accessible to different teams and ensuring that data remains discoverable and properly maintained. The **Model Catalogue** serves as a similar repository but focuses on managing models and algorithms.

Figure 27: URBREATH Initial tools – Data Catalogue/Model Catalogue



### NBS Registry

An NBS Registry is a centralized digital platform designed to catalog, manage, and share information about Nature-Based Solutions (NBS) across urban and rural settings. It enables city administrators to input, update, and share NBS initiatives, while allowing citizens and stakeholders to explore, search, and analyze these solutions. The registry promotes collaboration by connecting cities, providing access to statistical insights, and supporting decision-making through features like simulations and scenario planning. By integrating with tools and data sources via a microservices architecture, an NBS Registry fosters innovation, transparency, and informed implementation of sustainable, nature-driven solutions.

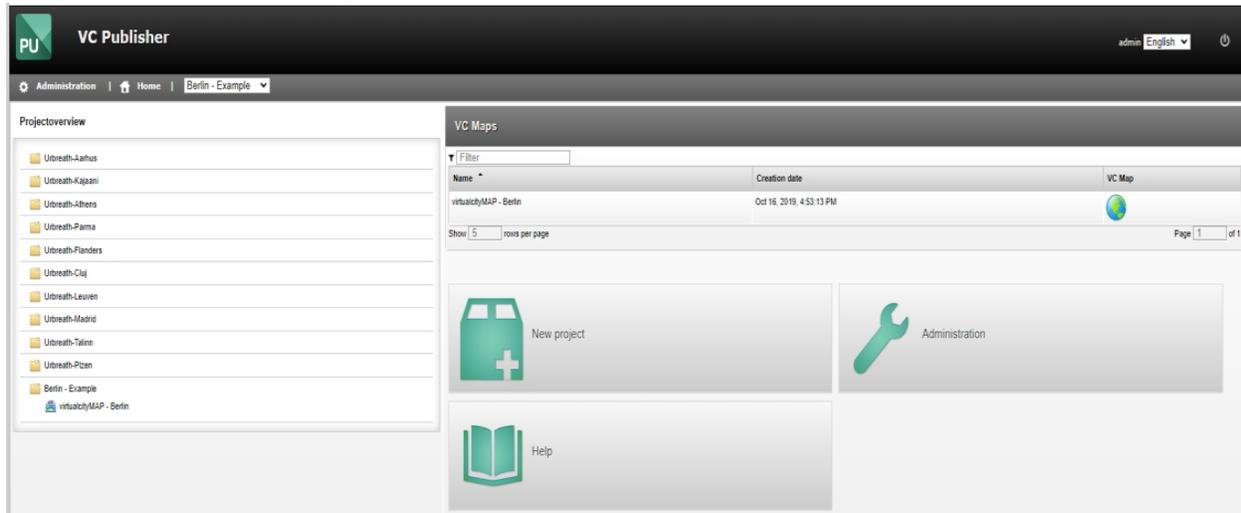
### VC Publisher

The **VC Publisher** is a specialized platform for creating and managing digital twins, particularly useful in generating Local Digital Twins (LDTs) for urban planning, infrastructure monitoring, and complex system simulations. It is designed to support the end-to-end workflow of digital twin development, including data integration, and continuous updates, ensuring that digital representations remain accurate and relevant to real-world counterparts. The VC Publisher provides ability to execute conversion jobs, transforming raw data into Cesium<sup>62</sup> streaming data. Jobs, Maps and more can be initiated using the OGC API Processes interface and offers project, user, and application management via a REST API or

<sup>62</sup> Cesium is an open-source solution to create 3D maps accessible through the Web - <https://cesium.com/>.

directly through a web browser after logging in. Created Cesium streaming data can be easily integrated into Unreal Engine and Unity Game Engine<sup>63</sup>.

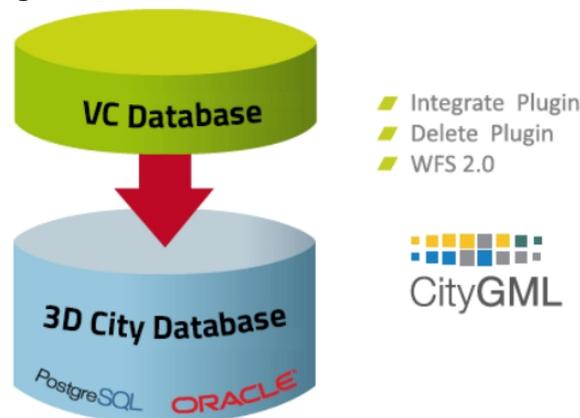
Figure 28: URBREATH Initial tools – VC Publisher



### VC Database

The VC Database is designed for the reliable storage of semantic city model data, ensuring consistency and security. It facilitates the seamless import and export of CityGML data, streamlining complex database operations and queries with user-friendly functionality. The database solution for CityGML data serves as a foundation for implementing additional processes and applications, enabling the querying of CityGML data or its conversion into other formats.

