This Project has received funding from European Comission by means of Horizon 2020, The EU Framework Programme for Research and Innovation, under Grant Agreement no. 700174

WWW.RESCCUE.EU

#resccueEU

RESCCUE

RESILIENCE TO COPE WITH CLIMATE CHANGE IN URBAN AREAS.

Resilience Assessment Framework

RAF

Description and implementation

Authors: M.A. Cardoso, R.S. Brito, C. Pereira, L. David, M.C. Almeida
Affiliation: LNEC

Date: 21 December 2020

RESILIENCE TO COPE WITH CLIMATE CHANGE IN URBAN AREAS.

RESCCUE - RESilience to cope with Climate Change in Urban arEas - a multisectorial approach focusing on water
Grant Agreement no.700174.

DELIVERABLE NUMBER:	D6.4
DELIVERABLE NAME:	Resilience Assessment Framework RAF. Description and implementation
WP:	WP6
DELIVERY DUE DATE:	31/08/2020
ACTUAL DATE OF SUBMISSION:	21/12/2020
DISSEMINATION LEVEL:	Public
LEAD BENEFICIARY:	LNEC
RESPONSIBLE SCIENTIST/ADMINISTRATOR:	Maria Adriana Cardoso
AUTHOR(S):	Maria Adriana Cardoso, Rita Salgado Brito, Cristina Pereira, Luís David, Maria do Céu Almeida – LNEC
CONTRIBUTOR(S):	Helene Fourniere, Giovanni Pagani, Andrea Noblega Carriquiry, Esteban Leon – UN-Habitat
INTERNAL REVIEWER:	Maria Rafaela Matos – LNEC
EXTERNAL REVIEWER:	Sozvin Salih – UN-Habitat Section 6.3 and Annex 4 – Aquatec

Document history

DATE	VERSION	AUTHOR	COMMENTS
15/09/2019	1.0	Maria Adriana Cardoso (LNEC)	First version of the deliverable
20/09/2019	1.1	Maria Adriana Cardoso (LNEC)	First revision of the deliverable
28/09/2019	1.2	Maria Adriana Cardoso (LNEC)	Second revision of the deliverable by all authors

29/10/2019	1.3	Maria Adriana Cardoso (LNEC)	Revision from the internal and external reviewers
31/10/2019	Final	Maria Adriana Cardoso (LNEC)	Final version of the document without link to strategies
15/10/2020	Draft	Maria Adriana Cardoso (LNEC)	Draft version of the document with link to strategies
21/12/2020	Final	Maria Adriana Cardoso (LNEC)	Final version of the document with link to strategies

1. Changes with respect to the DoA

This deliverable was not initially defined in the DoA. Following the work developed in WP6 it was proposed and approved in the Amendment No. AMD-700174-21. Afterwards a new activity within Task 6.2 was approved in the Amendment No AMD-700174-30, which results should incorporate this deliverable. For these reasons the deadlines were also reviewed.

2. Dissemination and uptake

Public (PU). The report is fully open and will be distributed through the web.

3. Short Summary of results (<250 words)

The deliverable presents the Resilience Assessment Framework – RAF description and implementation. The RAF main purpose is to assess resilience considering a multi-sectoral approach with focus on water and to support cities by contributing to the Resilience Action Plans (RAP) development and implementation, in order to become more resilient. The assessment approach directs and facilitates a structured resilience diagnosis of the cities and strategic urban sectors, following an objective driven-approach. It considers four resilience dimensions: organizational, governance relations top/down; spatial, urban space and environment; functional directed to strategic services and physical to assets/infrastructures. It allows identifying data gaps, opportunities, threats, strengths and weaknesses, highlighting the areas for improvement; outlining a path for the development of RAP, tailored to each city, by supporting decision-making in the selection of resilience measures and the development of strategies to enhance resilience; monitoring the progress of a city or service over time and facilitating communication among stakeholders. The RAF sought alignment with international frameworks for resilience assessment and made significant developments with regard to its scope and focus on urban services. For each of the four dimensions, resilience objectives are defined and for the dimensions specifically related to the urban services, they unfold firstly into sub dimensions, representing for each sub dimension one service to be assessed. The objectives are described by a set of criteria, which assemble the respective assessment metrics. Some of the RAF metrics correspond to or were adapted from existing

frameworks, mainly from UNDRR framework (former UNISDR) – found to be highly relevant for the scope of the RAF, and others were newly developed. It was tested in an on-going process in the three RESCCUE cities, involving the cities and services' managers, while being validated with stakeholders from these cities, through the organization of workshops. It integrates the identification of the links between resilience strategies and the assessment metrics of the framework to indicate the expected impacts of each strategy on the resilience assessment, and evaluate the impact of the strategies considered in the RAP developed for Barcelona, Bristol and Lisbon.

