URBAN GreenUP

D1.7: NBS scenarios generation tool

WP 1 , T 1.6

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[1] PU = Public

PP = Restricted to other programme participants (including the Commission Services)

RE = Restricted to a group specified by the consortium (including the Commission Services)

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Versions

Version	Person	Partner	Date
V0	José Fermoso, Esther San José	CAR	01/07/2020
V1	Paul Nolan	CFT	17/09 2020
V2	José Fermoso, Esther San José	CAR	18/09/2020
V3	Magdalena Rozanska	ACC ING	20/09/2020
V4	José Fermoso, Esther San José	CAR	23/09/2020
V5	Kaan Emir	DEM	23/09/2020
V6	José Fermoso, Esther San José	CAR	24/09/2020

Table of Content

List of Figures

0 Abstract

The aim of this report is to explain the rationale, construction and operation of the **Nature Based Solutions (NBS) scenarios generation tool**. As a way to easily and quickly identify the tool, it has been created the acronym **ToolUGU** and also a **logo** (Figure 1).

Figure 1. Acronym and logo of the NBS scenarios generation tool.

This tool has been created as a support tool for creating NBS scenarios in a systematized way. Within the context of the **URBAN GreenUP renaturing methodology** (Figure 2, section 2.1), ToolUGU can be used for several stages in order to make a more orderly process.

Through this report, the reader will understand the origin of the information and the formulas used to define and construct the ToolUGU. The document explains the different phases and uses of ToolUGU. It clearly indicates the source tasks where the information has been collected about NBS, challenges and barriers, boundaries and enablers. Input panels are described for each one of these aspects.

A KPIs prioritization analysis has been also included to be used both to the establishment of proper assessment frameworks for the NBS scenarios created and to make an extra filter to a more concisely definition of the NBS scenarios if needed. The calculation module is also explained to describe the formulas used to the creation of the list of recommended NBS for the user requirements.

Finally, the output report section will explain all the information included in the **selected NBS scenario**. This scenario will define a set of NBS to respond to the city challenges under a specified context. The output report will support the user in the renaturing process following the URBAN GreenUP renaturing methodology.

At this point, it must be mentioned that, the URBAN GreenUP methodology has been divided in three stages, and reported into D1.12, D1.13, D1.14 and D1.17 in more detail. The idea is to maintain the methodology report continuously updated with all the Project outcomes and lessons learned coming from the demonstration and replication actions executed along with the Project. With this report, the creation of the ToolUGU is completed. However, the final version will be delivered at the end of the project (M60) after coming validations of the methodology and the tool.

1 Introduction, scope and structure

A tool is defined as a piece of equipment that you use with your hands to make or repair something or as something that helps you to do a particular activity. In the case of **ToolUGU**, it is an open supporting tool of the **URBAN GreenUP Renaturing Methodology** focus on helping the users into the renaturing city process.

This deliverable includes several chapters covering the main aspects and stages followed to create the NBS Scenarios Generation Tool, ToolUGU. Initially, it will describe briefly the framework of the tool in the context of the URBAN GreenUP Renaturing methodology and the existing links with other tasks and WPs in the Project. It will be completed with the approach and workflow diagram of the process. Then, it will describe the calculation basis behind ToolUGU regarding the relation matrixes for Challenges vs. NBS, Barriers/Boundaries/Enablers vs. NBS and the KPIs prioritization criteria matrix.

Within the URBAN GreenUP work plan, WP1 addresses the creation of the renaturing methodology. Task 1.6 is about the creation of the NBS scenarios generation tool and the Key Performance indicators calculation prioritization criteria. This task is divided in two tasks, on the one hand, the NBS scenarios generation tool (Cartif is in charge) and on the other hand, the KPIs calculation prioritization criteria, with Demir in charge.

Task 1.6.1 is described as the development of a tool that will allow the systematizations of scenarios generation and will integrate the NBS identified in Task 1.1, and take into account the results of the City diagnosis, barriers and boundaries as well as social economic or technical criteria.

The creation process of ToolUGU runs parallel to the URBAN GreenUP Renaturing Methodology. The tool has been created according the needs of the methodology and a way to support the calculation processes and to make easier the decision making process. This tool is focused to the main users of the methodology during exploration stages 1B (Understand your “city” needs) and 2B (Choose your “city” targets) and then for the diagnosis stages 1C (Understand your “city” capacity) and 2C (Evaluate NBS Scenarios and select one). The users identify for this process are surely the same than those identify for these stages within the methodology:

- Public governments,
- Businesses
- Society
- Academia/r&d
- International bodies
- Financial institutions
- Other

ToolUGU is structured in three basic stages: inputs introduction, selection process and output report.

The input introduction stage consist on three inputs panels:

- **Scenario description panel** that will serve to define basic characteristics of the user scenario with generic data: title, generic description, location, objectives, constrains and notes.
- **Challenges panel** to select the challenges and sub-challenges applying the study.
- **Barriers panel** to introduce the barriers and boundaries appliying in the scenario (region, city, neighbourhood or city) but also to identify the possible enablers for the NBS implementation process.

The selection process uses the selection module to create the NBS scenario (the best NBS for the renaturing process). ToolUGU calculates the best NBS for the initial diagnosis carried out by the user. It also offers the user the possibility of making a manual selection from the recommended NBS.

Finally, the output report will show the description of the basic scenario and the information needed about the recommended NBS (or links to get it) for the implementation of the renaturing plan within the URBAN GreenUP methodology.

2 The framework of the NBS Scenarios Generation Tool

2.1 Renaturing methodology

URBAN GreenUP developed a systematic strategy to reach high level of impacts through the use of NBS. It aims to provide an integrated methodology to support the Urban Planning of NBS at the local city level, as a powerful strategy to contribute to increasing sustainability, addressing a range of societal challenges. URBAN GreenUP introduces the concept of **Renaturing Urban Planning (RUP)**, which incorporates NBS alongside the traditional urban planning aspects to generate a more sustainable approach to Urban Planning. In parallel to traditional planning processes, the methodology supports cities in the direct implementation of one or more NBS in a specific area or across the city to address specific societal challenges in a more effective and ecologically sustainable way.

This holistic approach to the methodology, the same the qualitative values considered into the tool, builds in part on the experience of the cities involved in Urban GreenUP. This includes both successes and problems encountered in the 'real world', and lessons learned through the process of implementing NBS in the 'leading' cities of Liverpool (UK), Izmir (Turkey), Valladolid (Spain), and simultaneously validated in 'follower' cities of Mantova (Italy), Ludwigsburg (Germany), Medellin (Colombia), Changdu (China), and Quy Nhon (Vietnam).

How to start?	1st. Understand your present	2nd. Choose your future aspirations	3rd. Integrate RUP and keep	"Renaturing Urban Plan"
A. Engage and Co-create	Action 1A. Identify and involve stakeholders	Action 2A. Prepare for co-delivery		**Chapter I.** Introduction to Re-naturing
B. Explore	Action 1B. Understand your "city" needs	Action 2B. Choose your "city" targets	Action 3B. Prepare RUP Plan integration into the Urban Plans of Local Municipality	**Chapter II.** City Targets
C. Diagnose	Action1C. Understand your "city" capacity	Action 2C. Evaluate NBS Scenarios and select one	Action 3C. Define list of NBS Projects and Actions	**Chapter III.** City NBS Adopted Scenarios
D. Visualize	Action 1D. Map challenges	Action 2D. Set spatial priorities for NBS	Action 3D. Prepare assessment of the Impact and Risk	**Chapter IV.** City Impact
E. Plan	Action 1E. Establish Baselines	Action 2E. Choose how success will be monitored	Action 3E. Prepare the Up-scale Plan	**Chapter V.** Monitoring Program and Action Plan
F. Inform	Action 1F. Promote the initiative	Action 2F. Publish the RUP	Action 3F. Define budget, roles and responsibilities	**Chapter VI.** Roles and Responsibilities
A. Engage and Co-create	Action 3A. Assess lessons learnt and validate the strategy			**Chapter VII.** Processes and reforms

Figure 2. Re-Naturing Methodology.

The Action 2C on evaluation of NBS scenarios, for which the URBAN GreenUP TooLUGU is created, is an important part of the diagnosis process and of the holistic re-naturing methodology considered in URBAN GreenUP Project.

The objective of the diagnosis methodology step - where are also included actions 1B understand your "city" needs, 1C Understand your "city" capacity, 2B Choose your "city" targets - is to deliver the results of the detailed exploration, analysis and diagnosis of the city/area in respect to the societal challenges selected for a city. In continuation, Action 2C, evaluating those NBS Scenarios and selecting one. It is precisely for this step where the supporting tool was created with aim to provide the user with a list of the best NBS for the needs, targets and capacities of the city (diagnosis/challenges/barriers/enablers) among all the possibilities of the NBS Catalogue. A deep analysis of barriers, boundaries and opportunities for corresponding NBS indicated will be also supported. The information will allow the selection of the city's societal challenge scenarios with selected NBS.

The analysis progresses with two actions more. *Action 1D. Map challenges* aimed to define the NBS picture, identifying the key areas of focus for each challenge and NBS, and the *Action 2E. Choose how success will be monitored* completing the tool with the KPIs evaluation and prioritization criteria for the selected scenario.

2.2 Link with other Task and WP

2.2.1 Source tasks

Figure 3 shows a diagram including the source tasks of information for task 1.6. The tool needs some inputs, which come from the Climate change challenge catalogue (currently called Societal Challenge Catalogue, from task 1.) and the NBS catalogue; as well as the results of city diagnosis, and barriers and boundaries.

The data need for the inputs section come from initial tasks of WP1. These tasks development the knowledge about NBS, societal challenges and barriers and boundaries. Additionally, through task 1.3 the bases for the city diagnosis have been established.

Sub-tasks 1.6.1 and 1.6.2 defined the calculation bases and the prioritization criteria to develop the tool. Finally, ToolUGU outputs will integrate the results of all previous tasks in a customized report including some related aspects developed in task 1.3 about city zoning.