Figure 29: URBREATH Initial tools – VC Database



<sup>63</sup> Unreal and Unity are two 3D game engines - <https://www.unrealengine.com/>; <https://unity.com/>.

## 11.3 Data analysis and processing

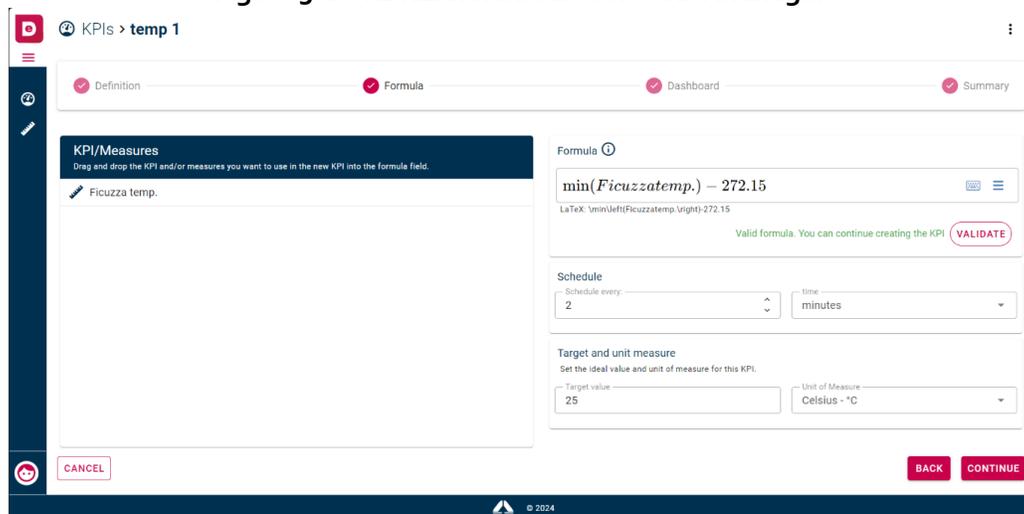
### KPI Manager

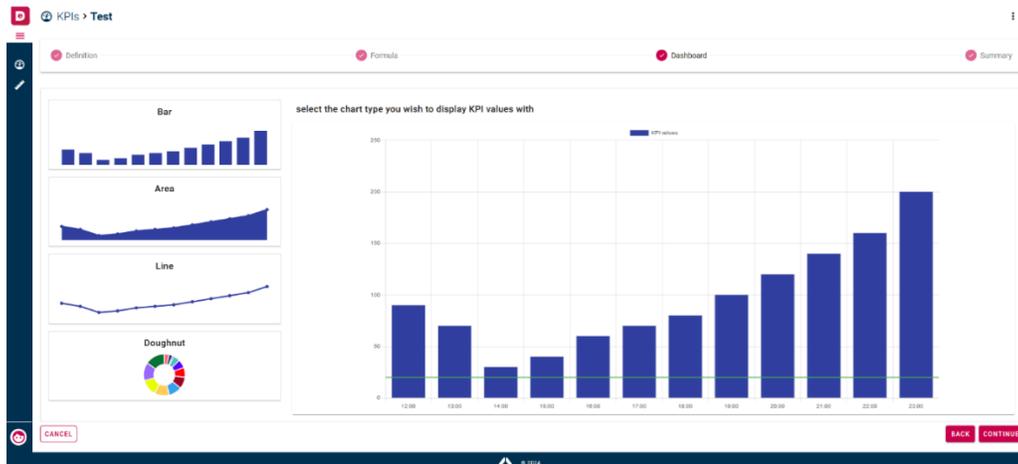
The KPI Manager is a comprehensive tool for tracking, analysing, and managing key performance indicators, providing valuable insights into organizational, project, or solution performance. By offering a centralized view of metrics, it empowers users to make informed decisions and plan strategically.

With its intuitive dashboards, charts, and graphs, the KPI Manager enables users to identify trends, patterns, and anomalies in the data at a glance. Tailored KPIs can be defined, targets set, and alerts configured to notify users of deviations from desired performance levels.

The tool monitors KPIs over time, allowing users to track performance trends and pinpoint areas needing improvement or intervention. Collaboration is streamlined by enabling users to share KPIs, dashboards, and reports with relevant stakeholders, fostering a shared understanding of performance goals and progress.