4. Evidence of accomplishment
   Report

Acknowledgment is due to all RESCCUE partners, particularly from UN-Habitat, to all external contributors, especially to those external to the project that participated in the Barcelona, Lisbon and Bristol workshops.

RESCCUE
RESILIENCE TO COPE WITH CLIMATE CHANGE IN URBAN AREAS.

Table of contents

RESCCUE
RESILIENCE TO COPE WITH CLIMATE CHANGE IN URBAN AREAS.

Summary Tables

RESILIENCE TO COPE WITH CLIMATE CHANGE IN URBAN AREAS.

Summary Figures

List of acronyms and abbreviations

ASCE – America Society of Civil Engineers
CC – Climate Change
Crit – Criteria
CRF – City Resilience Framework
CRPP – City Resilience Profiling Programme
CRPT – City Resilience Profiling Tool
CSG – coordination and supporting group
CSO – Combined Sewer Overflows
DRR – Disaster Risk Reduction
Ene – Energy service
United States Environmental Protection Agency
ERSAR – Entidade Reguladora de Águas e Resíduos em Portugal
F – Functional
GHG – Greenhouse gas
HFA – Hyogo Framework for Action
HT – High tension
ICLEI – Local Governments for Sustainability
LID – Low impact development
LT – Low tension
Met – Metric
Mob –Mobility service
MP – Most probable
MS – Most severe
MT – Medium tension
NIST–
Obj – objective
O – Organisational
P – Physical
PI – Performance indicator
RAF – Resilience Assessment Framework
RAF App – Resilience Assessment Framework web-tool for application
RAP – Resilience Action Plans
RESCCUE – Resilience to cope with Climate Change in Urban Areas
S – Spatial
SUDS – Sustainable Urban Drainage Systems
SWOT – Strengths Weaknesses Opportunities and Threats
Slw – Waste service

Swt – Sormwater service

UKWIR – UK Water Industry Research

UNDRR (formerly known as UNISDR) – United Nations Office for Disaster Risk Reduction

UNISDR (current UNDRR) – United Nations Office for Disaster Risk Reduction

WP – Work package

Wts – Water supply service

Wws – Wastewater service

1. Introduction

1.1. Background

This document is developed as part of RESCCUE (RESilience to cope with Climate Change in Urban arEas - a multisectorial approach focusing on water) project, which has received funding from the European Union's Horizon 2020 Research and Innovation program, under the Grant Agreement number 700174.

The Resilience Assessment Framework RAF description and implementation corresponds to the Deliverable 6.4 of Work Package 6 (WP6) – Validation Platform and First Applications. In the scope of WP6, a roadmap for resilience to climate change-related events in the RESCCUE cities – Barcelona, Lisbon and Bristol – is developed having the urban water cycle as the core, based on the RESCCUE developments and on the drivers, opportunities, context, existing practices and knowledge of each city. Each city selected relevant critical hazards being those associated with urban flooding common to all of them. The specific objectives of WP6 are:

- to carry out a structured resilience diagnosis in each city, for the domains selected to all case study areas;
- to review the cities resilience diagnosis, identifying opportunities for improvement in each city and sharing experiences of situations already implemented in the cities;
- to contribute to the Resilience Action Plans complementing as appropriate, based on the resilience strategies and existing relevant information produced in each city;
- to learn and share the results in order to maximize RESCCUE impact; and
- to produce general guidelines targeted to any other cities based on the learnings and outcomes of the demonstration in the RESCCUE cities.