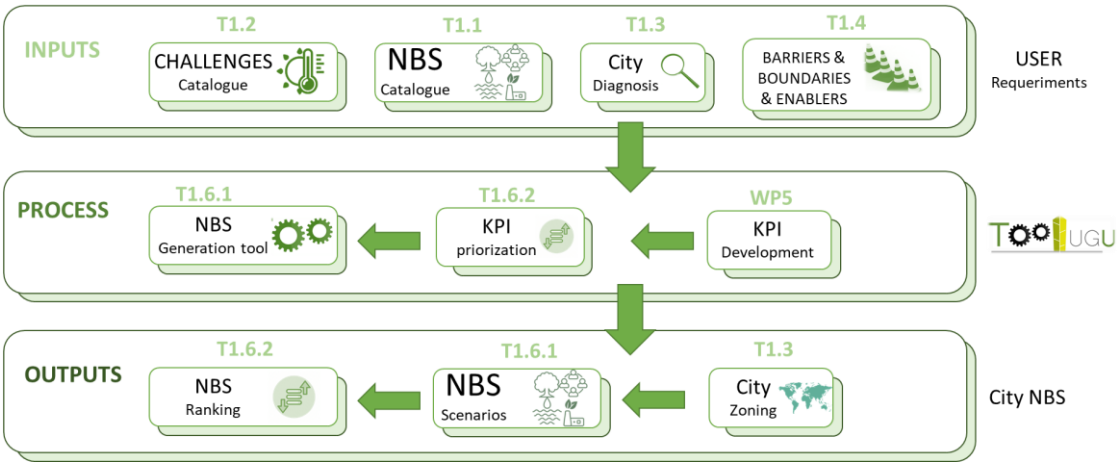


Figure 3. Sources tasks scheme for the development of ToolUGU.

2.2.2 KPIs prioritization

To complete the information about a proper NBS scenario within a renaturing plan, it is needed to propose an assessment framework. This framework has to be adapted to the NBS selected according to the experts indications but also depending on the city (or promoter) capacity or opinion.

The user has two options, to select the KPIs (from the proposed assessment framework according its challenges' selection) or to let the tool configures the KPIs according to its challenges' selection and proposed NBS. For the first option, ToolUGU contains a matrix acting as a prioritization criteria for KPIs selection for each NBS. In that matrix, users will match KPIs with NBSs by answering six questions described in section 2.1.4 of D1.8. Every match they do, it will reveal an average score. The prioritization of KPIs for each related NBS is then carried out by taking into consideration the average scores obtained within the process.

In case the user does not want or be able to fill in the matrix for the prioritization criteria, KPIs selection for the assessment framework will be performed according to the experts indications following the parameters inside the tool (completed using the same mechanism described in deliverable 1.8).

Deliverable 1.8 KPIs calculation tool and prioritization criteria contains all details of the matrix and its components.

2.2.3 The geographic dimension

The identification of ad hoc and placed based NBS in cities is a crucial issue. The design and delivery of NBS are evidence based. At one level, this science led approach enables us to show how NBS can have a positive impact on different challenges municipalities are facing nowadays (e.g.: flood risk reduction, urban heat island effect mitigation, etc.). Another strand of this evidence led approach is to target the NBS geographically to where they will have the greatest

impact. The use of spatial data and mapping for the analysis and representation of these data is an important element in NBS delivery.

The methodological approach that can be used to target activity is to assess an area, local or municipality wide, in terms of assets and pinch points (Figure 4).

Term	Description
Asset	Green infrastructure that is delivering a function or functions in an area of identified need. For example, woodland that is intercepting and storing water in an area of flood risk is a water management asset; it is providing functions that help to reduce the risk of flooding.
Pinch Point	Area where a need has been identified and where green infrastructure could provide part of the solution to address the need but at present is not.

Figure 4. Asset and pinch point description

As it is described in *Deliverable 1.6 Guidelines to city zoning*, these terms can be used in a decision grid (Figure 5), in which each quadrant formed describes the types of actions to be considered according to the levels of functionality and needs identified in a given geographical area.

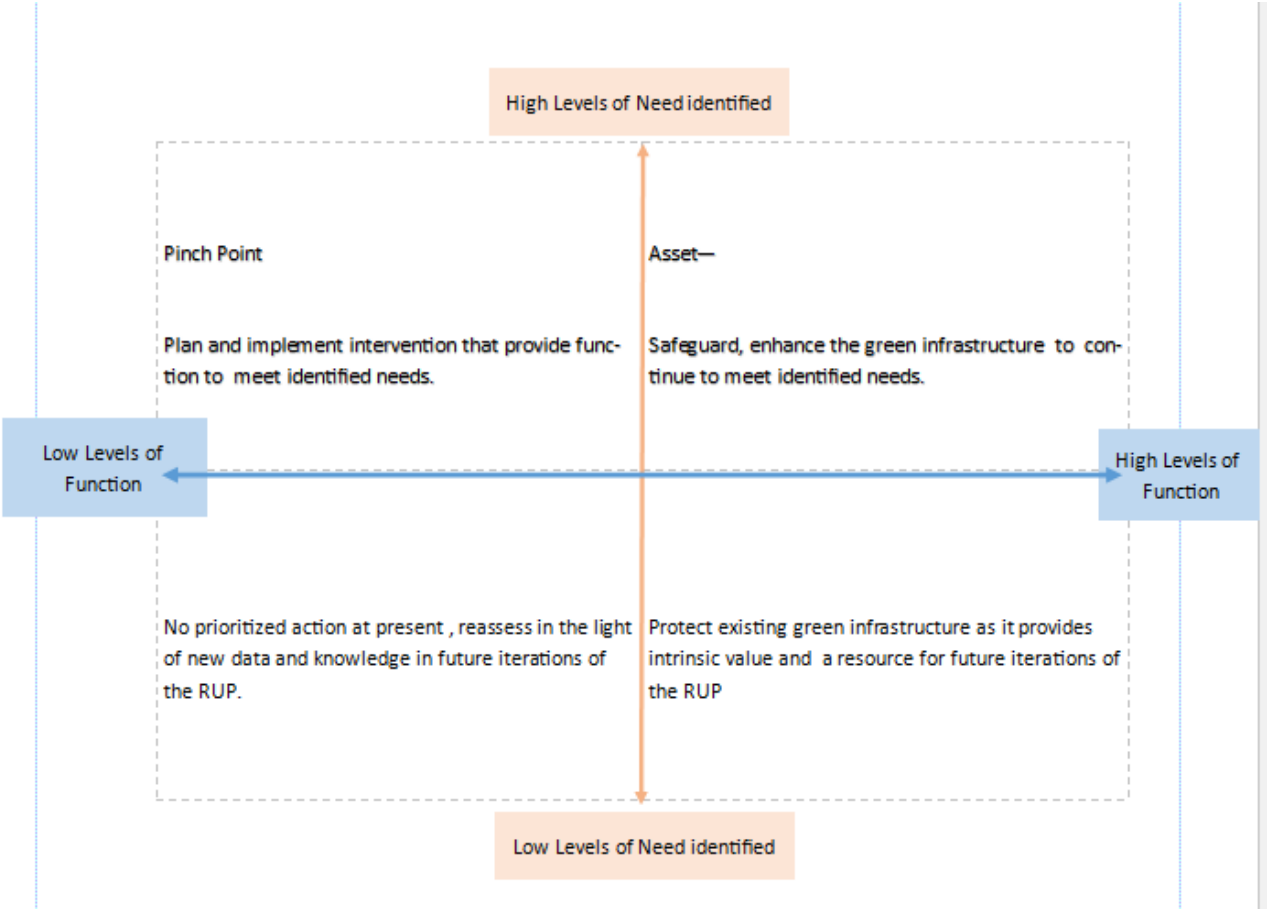


Figure 5. Assets and Pinch Points decision grid.

This simple approach enables areas across a municipality to be zoned and helps to target limited resources.

A clear strategy for gathering data, ensuring that the data used is high quality and likely to be accepted as robust by those who may be asked to support or to enable NBS deployment is critical. There is potentially an overwhelming amount of data that could be gathered and mapped, but mapping everything possible is unlikely to support effective decision making.

A clear geographic basis for zoning and for implementing NBS allows developing effective communication about programmes and projects. Zoning activity allows also to look for synergies with other non NBS programmes nearby to maximise impact.

This information, in line with the NBS Scenarios will allow stakeholders to create action plans to develop a proper Renaturing Urban Plan (RUP), by considering geographic dimension, city diagnosis and targets. Thus, by combining the mapping concept into this supporting tool will facilitate the identification of possible impacts cities may experience during and after the renaturing process. Furthermore, it may also help to anticipate the possible barriers to overcome in the broader city context.

3 Approach

The target of this subtask [1.6.1] will be the development of a tool that will allow the ***systematization of scenarios generation****, which will be created by the selection of one or several* ***NBS alternatives*** *(identified in task 1.1) that working in an integrated way will solve one or various problems. The selection of NBS's will be done taking into account the results of the* ***City/area diagnosis****, the possible* ***barriers and boundaries*** *identified through the procedure developed in task 1.4 but also taking into account the* ***social economic or technical criteria****.*

ToolUGU will offer a solution using NBS to specific city challenges following the user's requirements. The tool will generate one or several NBS scenarios integrating the knowledge developed in URBAN GreenUP about NBS and challenges (deliverable 1.1 and 1.2), existing barriers, boundaries and enablers (deliverable 1.5) and collecting user requirements and actuation characteristics following the framework defined in the city diagnosis and baseline definition process (deliverables 1.3 and 1.4).

A **scenario** is defined as a set of NBS selected to respond to the city challenges under a determined city context including physical, environmental and socioeconomic characteristics and taking into account existing barriers and boundaries. This context and boundary conditions is defined by a previous city/area diagnosis. The scenario could be generated for a specific street, neighbourhood, area or city.

NBS scenarios will be the result of the user interaction with ToolUGU. The user will examine the NBS scenario characteristics (NBS included, links to document and implementation guides, recommended KPIs to assess the impact…) and will decide if it is adequate according its expectations o it is needed to carry out another iteration. Task 1.6 is composed by two complementary and simultaneous sub-task:

- Sub-task 1.6.1 NBS scenarios generation tool
- Sub-task 1.6.2 KPIs calculation prioritization criteria

Both sub-tasks are complementary to build ToolUGU. Relationships **NBS / Challenges** and **NBS / Barriers and boundaries** (this also includes enablers) are collected from previous information generated within the Project. This information serves to filter user requirements and to select the most suitable NBS to face the challenges of a specific context identified by the user.

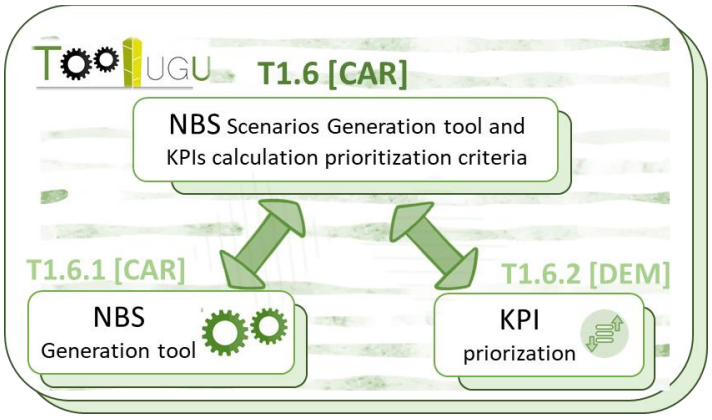


Figure 6. Sub-tasks included in task 1.6.