Figure 30: URBREATH Initial tools – KPI Manager





### Cost Benefit Analyzer

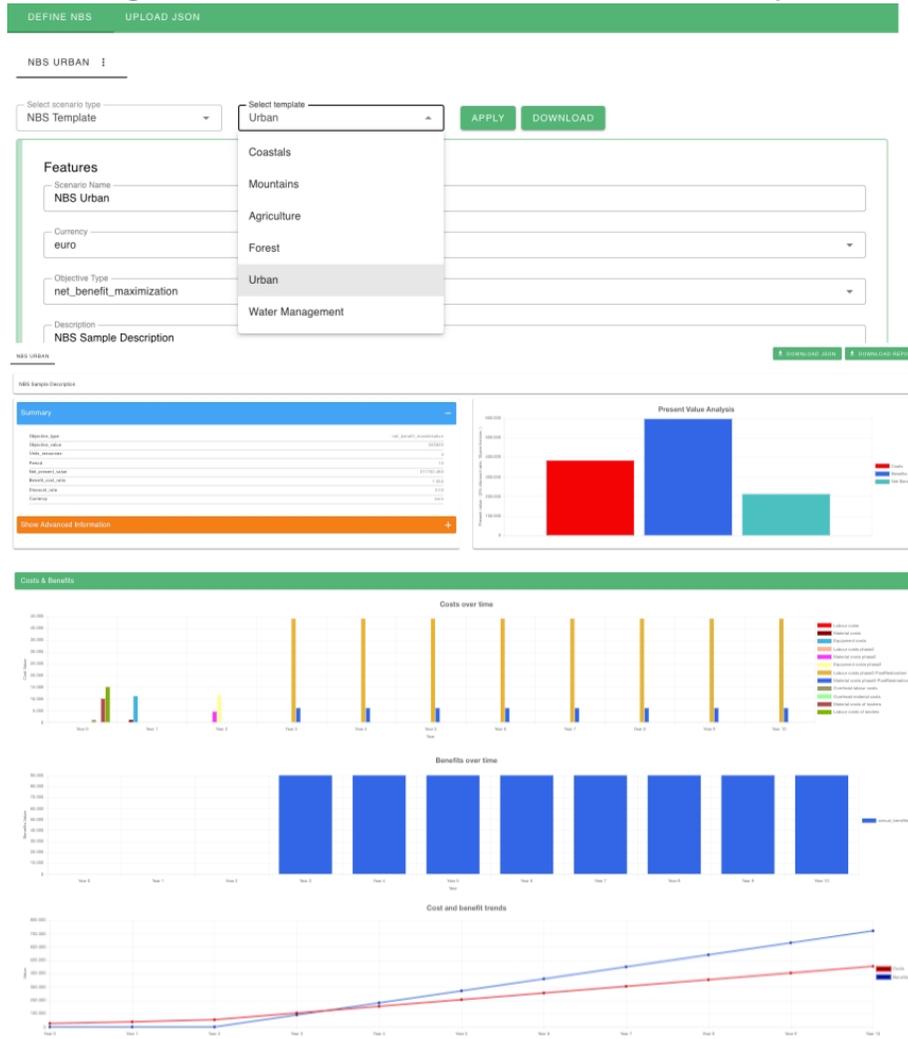
Enables users to create detailed scenarios for cost and benefit distribution, allowing them to select from various objective functions, such as Net Benefits Maximization or Break-Even Point Estimation.

The tool facilitates the analysis of Net Present Value<sup>64</sup> (NPV) by allowing users to define a custom time horizon for evaluation.

Results are presented in a clear and user-friendly format, combining tabular data with interactive graphs for deeper insights. These outputs can be conveniently exported as PDF reports, ensuring easy sharing with stakeholders.

<sup>64</sup> the value of all future cash flows (both positive and negative) over the whole duration of an investment discounted to the present.

**Figure 31: URBREATH Initial tools – Cost Benefit Analyzer**

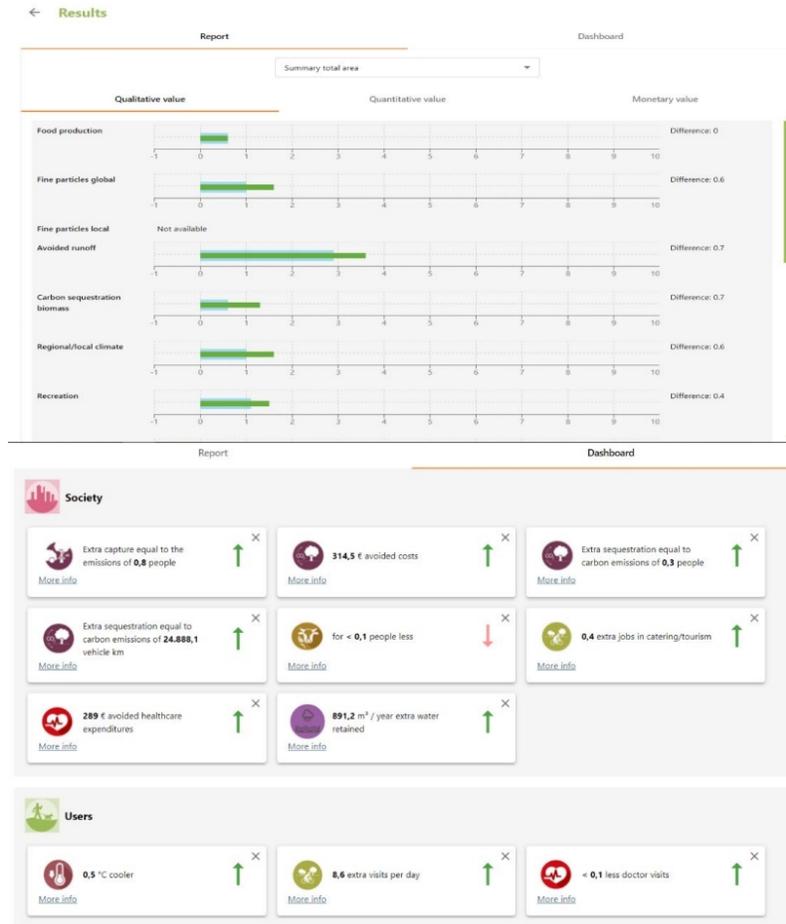


### Nature Value Explorer

The Nature Value Explorer provides practical methods for valuing ecosystem services, assisting planners, land managers, and policymakers in mapping the socio-economic importance of nature. For this purpose, it offers different functionalities and capabilities, such as:

- Assesses the impact of ecosystems on human well-being.
- Highlights the role of green spaces in recreation and health.
- Offers both qualitative and quantitative analyses of how ecosystem services are affected.
- Evaluates socio-economic value in both physical and monetary terms.
- Enables rapid assessment of project impacts.
- Facilitates comparison of results and collaborative discussions with other users.
- Expands beyond the Climate Portal by providing additional quantification of co-benefits.

Figure 32: URBREATH Initial tools – Nature Value Explorer



### **Biotope area factor and 3+30+300**

The Nature Based Solutions Institute (nbsi.eu)<sup>65</sup> has introduced the *3+30+300* rule a few years ago as a concept for developing urban forests and creating greener and healthier cities. The rule states that everybody should be able to see 3 large trees from their home, live in a neighbourhood with at least 30% tree canopy (or vegetation) cover, and be no more than 300 metres from the nearest public green space that allows for multiple recreational activities. This proves an easy framework for users to evaluate the availability of green in their cities.

The Biotope Area Factor (BAF) [7] is a tool used to measure the absorbent properties of a surface. It has been initiated by Berlin and other cities in and outside the EU. The concepts of the BAF have been clearly described for the application in an urban context by the urban development department of Berlin and its application in Canada. The calculation can be performed in different cities using essentially the same formula:

$$\frac{\text{Ecologically effective surfaces} \times \text{Ecological value factor per m}^2 \text{ of surface}}{\text{Total surface area of lot}}$$

As a straightforward concepts and easy to implement frameworks, both 3+30+300 and BAF will be integrated to offer users an analysis of access to green and its infiltration potential and biotope contributions.

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<sup>65</sup> <https://nbsi.eu/>

Figure 33: URBREATH Initial tools – 3+30+300<sup>66</sup>



### Climate Portal Flanders

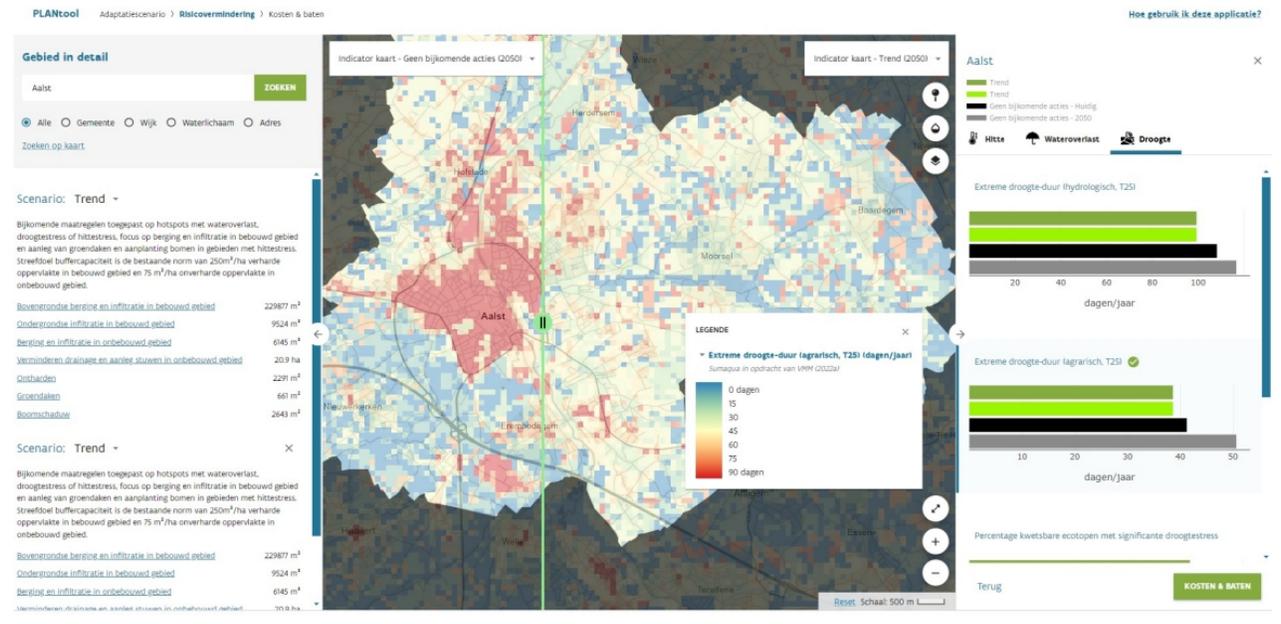
Climate Portal Flanders provides local authorities with a technological solution to develop climate adaptation strategies. The portal offers three main capabilities:

- **IMPACT:** risk and vulnerability assessment at local level (2050-2100)
- **PLAN:** which measures are possible and how many are needed to reduce vulnerabilities in a municipality
- **PROJECT:** estimate the adaptation score for a specific project design Focus on spatial data & modelled results

The tool enables users to screen the impact of changing climate on heat stress, drought and flooding challenges. At a city level gives an easy overview of these challenges. At neighbourhood level users can experiment with different greening strategies and evaluate what is needed to adapt to the changing climate conditions.