This document is to be used within the project to support the development of the Resilience Action Plans (RAP) by the cities and by all partners involved; it is also to be used by any city, service or organization intending to undertake a city or service resilience assessment to climate change with focus on water or develop a RAP. This document represents the written output of the development and early application of the Resilience Assessment Framework (RAF). Together with the RAF App tool, it completes the set of deliverables on the resilience assessment in WP6.

1.2. Resilience assessment relevance

The resilience concept has evolved along time and among disciplines (Patel and Nosal, 2016, Sharifi, 2016). In this framework, urban resilience refers to *the ability of human settlements to withstand, recover quickly and adapt from any plausible hazards. Resilience to disruptive events not only refers to reducing risks and damage from disasters, but also the ability to quickly bounce back to a stable state. Besides*

addressing disaster risk reduction, resilience includes changes in circumstances (UN-Habitat, 2018; UNISDR, 2017a,b; ARUP, 2015).

Urban areas are complex, vulnerable and continuously evolving, with interacting strategic services. The interdependent services and assets as well as the involvement of a multiplicity of stakeholders add complexity to the management of these areas. Besides, the significant impacts of climate dynamics (such as intense precipitation events, tidal effects, droughts or heat waves) in the strategic services, people, natural environment and economy, the aggravation of current conditions and emergence of new hazards or risk drivers need to be considered. According to Panda (2018), the World Economic Forum 2014 refers that by 2050 exposure of city dwellers to various hazards, including earthquakes, tsunamis, urban floods, cyclones and storm surges is expected to double. These challenges require an integrated and forward-looking approach to resilient and sustainable urban development, incorporating the interdependencies between systems as well as including stakeholders and citizens perceptions and needs. In order to achieve this several long-term agendas have been adopted as parts of the United Nations Agenda 2030 for Sustainable Development, such as the Sendai Framework for Disaster Risk Reduction 2015-2030, the Sustainable Development Goals, the New Urban Agenda and the Paris Agreement (Panda, 2018), all considering assessment steps for tracking implementation (UN-GA, 2016).

The World Health Organization (WHO, 2009), in its five key conclusions of the vision 2030 study, states that systematic assessments of the climate change resilience of all utilities and of rural water and sanitation programmes are needed, together with simple tools usable in various areas, such as for rapid assessment of the vulnerability of water utilities to climate change.

In order to identify the real needs to enhance urban resilience, as well as the efficiency and effectiveness of planed or implemented measures, it is fundamental to perform resilience assessment. Therefore, assessing current and expected future status of resilience are a basis for the cities to know where they stand, contributing to identify the strengths and weaknesses, thus supporting decision on strategies, actions and measures to adopt, planning in the long, medium and short terms and assessing progress. Cities are dynamic systems, with evolving hazards and, under the principle of continuous improvement (ISO 9001, 2015); it is essential to carry out regularly the assessment of their resilience and to have tools to support this.

1.3. Structure of the document

After this introduction, the structure of the deliverable is organized in sections as follows. Section 2 focuses on the RAF main purpose, scope and assumptions, as well as describes the RAF development process. Section 3 presents a literature review. Section 4 presents an overview of the RAF, describing the main concepts, general structure, RAF dimensions, objectives, assessment criteria and metrics, as well as the main results provided and the RAF App, a tool to facilitate its use. Section 5 provides a detailed description of the RAF. Section 6 describes the

results of the RAF to support diagnosis. Section 7 describes an approach for implementation of a city resilience assessment and section 8 suggests future developments.

2. About the Resilience Assessment Framework – RAF

2.1. Main purpose, scope and assumptions

Regarding the challenges posed to the urban areas by potential effects of climate dynamics, already described in 1.2, the development of Resilience Action Plans (RAP) constitutes an important process for the cities to plan their resilience enhancement in the long, medium and short terms, by defining who, what, how, with which resources, where and when to act. Thus, the main purpose of the developed Resilience Assessment Framework (RAF) is to contribute to support the RAP development and implementation by:

- directing and facilitating a structured resilience diagnosis of the cities and strategic urban sectors, following an objective driven-approach (ISO 9001) with defined criteria and identifying data gaps, opportunities, threats, strengths and weaknesses, highlighting the areas for improvement;
- outlining a path for the development of RAP, tailored to each city, by supporting decision-making in the selection of resilience measures and the development of strategies to enhance resilience;
- monitoring the progress of a city or service over time;
- facilitating communication among stakeholders.