3.1 Workflow diagram

ToolUGU workflow diagram is very simple. By introducing user requirements regarding city challenges and context, the tool will initially filter all NBS of the catalogue using the challenge/s selected. That is to say, it will remove from possible NBS to use those not affecting selected challenge/s. Additionally, the tool will sort possible NBS according on its impact on the challenge/s the city is facing.

Next, the list of NBS will be filtered by barriers, boundaries and enablers reducing the list of NBS that can be implemented highlighting the ones that can be promoted by existing enablers. Conversely, those NBS affected by existing barriers or out of the boundaries of the context will be removed from the list. This list includes all the NBS that can have a positive impact on the area of action and whose implementation is possible.

Finally, only 10 NBS will be selected and then reported for the creation of the scenarios. In case of multiple tie of the solutions, the user will be asked to remove the ones he / she does not want from the list until leaving a maximum of 10.

NBS Scenario report will show the best 10 NBS (at maximum) based on the framework of the user requirements (challenge/s, barriers, boundaries and enables, location and other physical characteristics). Furthermore, links to general information, reference documents for tendering process and to the selection of the reference KPIs to assess the NBS impacts, will be provided.

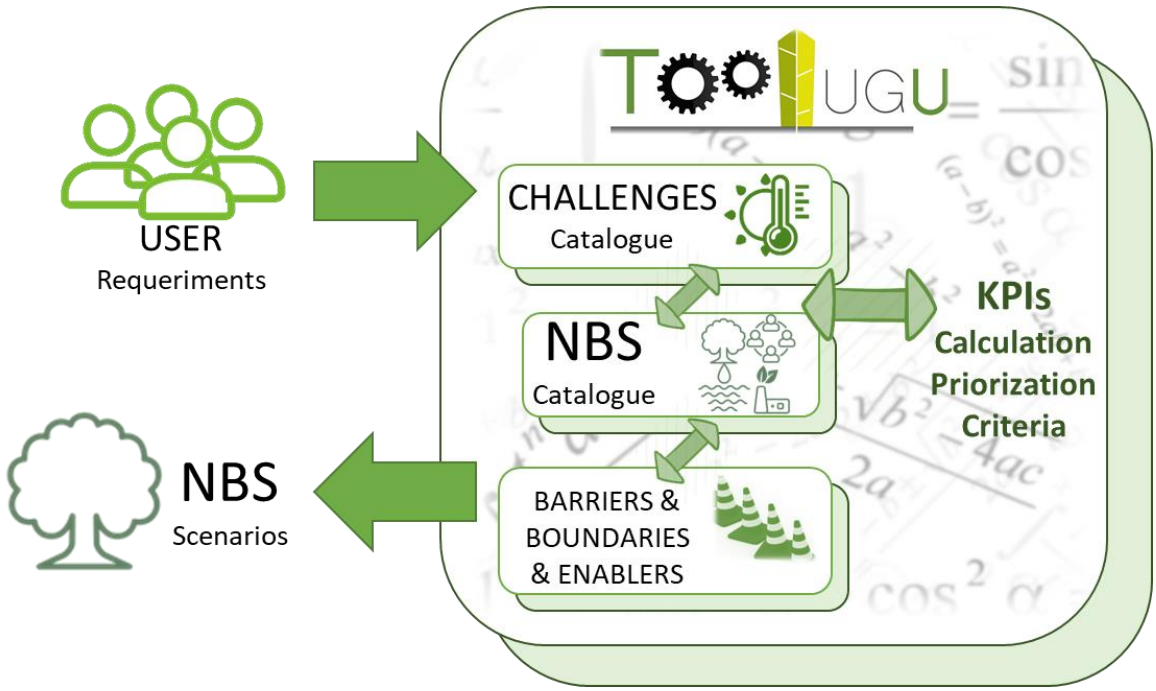


Figure 7. ToolUGU workflow.

4 Calculation basis

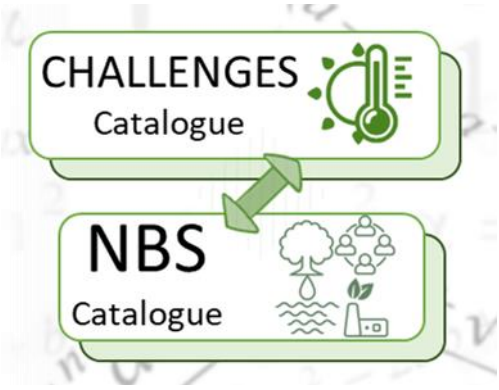
The interactions between the different elements of the URBAN GreenUP Renaturing methodology set the basis for the calculation processes that take place within the tool. The table below shows the main interactions that have been identified through the development of the methodology.

	NBS	CHALLENGES	KPI	BARRIERS	DIAGNOSIS	ZONING
NBS		X	X	X	X	X
CHALLENGES			X		X	X
KPI						
BARRIERS					X	
DIAGNOSIS						X
ZONING						

Figure 8. Interactions of the main elements identified in URBAN GreenUP Renaturing methodology.

Thus, as a first step in developing the tool, it is needed to establish those relational channels that allow the tool to create scenarios, taking in account the user inputs. Most of the interactions identified in Figure 8 have been considered as key relational channels for the tool, however, other interactions are considered as a separate part. That is the case of zoning aspect, closely related with the NBS scenarios but in a different dimension (geographic).

4.1 Challenge Versus NBS Matrix



Deliverable 1.2 Societal Challenge Catalogue developed a useful catalogue for the standardisation of a method to identify and classify the main city challenges. This catalogue allow practitioners to be able to examine these challenges in a simple way with accurate information about how these challenges might affect cities and how and why cities might come to understand urban vulnerability as soon as possible.

This report (D 1.2) includes technical and parametrisation aspects for challenges, in a standardised manner ready to be used in a systemic procedure of planning or decision-making processes. Delivery 1.2 includes not only a detailed description of climate change and societal

threats, but also the recommended NBS to face and address them. Figure 9 shows a snapshot of ToolUGU, with Challenges and sub challenges classification and their unique assigned code.

CHALLENGE	SUBCHALLENGE	CODE
Climate change mitigation and adaptation	Mitigation	C0101
	Adaptation	C0102
Water management	Flooding	C0201
	Water scarcity	C0202
	Water quality	C0203
	Circular economy	C0204
Green space management	[None]	C0400
Air quality	Primary pollutants. Particulate Matter	C0501
	Primary pollutants. Nitrogen oxides	C0502
	Secondary pollutants. Ozone	C0503
Urban regeneration	Managing urban growth	C0601
	Redevelopment areas	C0602
	Urban retrofitting	C0603
Participatory Planning and Governance	Green integrated management	C0701
	Environmental awareness	C0702
	City identity	C0703
Social Justice and Social Cohesion	Distribution	C0801
	Procedure	C0802
	Recognition	C0803
	Capability	C0804
Public Health and Wellbeing	Human health	C0901
	Physical activity	C0902
	Mental health and wellbeing	C0903
Potential economic opportunities and green jobs	Providing information to disseminate NBS industry	C1001
	Fostering multi-stakeholder cooperation	C1002
	Developing legislation and policies that promote NBS implementation	C1003
	Implementing appropriate planning procedures	C1004
	Setting several financial incentives for the implementation of NBS	C1005

Figure 9. Challenges and subchallenges and assigned code.

On the other hand, *Deliverable 1.1 NBS Catalogue* collects existing information about NBS, technical, economic and social aspects, in a standard way to be used in a systemic procedure of planning or decision-making. The list of NBS included in this table has been codified in the same way as the challenges (Figure 10 shows a snapshot of ToolUGU).

NBS GROUP	NBS DESCRIPTION	CODE
Green route	Cycle and pedestrian green route	N0101
Arboreal interventions	Shade trees	N0201
Arboreal interventions	Cooling trees	N0202
Arboreal interventions	Planting and renewal urban trees	N0203
Arboreal interventions	Arboreal areas around urban areas	N0204
Arboreal interventions	Trees re-naturing parking	N0205
Carbon capture	Urban carbon sink	N0301
SUDs	SUDs	N0401
SUDs	Grassed swales and water retention ponds	N0402
SUDs	Rain gardens	N0403
Flood actions	Urban catchment forestry	N0501
Flood actions	Hard drainage-flood prevention Unearth water courses	N0502
Flood actions	Channel re-naturing	N0503
Flood actions	Floodable park	N0504
Water treatment	Green filter area for waste water	N0601
Water treatment	Natural wastewater treatment	N0602
Green pavements	Hard drainage pavements	N0701
Green pavements	Green pavements green parking pavements	N0702
Green pavements	Cycle and pedestrian green pavement	N0703
Green pavements	Cool pavement	N0704
Smart soils	Enhanced nutrient managing and releasing soil	N0801
Smart soils	Smart soil production in climate-smart urban farming precinct	N0802
Smart soils	Smart soil and substrate	N0803
Pollinator	Pollinator verges and spaces	N0901
Pollinator	Pollinator walls/vertical	N0902
Pollinator	Pollinators roofs	N0903
Pollinator	Natural pollinator's modules	N0904
Pollinator	Compacted pollinator's modules	N0905
Vertical GI	Green fences	N1001
Vertical GI	Green noise barriers	N1002
Vertical GI	Green façade with climbing plants	N1003
Vertical GI	Hydroponic green façade	N1004
Vertical GI	Vertical mobile garden	N1005
Horizontal GI	Floating gardens	N1101
Horizontal GI	Green covering shelters	N1102
Horizontal GI	Electro wetland	N1103
Horizontal GI	Green roof	N1104
Horizontal GI	Green shady structures	N1105
Pollutants filter	Green filter area for air	N1201
Pollutants filter	Urban garden bio-filter	N1202
Resting areas	Parklets	N1301
Resting areas	Green resting areas	N1302
Urban farming	Climate-smart greenhouses	N1401
Urban farming	Urban orchards	N1402
Urban farming	Community composting	N1403
Urban farming	Small-scale urban livestock	N1404

Figure 10. NBS groups and description, and assigned code.

In this report (D1.2), the relationship between Challenges and NBS is quantified in values ranging from 0 to 5 (low to high incidence). Figure 11 shows an example.