<sup>66</sup> Credit: DataLab - <https://thedatalab.be/330300/>

Figure 34: URBREATH Initial tools – Climate Portal Flanders<sup>67</sup>



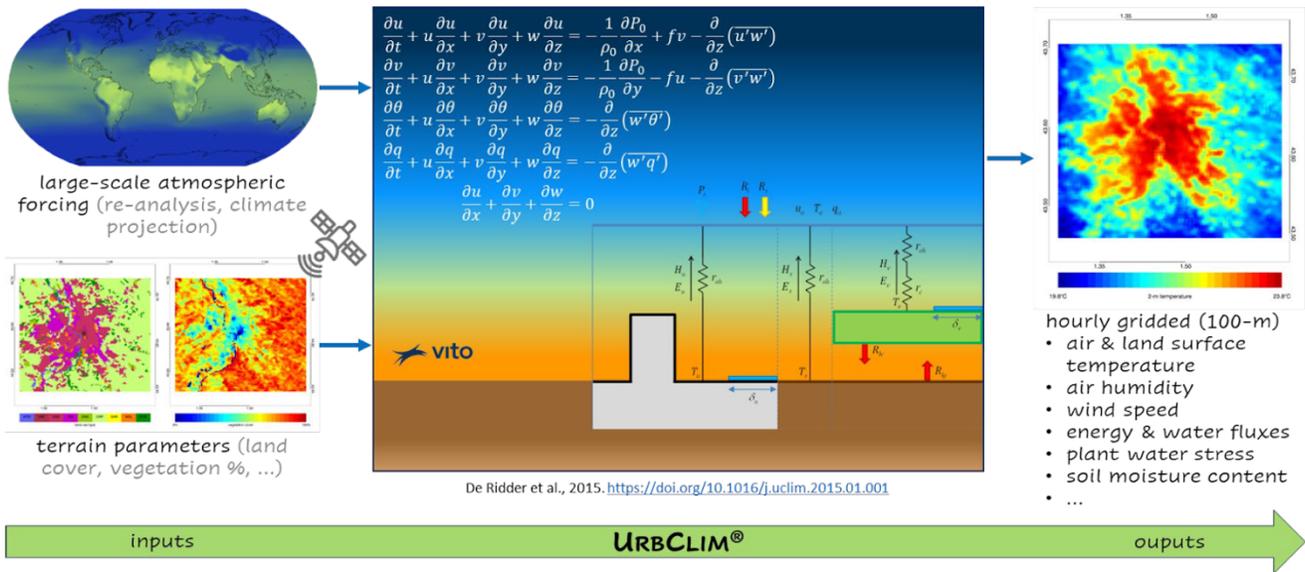
### Numeric models – Urban climate model UrbClim

UrbClim is a high-resolution urban boundary layer climate model, designed to simulate urban climates at a typical spatial resolution of 100 metres. The model consists of a land surface scheme built on a soil–vegetation–atmosphere transfer framework, coupled with a 3D atmospheric boundary layer module. UrbClim enables detailed analysis of UHI effects and air temperature distributions.

The output of this model enables user to analysis current and future heat stress challenges in their cities. The figure below shows an overview of the approach. A more elaborate description is available in [8].

<sup>67</sup> Credits Klimaatportaal Vlaanderen - <https://impacttool.toepassingen.vmm.vlaanderen.be/2>

Figure 35: URBREATH Initial tools – Numeric models – UrbClim



### Numeric models – Air Quality

The Air Quality Modeling Toolbox is designed for planning, assessment, and forecasting, fully and can be integrated into the DT platform. It enables users to quickly evaluate the impact of mobility and related measures on air quality, including:

- Traffic emissions
- Street canyon effects
- Can be expanded to include other sectors such as industry and shipping.