It should be noted that the RAF is not intended to provide a global indicator or to undertake benchmarking but to support the RAP development and implementation. Furthermore, different cities have varied contexts, face different hazards, have diverse services provided, have distinct maturity levels regarding resilience and may intend to assess the city resilience regarding a certain hazard or service. For these reasons, either using an overall figure or making comparisons need to be made with caution.

The RAF described herein considers the following assumptions:

- the scope of RESCCUE – urban resilience to **climate change** (CC), with focus on the **water cycle**, meaning that diverse resilience drivers such as earthquakes, economic crises, cyberattacks, are not taken into account;
- the emphasis is on the city, services and infrastructure resilience, meaning that resilience aspects such as social and political are not developed for diagnosis, but they are incorporated whenever significant for city, services and infrastructures resilience.
- the services within the RAF scope are the RESCCUE services, i.e. those comprised in the urban water cycle, **water supply**, **wastewater** and **storm water** and those having interconnections and interdependencies, closely

related with the water services: **waste** management, electrical **energy** supply and **mobility**;

- the external context of the city and services is considered by a standard characterization profile of the city and of the services;
- the city and services multi-scale, multi-sectoral, multi-hazards and interdependencies are addressed;
- the continuous improvement principle (ISO 9001) is followed and, since cities are dynamic, it addresses:
  - progress of the strategies' implementation and of their effect;
  - before – during – after an event;
  - changes in circumstances;
- the long, medium and short terms are incorporated considering three different and aligned assessment levels for the city, services and infrastructures while, as an integrated assessment, addresses the two first:
  - strategic – overlooking a long-term planning horizon (typically 15 to 20 years), requiring the involvement of the entire organisation, addressing the overall city and considering its vision;
  - tactical – overlooking a medium-term planning horizon (typically up to 3 to 5 years) and addressing departmental or sectoral activities in the city, services and infrastructure;
  - operational – referring to short-term horizon (typically 1 year), addresses the actions to be taken in the effective implementation of measures in the city, services and infrastructure,
- a flexible structure is used, based on assessment metrics, allowing to be expanded to other resilience drivers or dimensions (see section 4.1).

2.2. RAF development

2.2.1. Approach

The RAF development was carried out in a step-wise process, comprising:

- analysis of existing assessment frameworks;
- definition of a RAF preliminary proposal;
- validation of the RAF preliminary version;
- proposal of a RAF final version.

2.2.2. Analysis of existing assessment frameworks

Several tools and frameworks for assessing resilience have been developed in different fields of study by a wide variety of stakeholders. Grounded in the analysis of these existing frameworks, the RESCCUE scope (CC and water) and focus (city, services and infrastructure) shed light on additional gaps and needs, particularly in the assessment of strategic urban sectors and their interactions with both other sectors and in the wider urban system. The detailed analysis of existing assessment frameworks is presented in section 3.

2.2.3. Definition of a RAF preliminary proposal

Considering these scope and focus, RAF structures the analysis of services and infrastructures, and their contribution to the city resilience, while also capturing other city resilience dimensions (see section 4.1).

From the analysis of existing assessment frameworks (see section 3), a RAF preliminary proposal was defined, based on the RESCCUE scope. This first proposal was validated internally and externally before allowing for the development of a final version as presented in sections 4 and 5.

2.2.4. Validation of the RAF preliminary version

The approach to validate the RAF included different engagement methods to receive stakeholders' contributions, and providing them feedback, and specific activities to ensure stakeholder involvement (Figure 1). In this specific context, players and stakeholders included not only people from the city and the services being assessed (i.e. individuals – RESCCUE partners or not – involved with resilience aspects in the management of the city and of each service under the RAF scope), but also other participants relevant to the project's aims.

The RAF preliminary version went through a two-step validation, both internal (involving internal RESCCUE partners) and external (involving other external stakeholders). Representatives of research, city and urban services worked together for awareness, knowledge-transfer and involvement, in a mutual benefit process required for city resilience enhancement. The implemented validation **activities** were the following:

1. Working group discussions (for internal validation);
2. Workshops (for both internal and external validation);
3. RAF testing (for internal validation).