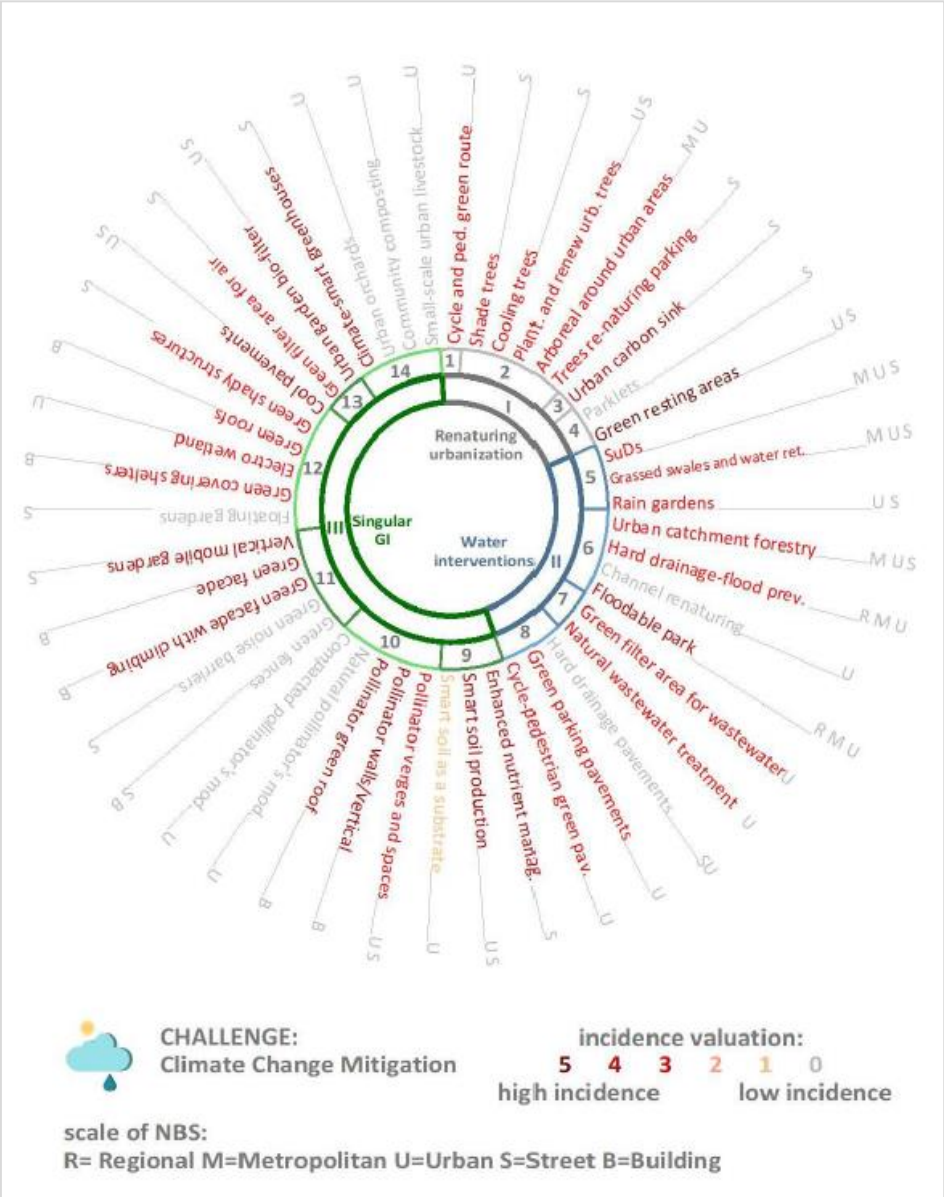


Figure 11. NBS evaluation chart from Deliverable 1.1 NBS Catalogue.

Therefore, both reports are a valuable starting point for the construction of the relational matrix called **Challenges vs. NBS Matrix**. However, to provide the tool with a more accurate calculation basis with the constraints of a city and to generate a more precise NBS identification, a further assessment has been carried out by including also the sub-challenges in the quantification.

In *Deliverable 1.1 NBS Catalogue*, the incidence of the different sub-challenges included in each challenge is not clearly defined. To provide accurate information for the construction of the matrix, a survey has been designed addressed to specific project partners. In this survey, expert partners were asked to evaluate and rate those NBS within their expertise, in relation to the sub-challenges. The NBS template includes a table in which the expert partner can select a challenge, sub-challenge, and rate it by using the same scale as in *Deliverable 1.2*. They can also include a brief comment in order to include any observation, source, or additional information than can be useful in further updates/reviews. This survey template could serve also in future

revisions of the values, as a result of further analysis based on monitorization activities in this Project. Figure 12 shows an example of the template.

NBS GROUP	NBS NAME	PARTNER
Pollinator	Pollinators roofs	CAR

Impact assessment table

Please select the challenges (including subchallenges) related to this NBS, and assign value to their impact.
Values range from 5 (large positive impact) to 1 (weaker impact). The value -1 has also been included to indicate possible negative impacts that may be generated by the NBS.

CHALLENGE	SUBCHALLENGE	VALUE	COMMENTS
Green space management	[None]	2	Not neccesarily green space
Climate change mitigation and adaptation	Mitigation	2	Not key for carbon sequestation
Climate change mitigation and adaptation	Adaptation	3	Poss reduction in ambient air temp
Air quality	Primary pollutants. Particulate Matter	3	Depends on spp and location
Air quality	Primary pollutants. Nitrogen oxides	3	Depends on spp and location
Air quality	Secondary pollutants. Ozone	3	Depends on spp and location
Urban regeneration	Managing urban growth	4	
Urban regeneration	Redevelopment areas	4	
Urban regeneration	Urban retrofitting	4	
Social Justice and Social Cohesion	Distribution	2	Not proven
Social Justice and Social Cohesion	Procedure	2	?
Social Justice and Social Cohesion	Recognition	2	Not yet proven
Social Justice and Social Cohesion	Capability	2	Not yet proven
Public Health and Wellbeing	Human health	3	Not yet proven
Public Health and Wellbeing	Physical activity	1	
Public Health and Wellbeing	Mental health and wellbeing	2	Only if visible from above
Water management	Flooding	3	
Water management	Water scarcity	1	Not necc an issue in Liverpool!
Water management	Water quality	3	
Water management	Circular economy	2	
Potential economic opportunities and green jobs	Providing information to disseminate NBS industry	3	Only if can prove benefits
Potential economic opportunities and green jobs	Fostering multi-skateholder cooperation	3	Only if can prove benefits
Potential economic opportunities and green jobs	Developing legislation and policies that promote NBS implementation	3	Only if can prove benefits
Potential economic opportunities and green jobs	Implementing apropiate planning procedures	3	Only if can prove benefits
Potential economic opportunities and green jobs	Setting several financial incentives for the implementation of NBS	3	Only if can prove benefits
Participatory Planning and Governance	Green integrated management	3	Only if visible and proven
Participatory Planning and Governance	Environmental awareness	3	Only if visible and proven
Participatory Planning and Governance	City identity	3	Only if visible and proven

Figure 12. Template for NBS vs Challenges evaluation, including sub-challenges.

The survey results are transferred into a quantitative interaction matrix in which NBS are listed in rows, and Challenges and Sub-challenges in columns (Figure 13).

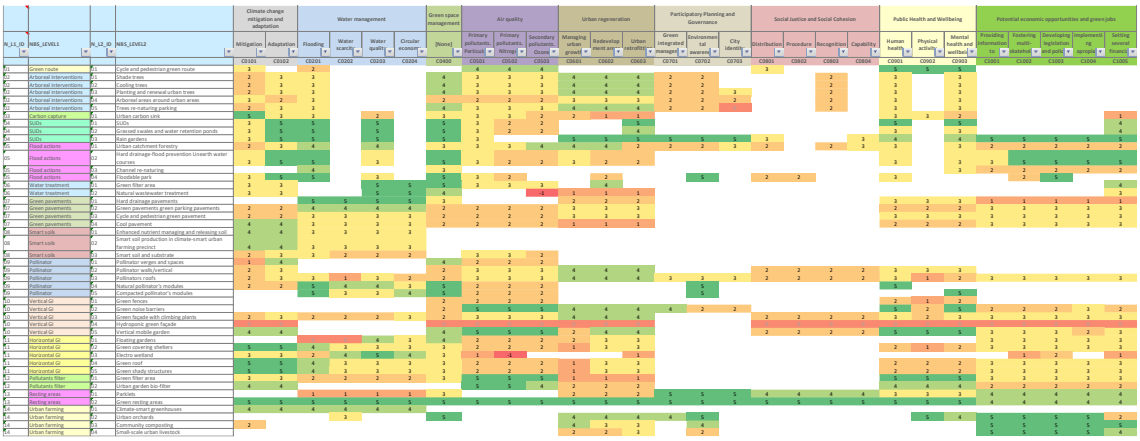


Figure 13. NBS vs Challenges matrix (A).

This is a 46 x 28 matrix, in which a total of 46 NBS are listed in rows and 28 Sub-challenges are listed in columns, grouped by Challenges. Thus, naming the matrix **NBS vs Challenges as matrix A (46x28),** each individual item from the matrix, a_{ij} represents the value assigned for experts during the evaluation process**.**

$$A = \begin{pmatrix} a_{1;1} & \cdots & a_{1;28} \\ \vdots & \ddots & \vdots \\ a_{46;1} & \cdots & a_{46;28} \end{pmatrix}$$

4.2 Barriers/enablers NBS matrix

4.2.1 Groups of barriers adopted

With a similar structure to the challenges, a relational matrix has been constructed. Starting from the Deliverable 1.5 produced through Task 1.4, a list of barriers has been included into the structure of the tool. This list corresponds to the experiences gathered from the design and implementation of NBS in the three front runner cities of URBAN GreenUP Valladolid (Spain), Liverpool (UK) and Izmir (Turkey), as well as from the planning constrains identified by the follower cities. Based on this information, it has been possible to identify a detailed description of potential barriers and boundaries: country specific barriers and overcoming barriers subsections under categories of political, technical, legal and organizational, social and cultural and financial barriers.