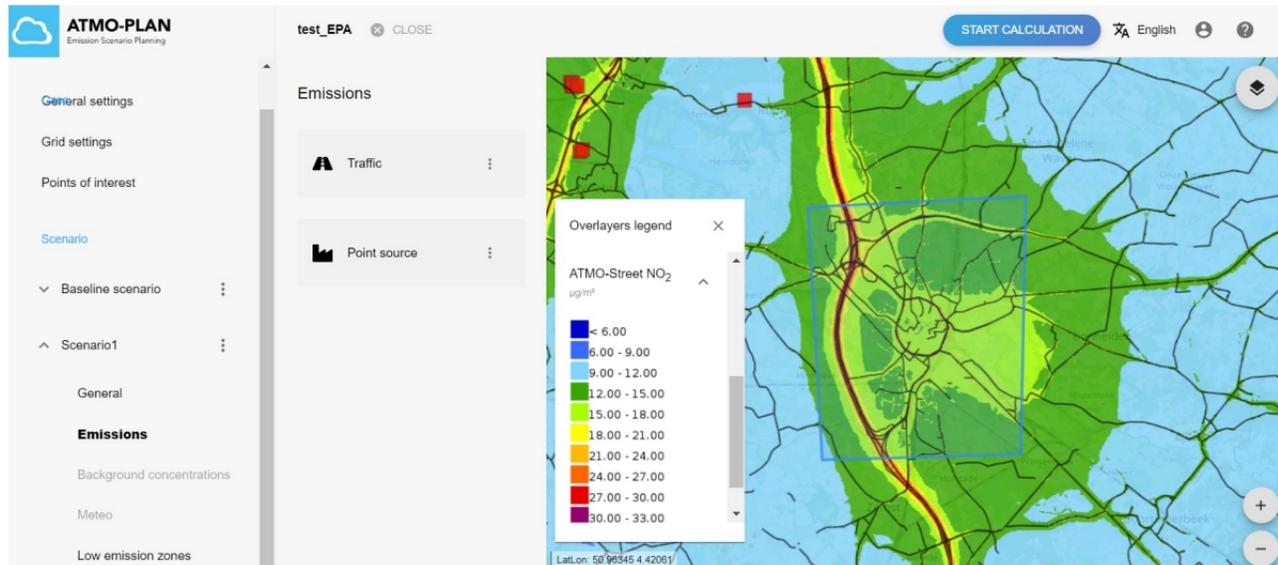
As part of the proof-of-concept digital twin solutions offered by the Horizon project DUET (<https://www.digitalurbantwins.com/>), air quality models have been integrated into a digital twin architecture. URBREATH will build on this previous integration to make steps towards a more robust model coupling and integration with other models to evaluate the impact of NBSs. VITO integrated the FASTRACE<sup>68</sup> traffic emission model and the QUARK<sup>69</sup> air quality model to evaluate mobility choices for air quality impact. Stand-alone applications can also be applied for a first screening of the air quality situation in the URBREATH cities and check the contribution of different sectors including road transport and NFR<sup>70</sup> (Nomenclature for reporting) sectors. The figure below shows an example for Belgium.

<sup>68</sup> <https://vito.be/en/applications/fastrace-determine-emission-your-region>

<sup>69</sup> <https://atmosys.vito.be/en/quark>

<sup>70</sup> Nomenclature for reporting refers to the format for the reporting of national data in accordance with the Convention on Long-Range Transboundary Air Pollution (CLRTAP) also remitted to the European Environment Agency (EEA). Source: Euskal Estatistika Erakundea Instituto Vasco de Estadística

**Figure 36: URBREATH Initial tools – Numeric models – Air Quality: Example of analysis of road traffic scenario for nitrogen dioxide concentrations in Belgium**



### Water Discharge Prediction

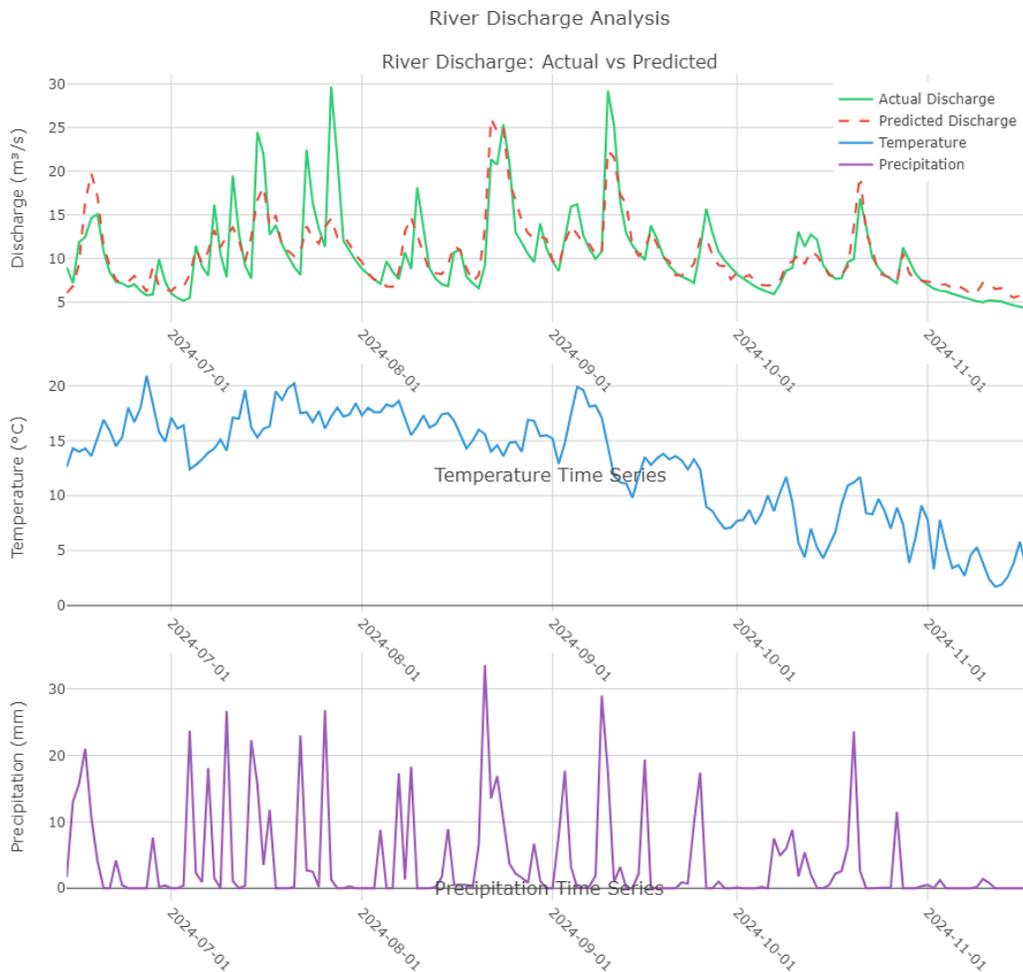
This AI-based model is currently under development and aims to predict high water discharge events, potentially becoming a valuable tool for improving flood risk management. By exploring a combination of meteorological, hydrological, and historical data, the model is being designed to provide estimates of expected water discharge levels, with the goal of helping stakeholders take proactive measures to mitigate flood-related risks.