During this process, players and stakeholders contributions to the final version of the RAF were included, by incorporating their concerns as well as their own context and reality, and by applying it discussing the results to validate the RAF applicability. For this, several methods and tools were used:

- Surveys: questionnaires addressed to each participant, followed by presentation of results and debate;
- Sectoral brainstorming (brainstorming with urban services' teams): brainstorming within groups organised by sectors, focused on problems proposed to the group, composed of participants from or related to a specific urban service, followed by a presentation of results and debate;
- Combined brainstorming (mixed-teams brainstorming): brainstorming within groups organised with diverse sectors, discussing problems with participants from different stakeholders, followed by a presentation of results and debate;

- RAF App: web based application tool reproducing the RAF structure, facilitating for each city research site the selection of applicable dimensions (see section 4.1) and services to assess, as well as a set of metrics (associated to a relevance degree and analysis level), allowing private submission of answers to the metrics; results are provided in the form of reports and other complementary materials (Brito *et al.*, 2019, Lopes et al., 2019);
- RAF sharing: presentations of the RAF proposal and respective RAF results' summary, followed by debate.

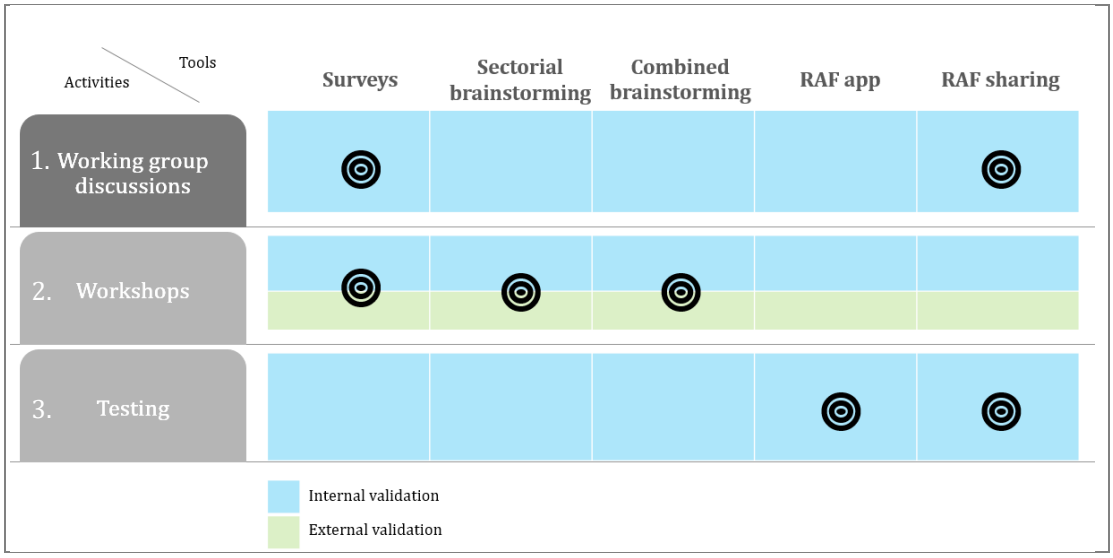
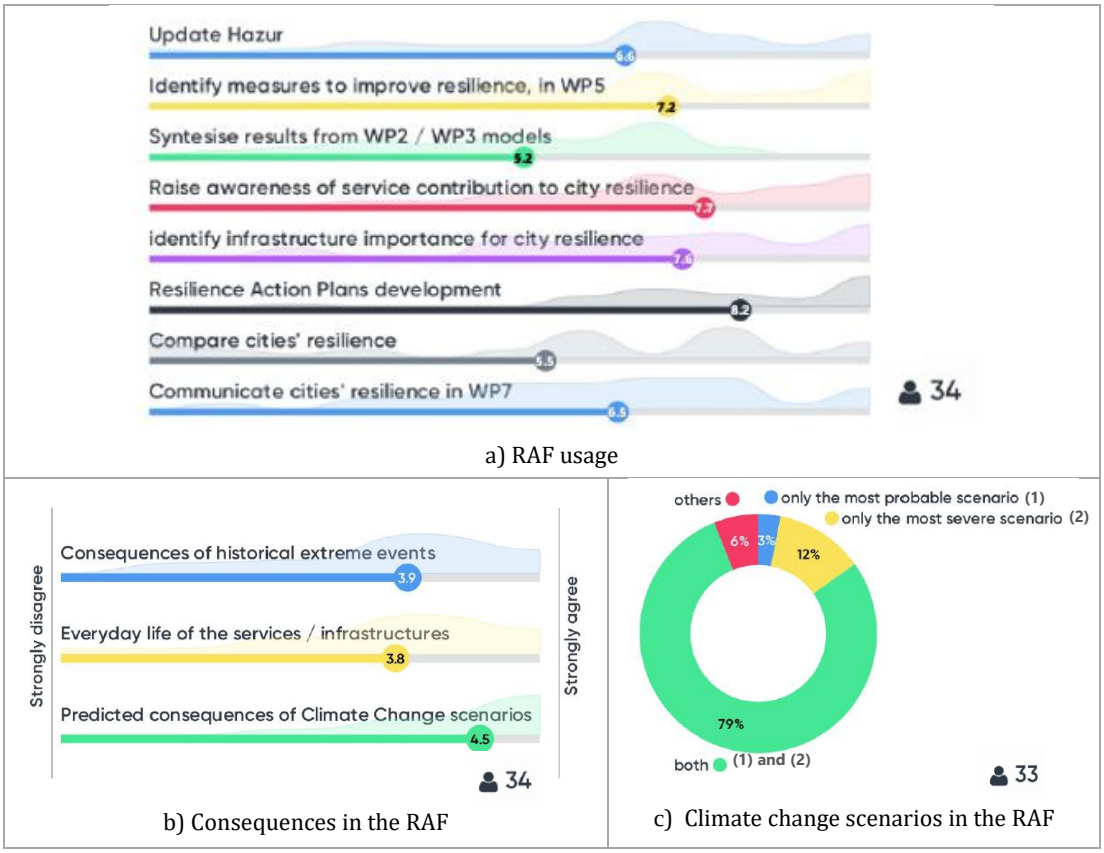