GROUP OF BARRIERS	BARRIER	SENTENCES	BAR_LEVEL4
Political barriers	**Disconnection between short term actions and long-term goals**	**Coordination between departments of the local public administration,**	
Political barriers	Disconnection between short term actions and long-term goals	**Political interests in electoral campaign periods,**	
Political barriers	Disconnection between short term actions and long-term goals	**Interventions construction in the short term with visible results in the long term,**	
Political barriers	Disconnection between short term actions and long-term goals	**Slow periods for public tendering processes**	
Political barriers	**Discontinuity between short-term actions and long- term plans**	**Frequent changes in local authority or other governing administration**	

GROUP OF BARRIERS	BARRIER	SENTENCES	BAR_LEVEL4
Political barriers	Discontinuity between short-term actions and long- term plans	**Disconnect of governance with national policy**	
Political barriers	Discontinuity between short-term actions and long- term plans	**Disconnect of governance locally**	
Political barriers	Discontinuity between short-term actions and long- term plans	**Austerity and funding cuts**	
Political barriers	**Revisions of the long-term strategic plans of the city**		
Political barriers	**Country Specific Political Barriers**		

Figure 14. Group of political barriers identified.

GROUP OF BARRIERS	BARRIER	SENTENCES	BAR_LEVEL4
Technical barriers	**Infrastructural challenges**	**Current technical/operational practices of city governments**	
Technical barriers	Infrastructural challenges	**Difficulties finding suitable places in the urban space**	
Technical barriers	Infrastructural challenges	**Buildings structural overcapacity to support the weight of green infrastructure**	
Technical barriers	Infrastructural challenges	**The existence of construction companies with demonstrated experience in NBS construction in the local environment**	
Technical barriers	Infrastructural challenges	**Arboreal and plant interventions technical barriers**	
Technical barriers	**Location of the interventions in the urban space**	**Lack of space in the urban environment**	
Technical barriers	**Country Specific Technical Barriers**		

Figure 15. Group of technical barriers identified.

GROUP OF BARRIERS	BARRIER	SENTENCES	BAR_LEVEL4
Legal / Organizational Barriers	**Legal Barriers**	**Compliance with local basic legislation**	**General urban planning plan/urban planning/town planning**
Legal / Organizational Barriers	Legal Barriers	Compliance with local basic legislation	**Municipal ordinances / city ordinance/city regulation**
Legal / Organizational Barriers	Legal Barriers	Compliance with local basic legislation	**Local strategic plans**
Legal / Organizational Barriers	Legal Barriers	**Land ownership**	
Legal / Organizational Barriers	Legal Barriers	**Lease agreements**	
Legal / Organizational Barriers	Legal Barriers	**Covenants**	
Legal / Organizational Barriers	Legal Barriers	**Local permits for construction work**	

GROUP OF BARRIERS	BARRIER	SENTENCES	BAR_LEVEL4
Legal / Organizational Barriers	Legal Barriers	**Rights of way**	
Legal / Organizational Barriers	Legal Barriers	**Maintenance and duty of care**	
Legal / Organizational Barriers	Legal Barriers	**Possible lack of ordinances and local regulations**	
Legal / Organizational Barriers	Legal Barriers	**Public-private collaboration**	
Legal / Organizational Barriers	**Organizational barriers**	**Departmental / Institutional silos**	
Legal / Organizational Barriers	Organizational barriers	**Vertical/Horizontal Hierarchy, work culture**	
Legal / Organizational Barriers	Organizational barriers	**Lack or absence of a capacity for organizational learning**	
Legal / Organizational Barriers	Organizational barriers	**Lack of engagement with programs**	
Legal / Organizational Barriers	**Country Specific Legal Barriers**		

Figure 16. Group of legal/organizational barriers identified.

GROUP OF BARRIERS	BARRIER	SENTENCES	BAR_LEVEL4
Social / Cultural Barriers	**Knowledge Gaps - Fear of the Unknown**		
Social / Cultural Barriers	**Lack of Awareness**		
Social / Cultural Barriers	**Green Gentrification and Social Inclusiveness**		
Social / Cultural Barriers	**Paradigm of growth**		
Social / Cultural Barriers	**Country Specific Social Barriers**		

Figure 17. Group of social /cultural barriers identified.

GROUP OF BARRIERS	BARRIER	SENTENCES	BAR_LEVEL4
Financial Barriers	**Perception of Eco Services Valuation**		
Financial Barriers	**Public Private Partnerships**		
Financial Barriers	**Country Specific Financial Barriers**		

Figure 18. Group of financial barriers identified.

4.2.2 Calculation of impact of each barrier for NBS

The evaluation of each NBS throughout the prism of the barriers has been organized into a quality level. In **D1.5**, each front runner city expressed their vision according the level of difficulty detected during the implementation of the NBS, **the NBS barrier level**. The tables are crossing the NBS specified for each city with the barrier categories. A value between 1 to 5 regarding importance of the barrier category has been provided by the stakeholders of city consortiums of the project with the results of their self-assessments. Cities elaborated and explained the most important categories by evaluating their own experiences in subsequent sections.

In this case this task is not as "easy" than the challenges matrix as the value given may be not universal. This value strongly depends by the local city situation, its NBS implementation capacity. Moreover, there are cases where not all of the NBS were evaluated for a specific location. For instance:

- In cases where NBS has not been implemented, the value has not been assigned, and the tool indicating "data not covered". The matrix shows no value for that.
- In cases where the same NBS has been evaluated by 2 or more cities with different values, the most restrictive value has been considered.

Consequently, it is important that the user treats the indicated value as the recommendation only, the possible barrier level, and never the exact one. The level of the value should be deeply analyzed during the city diagnosis process and depending the factors like:

- Site analysis and climate (geomorphology, water, subsoil, vegetation, but also and for specific climate definition, solar impact, average temperatures, wind direction)
- Urban zoning analysis (construction and public spaces balance, and equipment's, build environment character, use of soil, construction elements available for NBS)
- Local legal regulations and politics (NBS related and other related specific city data)
- List of city specific goals proposed and SWOT analysis (weaknesses, strengths, opportunities and treads identified)

The detail analysis process it is proposed in **D1.3 "City and area diagnosis procedure".** At the moment of writing this deliverable, this work is under development, so the matrix is completed with fictional values in order to run the tool. The information should be completed at the more mature level of the project, once the results from the implementation and evaluation processes will be available. The idea is that the follower cities will evaluate their perception according those values, once are elaborated their RUP plans in M48. Then, these values will be transferred to update and complete the matrix.

		Political barriers										Technical barriers						
		Disconnection between short term actions and long-term goals				Discontinuity between short-term actions and long- term plans				Revisions of the	Country Specific	Infrastructural challenges					Location of the	Country Specific
		Coordination between departments of the local public administration,	Political interests in electoral campaign periods,	Interventions construction in the short term with visible results in the long term,	Slow periods for public tendering processes	Frequent changes in local authority or other governing administration	Disconnect of governance with national policy	Disconnect of governance locally	Austerity and funding cuts			Current technical/operational practices of city governments	Difficulties finding suitable places in the urban space	Buildings structural overcapacity to support the weight of green infrastructure	The existence of construction companies with demonstrated experience in NBS construction in the local	Arboreal and plant interventions technical barriers	Lack of space in the urban environment	
NBS_LEVEL1	NBS_LEVEL2																	
Green route	Cycle and pedestrian green route	1	3	4	5	5	2	4	5	0	4	5	2	3	4	3	2	0
Arboreal interventions	Shade trees	1	2	4	1	1	2	2	3	0	1	2	4	3	0	5	3	2
Arboreal interventions	Cooling trees	3	3	0	3	2	0	1	4	5	3	0	0	0	0	5	0	0
Arboreal interventions	Planting and renewal urban trees	0	0	1	5	3	4	1	3	3	4	2	0	1	1	3	1	4
Arboreal interventions	Arboreal areas around urban areas	4	4	1	3	4	3	1	4	1	4	2	4	5	5	2	2	5
Arboreal interventions	Trees re-naturing parking	2	0	2	2	4	3	4	4	1	2	3	2	4	2	3	4	3
Carbon capture	Urban carbon sink	1	1	1	0	1	4	5	4	4	5	3	4	4	0	1	2	0
SUDs	SUDs	2	5	3	2	2	5	5	5	2	5	2	4	0	3	2	5	4
SUDs	Grassed swales and water retention ponds	4	1	3	5	0	4	3	1	4	1	3	3	3	2	2	3	5
SUDs	Rain gardens	5	1	5	0	4	3	0	3	3	1	0	3	5	1	0	2	3
Flood actions	Urban catchment forestry	1	0	1	1	3	3	5	5	2	1	1	1	2	2	5	3	4
Flood actions	Hard drainage-flood prevention Unearth water courses	0	5	5	0	2	5	4	1	2	2	4	3	2	3	5	1	0
Flood actions	Channel re-naturing	4	5	4	5	5	4	2	3	2	4	4	2	0	3	2	3	5
Flood actions	Floodable park	1	2	1	1	0	0	2	2	3	3	1	1	4	5	5	4	4
Water treatment	Green filter area	1	2	3	1	3	3	0	0	1	4	5	1	5	0	0	3	2
Water treatment	Natural wastewater treatment	3	5	1	1	4	0	0	5	1	1	3	2	1	0	3	3	1
Green pavements	Hard drainage pavements	4	1	3	4	2	1	3	2	5	2	1	2	4	2	1	2	1
Green pavements	Green pavements green parking pavements	1	0	3	1	2	5	5	1	5	2	2	2	5	2	0	0	4
Green pavements	Cycle and pedestrian green pavement	1	0	5	1	3	2	3	2	2	5	2	3	5	3	5	4	5

Figure 19. NBS vs Barriers matrix (fragment, example)

This is a 41 x 46 matrix, in which a total of 46 NB are listed in rows and S 41 barriers are listed in columns. Thus, naming the matrix **NBS vs Barriers as the matrix C (46x41),** each individual item from the matrix, c_{ij} represents the value assigned for cities during the evaluation process**.**

$$C = \begin{pmatrix} c_{1\,1} & \cdots & c_{1\,41} \\ \vdots & \ddots & \vdots \\ c_{46\,1} & \cdots & a_{46\,41} \end{pmatrix}$$

4.3 KPIs prioritization matrix

While the conservation and sustainable development community considers NBS to be a strong method of addressing climate change and its associated challenges in urban environments, there is still a tendency to implement mainly traditional engineering and architectural solutions. In order to promote NBS market development it is needed a parallel development of a homogenised assessment framework to value real impacts and compete with traditional solutions.

In this sense, URBAN GreenUP methodology uses the knowledge developed within the project to provide an adequate assessment framework for the NBS scenario created. Within the sub-task 1.6.2, it has been stablished a mechanism to prioritized the best KPIs for each NBS for different contexts.