The model is envisioned to rely on meteorological inputs such as precipitation (rainfall and snowfall), temperature, humidity, wind speed, and wind direction to analyse weather patterns that influence water flow and accumulation. In the future, it could also integrate hydrological data, including river flow rates, snow measurements, and soil moisture content, to better understand environmental conditions and their capacity to manage incoming water. Additionally, historical data on past flood events, flood maps, and water discharge rates are being considered to enhance the model's ability to identify patterns and conditions historically associated with high discharge or flooding.

Once fully developed, the model's output is expected to offer quantified predictions of water discharge levels. These predictions could be correlated with historical flooding events and maximum water load thresholds for specific areas, providing insights into the likelihood and severity of potential flood risks. While still in progress, this tool holds promise for informing decision-making, improving preparedness, and guiding the implementation of targeted flood mitigation strategies. When completed, it could serve as a critical resource for early warnings and long-term planning in flood-prone regions.

([https://en.eurostat.eus/documentos/elem\\_13174/definicion.html#:~:text=Definition%20NFR%20Nomenclature&text=Acronym%20of%20Nomenclature%20for%20Reporting,European%20Environment%20Agency%20\(EEA\).](https://en.eurostat.eus/documentos/elem_13174/definicion.html#:~:text=Definition%20NFR%20Nomenclature&text=Acronym%20of%20Nomenclature%20for%20Reporting,European%20Environment%20Agency%20(EEA).))

**Figure 37: URBREATH Initial tools – Water Discharge Prediction**

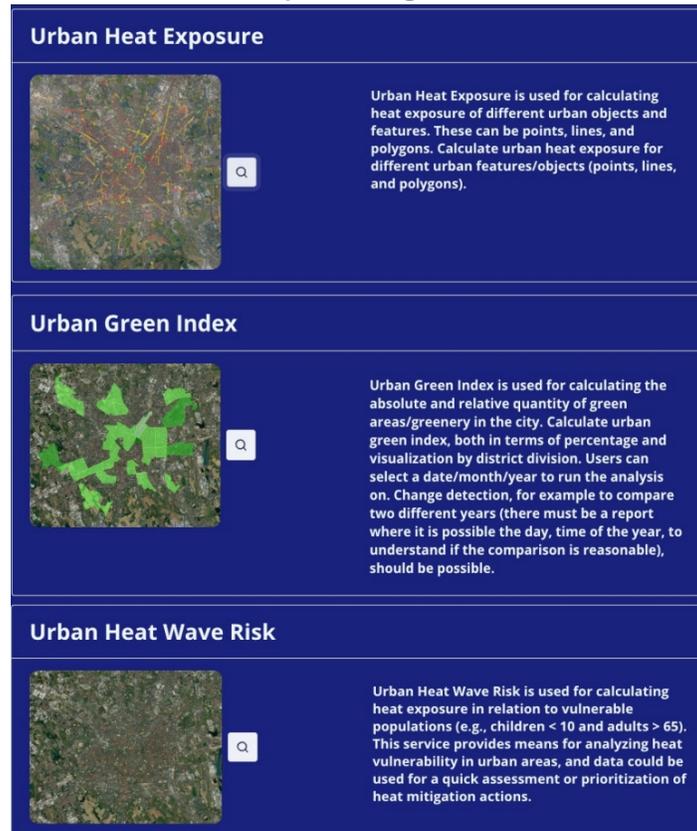


### Spotted Digital Services Satellite Imagery Analysis

Provide following analysis on Area of Interests inside the city:

- Urban Heat Exposure: heat exposure of different urban objects and features.
- Urban Heat Wave Risk: calculating heat exposure risk in relation to vulnerable populations (e.g., children < 10 and adults > 65).
- Urban Green Index: calculating the absolute and relative quantity of green areas/greenery in the city

Figure 38: URBREATH Initial tools – Spotted Digital Services Satellite Imagery Analysis



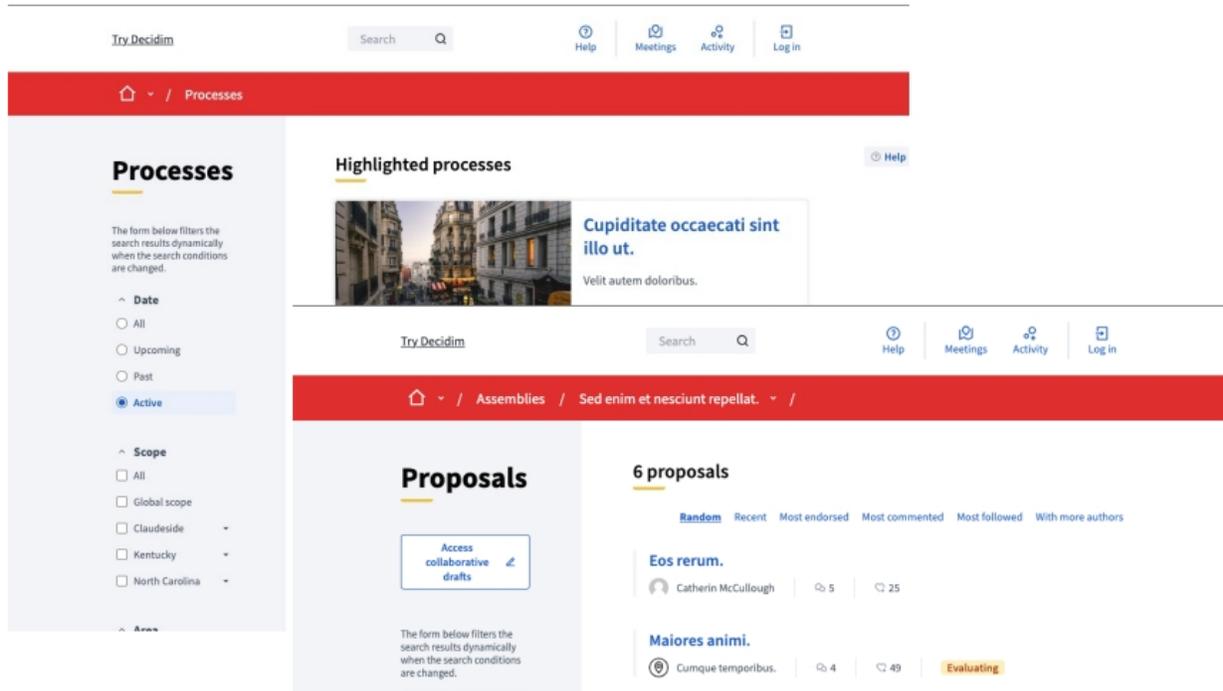
## 11.4 E-participation

### Decidim

Decidim is a digital open-source platform designed to support online participatory process. Decidim offers different types of participatory activities, such as ideas management, surveys, discussion forums, voting, etc. The platform is highly customizable and adaptable, supporting different types of decision-making workflows and offering virtual spaces and features like surveys, proposals, debates, and events management. Decidim has been adopted by various European cities, regions, and both public and private organizations<sup>71</sup> for managing a wide range of participatory processes, including urban space design, public policy planning, assembly management, consultations, referendums, and more.

<sup>71</sup> <https://decidim.org/usedby/>)

Figure 39: URBREATH Initial tools – Decidim<sup>72</sup>



### e-Participation Mobile App

A highly customizable, user-friendly e-participatory app tailored to meet the specific needs of a project. Participatory Features:

- **On-map NBS Scenarios and Implementation Tracking:** Users can interact with interventions on the map, view detailed information, comment, vote, and share on social media.
- **Projects:** Users can browse a full list of projects or filter them by categories, priority, impact, implementation stage, or proximity.
- **Proposals:** Serves as a forum for idea exchange, where the most supported proposals may become official initiatives adopted by municipal authorities.
- **Consultations:** Municipal authorities can place draft legislation under public consultation, allowing users to engage in policymaking by commenting, liking, or disliking specific articles of the draft.
- **Polls:** Users can participate in various polls to express their opinions.
- **Trending Now:** Displays the most popular topics based on user engagement.

Conventional Features:

- **Agenda:** Shows upcoming events and community meetings.
- **News Feed:** Keeps users updated with the latest information and announcements.

<sup>72</sup> Credits Associació de Software Lliure Decidim - <https://decidim.org/>

Figure 40: URBREATH Initial tools – e-Participation Mobile App