For the KPIs prioritization process, Project partners have participated at different stages. Initially, WP5 collaborated with WP2-4 for defining the best KPIs according their city challenges

and planned NBS. This process conducted to the creation of an integrated assessment framework (deliverables 5.1 and 5.5) for the Project that was locally adjusted for each front-runner city demonstration. Considering these results of this output and the pre-determined prioritization questions (see deliverable 1.8), scoring will be made between 1 and 5 for each KPI to determine the priority of this KPI for each NBS. This process is still under development and the matrix is not properly completed yet. All details of the matrix and its components described in detail in D1.8: KPIs calculation tool and prioritization criteria.

KPIs prioritization matrix has almost the same structure than Barriers/enablers NBS matrix. As the input data the NBS list from previous sections of the tool and KPIs list which determined by taking into consideration the challenges from Challenge Versus NBS Matrix will be included.

These KPIs priorization matrix can be used both for proposing a customized assessment framework for the NBS Scenario proposed or for making an additional filtering if the user knows which KPIs wants to use.

5 Inputs and outputs

5.1 Inputs panels

5.1.1 Scenario description

This panel collects the general inputs of the Scenario provided by the user. The object of this panel is to identify the Scenario by giving a name, a general description and a location.

The NBS Scenario is named by the **Short name** field which identifies the NBS Scenario with a unique value. It can be formed as an acronym, code, or a short sentence and it can be composed also by numbers (i.e. *SCENARIO1, SCENARIO2*, etc). The user can include also the **project title**, in order to attach different NBS Scenarios to a unique project. Finally, user may indicate other data regarding Scenario general **location** (Country, Region and City), as well as Zone, in order to link the Scenario directly with City Zoning activities (geographic dimension).

SCENARIO DATA		Please, provide data into the blocks.
NBS SCENARIO	*A short name for your scenario, you can include acronym code numbers, etc.*	SCENARIO1 SCENARIO1 SCENARIO1 SCENARIO1 SCENARIO1 SCENARIO1
PROYECT TITLE	*Full title of the renaturing proyect*	This is an example of the Scenario 1
DESCRIPTION	*Describe briefly your scenario (environment, location, etc.)*	The Scenario 1 is only an example for this NBS Scenario generation tool, just to check everything is ok.
LOCATION	*Country*	COUNTRY
	Region	REGION
	City	CITY
	Zone	ZONE1
OBJECTIVES	*Indicate a maximum of 5 main objetives for your scenario (i.e., flooding, engagement, etc)*	This is the objetive 1
		This is the objetive 2
		This is the objetive 3
		This is the objetive 4
		This is the objetive 5
CONSTRAINS	*Indicate a maximum of 5 main constrains for your scenario (i.e., total budget, social agreement, etc)*	This is the constrain 1
		This is the constrain 2
		This is the constrain 3
		This is the constrain 4
		This is the constrain 5
NOTES	*Other relevant considerations for your scenario*	This is an open space for other considerations

Figure 20. Scenario description panel.

There is also a place to resume the main **Objectives** to achieve in this NBS Scenario and main **Constrains** detected. Both concepts are related with the Challenges and the Barriers and Boundaries concepts, respectively. The aim is to resume the main ideas of the NBS Scenario in a more comprehensive and non-standardized way. In addition, a final free space has been left to include other additional information/clarification.

In this tab, there are no selection panels so the user can introduce free text. However, the length of the texts is shorted by a determinate number of characters in order to fit in the output template. A warning sign is shown if the user exceeds the maximum number of characters.

Characters	Warnings
60/50	*you have exceeded the maximum number of characters*

Figure 21. Characters control cell and warning message.

The information of this panel will feed the output report, in concrete, the portrait and the first page of the document ***Scenario Description***.

5.1.2 Challenges panel

This panel helps the user in the evaluation of the challenge and sub-challenges. A total number of 10 Challenges can be selected, but reaching this value is not mandatory.

CHALLENGE	SUBCHALLENGE	DESCRIPTION	WEIGHT	PERCENTAJE
First select your challenges	*Select one subchallenge. Repeat the challenges to add more subchallenges*	*A brief description will be shown for each subchallenge. Do not change this column*	*Assingn weight to the subchallenge from 10 to 100*	*Do not change this column*
Air quality	Secondary pollutants. Ozone	Known as tropospheric or ground-level ozone, this gas is harmful to human health and the environment. Since it forms from emissions of volatile organic compounds (VOCs) and nitrogen oxides (NOX), these pollutants are regulated under air quality standards [11]. Long-term objective for ozone concentrations is established at 120 µg/m3 by the	50	22,73
Air quality	Primary pollutants. Nitrogen oxides	Nitrogen oxides are a group of gases made up of nitrogen and oxygen that cause acid rain and other environmental problems, such as smog and eutrophication of coastal waters. Burning fossil fuels, such as coal and gasoline, releases NOX into the atmosphere [11]. Twenty-two of the EU-28 recorded concentrations above the annual limit value (10.5 % of all the stations measuring NO2 [12]). EU Ambient Air	50	22,73
Climate change mitigation and adaptation	Adaptation	Adjustment in natural or human systems to a new or a changing environment. Adaptation to climate change refers to adjustments in natural or human systems in response to actual or expected climatic stimulus or their impacts, which moderate harm or exploit benefits. Several types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation and	40	18,18
Climate change mitigation and adaptation	Mitigation	An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases, sometimes referred to as limiting climate change	20	9,09
				0,00
Climate change mitigation and adaptation	Adaptation	Adjustment in natural or human systems to a new or a changing environment. Adaptation to climate change refers to adjustments in natural or human systems in response to actual or expected climatic stimulus or their impacts, which moderate harm or exploit benefits. Several types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation and	30	13,64
Climate change mitigation and adaptation	Mitigation	An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases, sometimes referred to as limiting climate change	30	13,64
				0,00
				0,00
				0,00

Figure 22. Challenges selection panel (example).

The user selects firstly the **Challenge**. Then the user selects the **Sub-challenge**, which is automatically filtered according to the chosen Challenge before. A brief **Description** of the

selected item is automatically shown in order to provide more information to the user. This information sources from Deliverable 1.2.

Once selected, the user will evaluate the sub-challenges by assigning an importance rate level, with values ranging from 10 to 100 (**Weight**). This is also a selection panel, so selectable values are limited.

Then, the system will calculate the **Percentage** distribution of weights assigned, with a graphical representation of the values.

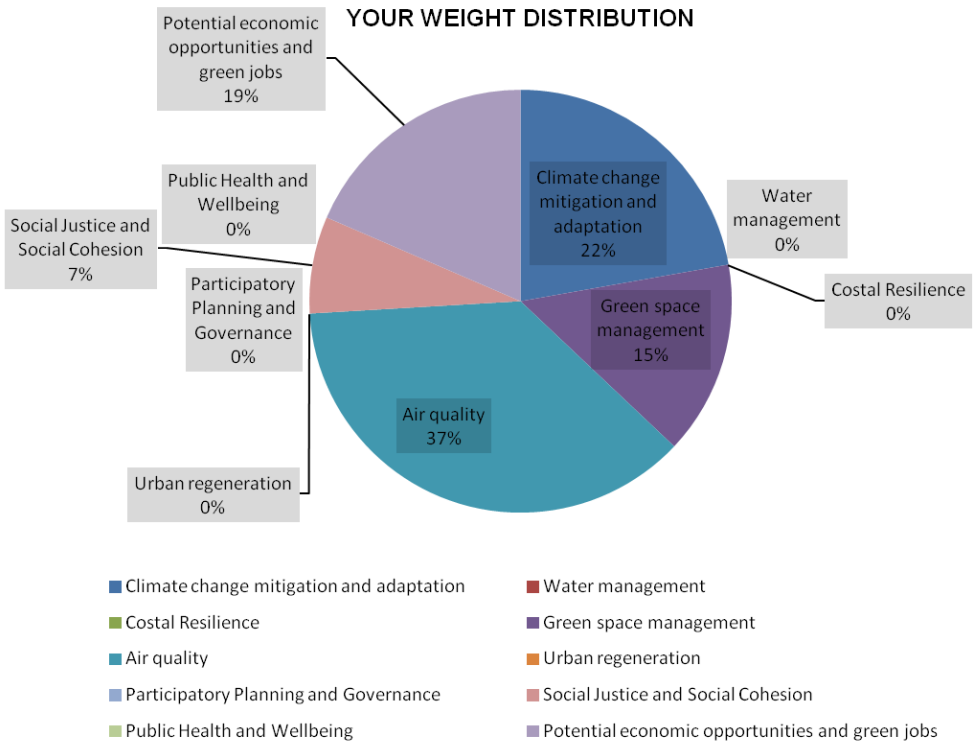


Figure 23. Selected challenges chart (example).

This percentage values are automatically transferred to a calculation matrix named as **matrix B (28 x 1)**, in which the 28 Sub-challenges are listed in rows, grouped by Challenges. Each individual item from the matrix $\boldsymbol{b_{ij}}$ represents the Percentage value assigned by the user through this panel**.**

$$B = \begin{pmatrix} b_{1;1} \\ \vdots \\ b_{28;1} \end{pmatrix}$$

As a final result of the calculation process related to the challenges, the matrix product of the (A x B) matrix is made. The output is a 46 x 1 matrix, in which a total of 46 NBS are listed in columns, and each individual item from the matrix, $\boldsymbol{ab_{ij}}$ represents the score obtained for each NBS.

$$(A \cdot B) = \begin{pmatrix} a_{1\ 1} & \cdots & a_{1\ 28} \\ \vdots & \ddots & \vdots \\ a_{46\ 1} & \cdots & a_{46\ 28} \end{pmatrix} \cdot \begin{pmatrix} b_{1\ 1} \\ \vdots \\ b_{28\ 1} \end{pmatrix} = (ab_{1\ 1} \quad \dots \quad ab_{1\ 46})$$

The higher the value, the greater the suitability of the NBS for the proposed challenge scenario. Then the NBS are ranked taking into account those values and grouped into Quartiles.

5.1.3 Selection Module

This module will serve to the user select the NBS from the available list of NBS provided by the ToolUGU. Thus, through this step the user will be able to know which NBS are more recommendable for the situation configured in the challenges panel, and among them, eliminate those in which he is not interested or it is not possible to implement in his city. At the end of this part, 10 NBS will finally be chosen.

Taking into account the scoring obtained in $(A \cdot B)$ matrix; NBS are ranked in two different lists.

The first list shows the top 12, which corresponds to the Quartile 4 classifications; this will be the most recommended NBS for the user: “Top 12 NBS Selection”.

TOP 12 NBS SELECTION			
NBS ranked in terms of the Challenges/subchallenges selected and weights assigned (QUARTILE 4)			
RANKING	NBS DESCRIPTION	NBS GROUP	USER'S SELECTION
DO NOT CHANGE THIS COLUMN	*DO NOT CHANGE THIS COLUMN*	*DO NOT CHANGE THIS COLUMN*	*Select "NOT INCLUDE" if you want to eliminate one or more NBS from the list 10 NBS will be finally selected*
1	Green resting areas	Resting areas	NOT INCLUDE
2	Vertical mobile garden	Vertical GI	
3	Floodable park	Flood actions	NOT INCLUDE
4	Green filter area for air	Pollutants filter	
5	Natural pollinator's modules	Pollinator	NOT INCLUDE
6	Pollinators roofs	Pollinator	
7	Urban catchment forestry	Flood actions	
8	Trees re-naturing parking	Arboreal interventions	NOT INCLUDE
9	Planting and renewal urban trees	Arboreal interventions	
10	Cooling trees	Arboreal interventions	
11	Shade trees	Arboreal interventions	
12	Urban garden bio-filter	Pollutants filter	

Figure 24. Top 12 NBS selection panel (example).

Additionally, a second list is offered with other 11 ranked NBS, which corresponds to the Quartile 3 classifications. This list will provide extra NBS to help the user to complete the selection: “Other NBS recommended”.

OTHER NBS RECOMMENDED			
NBS ranked in terms of the Challenges/subchallenges selected and weights assigned (QUARTILE 3)			
RANKING	NBS DESCRIPTION	NBS GROUP	USER'S SELECTION
DO NOT CHANGE THIS COLUMN	*DO NOT CHANGE THIS COLUMN*	*DO NOT CHANGE THIS COLUMN*	*Select "NOT INCLUDE" if you want to eliminate one or more NBS from the list 10 NBS will be finally selected*
13	Rain gardens	SUDs	
14	Green noise barriers	Vertical GI	
15	Green filter area for waste water	Water treatment	
16	Compacted pollinator's modules	Pollinator	NOT INCLUDE
17	Hard drainage-flood prevention Unearth water courses	Flood actions	
18	Grassed swales and water retention ponds	SUDs	
19	SUDs	SUDs	
20	Green shady structures	Horizontal GI	
21	Green roof	Horizontal GI	
22	Green covering shelters	Horizontal GI	
23	Urban carbon sink	Carbon capture	

Figure 25. Additional NBS selection panel (example).

By selecting "**NOT INCLUDE**" in the **User's selection** column, the tool will eliminate those NBS from the list. The final selection is shown in a third panel located at the right.

YOUR FINAL NBS SELECTION		
NBS ranked including your selection		
RANKING	NBS DESCRIPTION	NBS GROUP
DO NOT CHANGE THIS COLUMN	*DO NOT CHANGE THIS COLUMN*	*DO NOT CHANGE THIS COLUMN*
1	Vertical mobile garden	Vertical GI
2	Green filter area for air	Pollutants filter
3	Pollinators roofs	Pollinator
4	Urban catchment forestry	Flood actions
5	Planting and renewal urban trees	Arboreal interventions
6	Cooling trees	Arboreal interventions
7	Shade trees	Arboreal interventions
8	Urban garden bio-filter	Pollutants filter
9	Rain gardens	SUDs
10	Green noise barriers	Vertical GI

Figure 26. Final NBS Selection table (example).

Tool will show a total amount of 12 NBS based on the challenges and subchallenges evaluation provided by the user. Then, the user can select a total of 10 NBS from the list, taking in account the ranked output provided.

5.1.4 Barriers panel

The barriers panel has been developed as a survey panel in which the user analyses the each of the barriers or enablers that concerns to the scenario.

Barriers definition

BARRIERS PANEL	PROBABILITY FACTOR	RISK VALUE FOR NBS IMPLEMENTATION
Read the sentences and score them to evaluate the barriers in your scenario	*factors (1)Strongly agree (0,75) Agree (0,5) Neutral (0,25) Disagree (0) Strongly disagree*	*Result value from matrix NBS vs Barriers vs PROBABILITY - High Risk - Medium Risk - Low Risk where for medium-high risk the contigency plan is suggested*
Political barriers		
Disconnection between short term actions and long-term goals	0	#¡DIV/0!
Coordination between departments and administrations is tedious and the workflow between them is time-consuming.		
We are in electoral campaign period, and it will affect the implantation process of the NBS		
Achieving visible results in the short term is a priority.		
Tendering processes are usually complex and there is no chance for assigning specific staff to develope tendering process for innovative actions.		
Discontinuity between short-term actions and long- term plans	0	
There is a tension between central and local goverment agendas, and/or they are from different parties		
There are frequent changes in local authority or other governing administration		
There are not a common interest between metropolitan municipalities and district municiaplities and this may affect the NBS implementation.		
Austerity polilcies may affect the NBS implementation.		
Revisions of the long-term strategic plans of the city	0	
There is a physical plan that may affects the development of Nature-Based Solutions		
There is a thematic strategic plan that may affects the development of Nature-Based Solutions		
Revisions of the long-term strategic plans of the city	0	
There is a physical plan that may affects the development of Nature-Based Solutions		
There is a thematic strategic plan that may affects the development of Nature-Based Solutions		
Country Specific Political Barriers	0	
[If there is any other specific political barrier, please specify it]		
Technical barriers		
Infrastructural Barriers	0	0
Authorities are locked in "practice of carrying out infrastructural work"		
Limited structural capacity of affected buildings to support the weight of green infrastructure		
Absence of construction companies with demonstrated experience in NBS construction in the local environment.		
Technical barriers for plants and trees selection and interventions		
Location of the interventions in the urban space	0	#¡DIV/0!
Authorities are locked in "practice of carrying out infrastructural work"		

Figure 27. Barriers panel evaluation (example).

This panel considers 2 different values: probability factor and risk value.

The **probability factor** indicates that the barrier is likely/unlikely to occur in short-medium term (actual state) and long term (future 10-30 years* according current European plans till 2030-2050). The total value between 0-1, where 0 strongly disagree and 1 strongly agree, should be indicated by user where field "**barrier probability**".

Probability factor for a given barrier	Description
1.00	Strongly agree
0.75	Agree
0.50	Neutral
0.25	Disagree
0.00	Strongly disagree

Figure 28. Probability factor values description.

These values are automatically transferred to a calculation matrix named as **matrix D (41 x 1)**, in which the 41 barriers are listed in rows. Each individual item from the matrix $\boldsymbol{d_{ij}}$ represents the value assigned by the user through this panel**.**

$$D = \begin{pmatrix} d_{1\,1} \\ \vdots \\ d_{41\,1} \end{pmatrix}$$

The impact value that different barriers may have for a specific NBS is calculated as the matrix product (C x D). The output is a 46 x 1 matrix, in which a total of 46 NBS are listed in columns, and each individual item from the matrix, $\boldsymbol{cd_{ij}}$ represents the score obtained for each NBS regarding Barriers impact.

$$(C \cdot D) = \begin{pmatrix} c_{1\,1} & \cdots & c_{1\,41} \\ \vdots & \ddots & \vdots \\ c_{46\,1} & \cdots & a_{46\,41} \end{pmatrix} \cdot \begin{pmatrix} d_{1\,1} \\ \vdots \\ d_{41\,1} \end{pmatrix} = (cd_{1\,1} \quad \ldots \quad cd_{1\,46})$$

Then, this value $\boldsymbol{cd_{ij}}$ is resumed **in** the **total** risk value**,** in scale of:

- High risk value, overcoming barriers should be considered
- Medium risk value, overcoming barriers are suggested
- Low risk value, NBS solution likely to be adopted

Final Risk of Barrier is identified evaluating the number of barriers indicated as probable, the level of probability, and the NBS barrier level indicated in the initial data base.

Barrier	Level 1	2	3	4	5	Probability	Risk Value
1x	1					>0	Low Risk Value
	1					0,5	Low Risk Value
	1					1	Low Risk Value
		2				>0	Low Risk Value
		2				0,5	Medium Risk Value
		2				1	Medium Risk Value
			3			>0	Low Risk Value
			3			0,5	Medium Risk Value
			3			1	High Risk Value
				4		>0	Medium Risk Value
				4		0,5	High Risk Value
				4		1	High Risk Value
					5	>0	High Risk Value
					5	0,5	High Risk Value
					5	1	High Risk Vale

Figure 29. Risk value identified for NBS.

The different barriers may occur at the same NBS implementation, or can be multiplied in NBS Scenario, in consequence, the risk also will increase, as a result of multi barrier implementation. Contingency plan should be adopted at least in medium-high risk barriers scenarios. This information will be included in the **Output report**.

Scenario Risk Level	Barrier Risk by NBS intervention
0	Not apply
1	No relevance in case it occur
2	Low relevance in 1-3 sub-barriers
3	Low relevance in ≥3 sub-barriers
4	Medium relevance in 1-2 sub-barriers
5	Medium relevance in ≥3 sub-barriers
6	High relevance in at least 1 sub-barriers
7	High relevance in at least 2 sub-barriers or High- Medium relevance coexistence
8	High relevance in at least ≥3
9	High relevance in at least ≥3 sub-barriers or High -Medium relevance coexistence
10	High relevance in most of sub-barriers

Figure 30. Scenario risk levels.

5.2 Output report

The final output is the tab named “Print” which is designed with a former structure to be a report that can be printed directly in PDF or paper. Then, it can be annexed to the Renaturing Urban Plan or any other planning tool.

The content is self-completed with the information provided by the user in the inputs, so it is no necessary to updated, and it is not recommended to modify it.

The first page is the report portrait; it contents the logo and identification of the URBAN GreenUP project, and includes the **title and description** of the NBS Scenario. The next page, contents the result of the **Scenario description panel**.

URBAN GreenUP

NBS SCENARIOS GENERATION TOOL

SCENARIO: SCENARIO1
This is an example of the Scenario 1
LOCATION: ZONE1 (CITY)
REGION, COUNTRY

POWERED BY:

Authors:
URBAN GreenUP
SCC-02-2016-2017
Innovation Action – GRANT AGREEMENT No. 730426

NBS SCENARIOS GENERATION TOOL
REPORT

1. SCENARIO DESCRIPTION

SCENARIO **SCENARIO1**
This is an example of the Scenario 1

DESCRIPTION
The Scenario 1 is only an example for this NBS Scenario generation tool, just to check everything is ok.

LOCATION
Country COUNTRY
Region REGION
City CITY
Area ZONE1

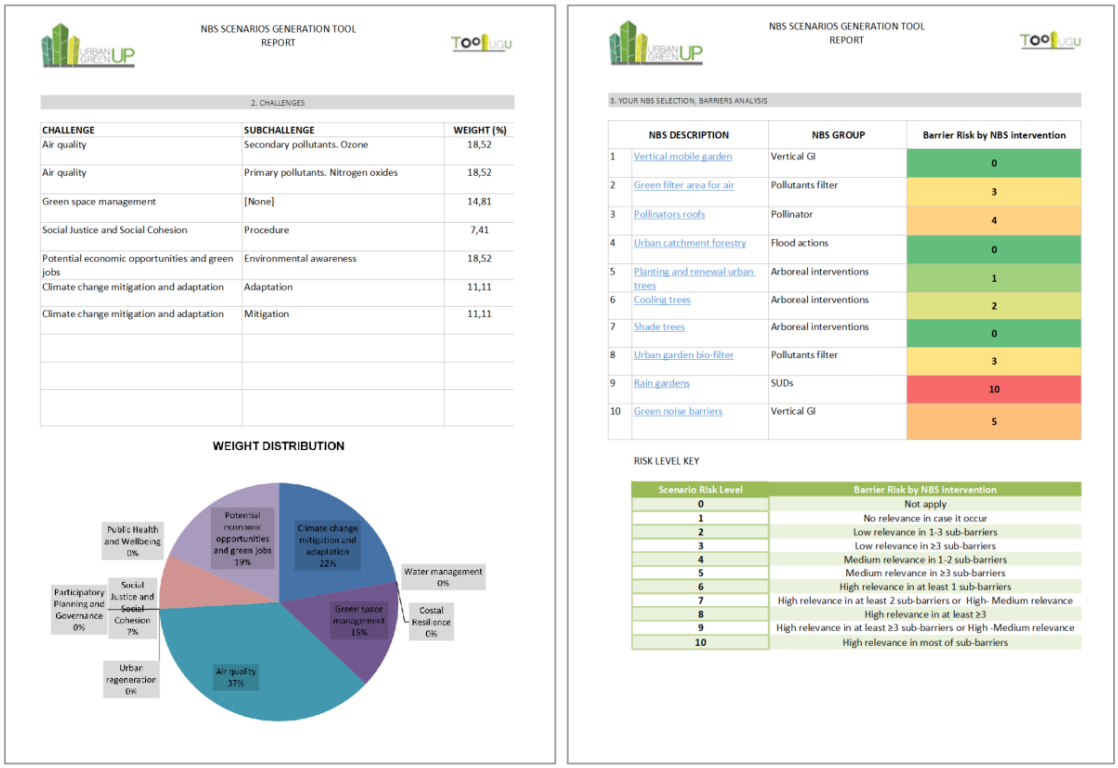
OBJETIVES
1. This is the objetive 1
2. This is the objetive 2
3. This is the objetive 3
4. This is the objetive 4
5. This is the objetive 5

CONSTRAINS
1. This is the constrain 1
2. This is the constrain 2
3. This is the constrain 3
4. This is the constrain 4
5. This is the constrain 5

OTHER RELEVANT CONSIDERATIONS
This is an open space for other considerations

Figure 31. Report output: Pages 1 (portrait) and 2 (Scenario description) (example).

The next two pages continue with the output from the tool. Page 3 contains the results of challenges weight distribution, including the chart, done in the **Challenges panel**. Page 4 covers the NBS selection done by the user in the **Selection module**, including the results of the barriers analysis performed in the **Barriers panel**.



NBS SCENARIOS GENERATION TOOL
REPORT

2. CHALLENGES

CHALLENGE	SUBCHALLENGE	WEIGHT (%)
Air quality	Secondary pollutants. Ozone	18,52
Air quality	Primary pollutants. Nitrogen oxides	18,52
Green space management	[None]	14,81
Social Justice and Social Cohesion	Procedure	7,41
Potential economic opportunities and green jobs	Environmental awareness	18,52
Climate change mitigation and adaptation	Adaptation	11,11
Climate change mitigation and adaptation	Mitigation	11,11

WEIGHT DISTRIBUTION

NBS SCENARIOS GENERATION TOOL
REPORT

3. YOUR NBS SELECTION, BARRIERS ANALYSIS

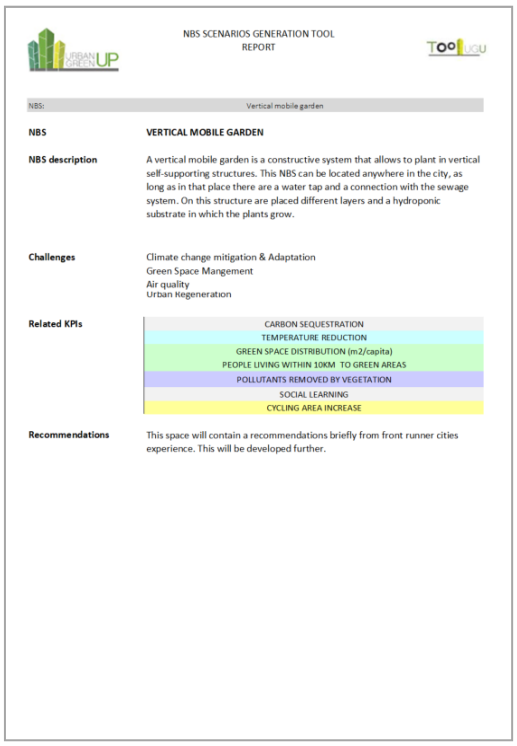
	NBS DESCRIPTION	NBS GROUP	Barrier Risk by NBS intervention
1	Vertical mobile garden	Vertical GI	0
2	Green filter area for air	Pollutants filter	3
3	Pollinators roofs	Pollinator	4
4	Urban catchment forestry	Flood actions	0
5	Planting and renewal urban trees	Arboreal interventions	1
6	Cooling trees	Arboreal interventions	2
7	Shade trees	Arboreal interventions	0
8	Urban garden bio-filter	Pollutants filter	3
9	Rain gardens	SUDs	10
10	Green noise barriers	Vertical GI	5

RISK LEVEL KEY

Scenario Risk Level	Barrier Risk by NBS Intervention
0	Not apply
1	No relevance in case it occur
2	Low relevance in 1-3 sub-barriers
3	Low relevance in ≥3 sub-barriers
4	Medium relevance in 1-2 sub-barriers
5	Medium relevance in ≥3 sub-barriers
6	High relevance in at least 1 sub-barriers
7	High relevance in at least 2 sub-barriers or High- Medium relevance
8	High relevance in at least ≥3
9	High relevance in at least ≥3 sub-barriers or High -Medium relevance
10	High relevance in most of sub-barriers

Figure 32. Report output: Pages 3 (challenges) and 4 (NBS selection and barriers) (example).

The next pages, shows a detailed information for each NBS listed (10 pages in total); including recommended KPIs and brief description based on NBS Cards. This information can be completed with a valuable feedback from front-runner cities regarding recommendations for overcoming barriers, implementation experience and monitoring tips/advices.



NBS SCENARIOS GENERATION TOOL
REPORT

NBS:	Vertical mobile garden
NBS	**VERTICAL MOBILE GARDEN**
NBS description	A vertical mobile garden is a constructive system that allows to plant in vertical self-supporting structures. This NBS can be located anywhere in the city, as long as in that place there are a water tap and a connection with the sewage system. On this structure are placed different layers and a hydroponic substrate in which the plants grow.
Challenges	Climate change mitigation & Adaptation Green Space Mangement Air quality Urban Regeneration
Related KPIs	CARBON SEQUESTRATION TEMPERATURE REDUCTION GREEN SPACE DISTRIBUTION (m2/capita) PEOPLE LIVING WITHIN 10KM TO GREEN AREAS POLLUTANTS REMOVED BY VEGETATION SOCIAL LEARNING CYCLING AREA INCREASE
Recommendations	This space will contain a recommendations briefly from front runner cities experience. This will be developed further.

Figure 33. Report output: Pages from 5 to 14 NBS description (example).

6 Conclusions

ToolUGU is an open supporting tool of the **URBAN GreenUP Renaturing Methodology** focus on helping the users into the renaturing city process.

Within the URBAN GreenUP work plan, WP1 addresses the creation of the renaturing methodology. Task 1.6 is about the creation of the NBS scenarios generation tool and the Key Performance indicators calculation prioritization criteria. Task 1.6.1 is described as the development of a tool that allows the systematizations of scenarios generation and integrates the NBS identified in Task 1.1, and take into account the results of the City diagnosis, barriers and boundaries as well as social economic or technical criteria.

This deliverable includes several chapters covering the main aspects and stages followed to create the **NBS Scenarios Generation Tool, ToolUGU**. From the framework of the tool in the context of the URBAN GreenUP Renaturing methodology and the existing links with other tasks and WPs in the Project to the output of the tool, a customized report generation for the NBS scenario generated through the process. It also covers the approach and workflow diagram of the process a description of the calculation basis behind ToolUGU regarding the relation matrixes for Challenges vs. NBS, Barriers/Boundaries/Enablers vs. NBS and the KPIs prioritization criteria matrix.

The creation process of ToolUGU runs parallel to the URBAN GreenUP Renaturing Methodology. The tool has been created according the needs of the methodology and a way to support the calculation processes and to make easier the decision making process. This tool is focused to the main users of the methodology during exploration stages 1B (Understand your “city” needs) and 2B (Choose your “city” targets) and then for the diagnosis stages 1C (Understand your “city” capacity) and 2C (Evaluate NBS Scenarios and select one).

ToolUGU is structured **three basic stages**: inputs introduction, selection process and output report. The **input introduction stage** consist on three inputs panels: 1) The scenario description panel, 2) The challenges panel and 3) The barriers panel.

The **selection process** uses the selection module to create the NBS scenario (the best NBS for the renaturing process). ToolUGU calculates the best NBS for the initial diagnosis carried out by the user. It also offers the user the possibility of making a manual selection from the recommended NBS.

Finally the **output report** will show the description of the basic scenario and the information needed about the recommended NBS (or links to get it) for the implementation of the renaturing plan within the URBAN GreenUP methodology.

In this point, it must be mentioned that, the URBAN GreenUP methodology has been divided in three development stages, and reported in D1.12, D1.13, D1.14 and D1.17 in more detail. The idea is to maintain the methodology report continuously updated with all the Project outcomes and lessons learnt coming from the demonstration and replication actions executed along the Project. With this report, the stage of the ToolUGU creation is finished. However, the final version will be delivered at the end of the project (M60) after coming validations of the methodology and the tool.