Figure 1 – Activities and tools used for internal and external RAF validation

Activity 1 was implemented throughout the project, mainly using surveys and RAF sharing tools. As examples, Figure 2 illustrates the results of some of these surveys. The purpose of these working group discussions was mainly to create awareness to RAF specificities, align the RAF development with project expectations and adjust some details of RAF. These discussions were a fundamental step for the internal validation of the framework, since they created awareness in the participants on the specificities of urban resilience assessment, while providing a valuable sharing place for multi-sectoral experiences and concerns. From these discussions, the following outcomes for RAF became were evident (Figure 2a):

- to support the resilience action plans in the cities;
- to raise awareness of the services contributions to the cities resilience;
- to identify the importance of the infrastructures to the city resilience; and
- to identify measures to improve resilience.

Stakeholders strongly agreed on the importance to assess predicted consequences of both CC scenarios and historical extreme events, and agreed to minimize the assessment of everyday life events (Figure 2b). Agreement was also evident on assessing both the most probable and the most severe CC scenarios, for the different hazards to be studied (Figure 2c).



a) RAF usage

b) Consequences in the RAF

c) Climate change scenarios in the RAF

Figure 2 – Examples of survey results from the working group discussions

These surveys were a relevant tool to collect project partners' opinions on the development path of the framework, but also served as unpredicted teasers, unexpectedly challenging the partners, daring them to confront their preconceived ideas on a subject with different thoughts and perspectives.

Activity 2 workshops were implemented in each city research site – Barcelona, Bristol and Lisbon – providing an opportunity to engage every stakeholder, by raising awareness on their individual contribution to city resilience, and integrating their contributions in the framework. Workshops were designed to get stakeholders' opinion on the RAF relevance and applicability, as well as to incorporate stakeholders' concerns into its structure. During the workshops, application of several surveys and sectoral and combined brainstorming was carried out.

Brainstorming sessions provided an opportunity, not only to collect inputs for the project, but also for the people working in the same city (sometimes needing to solve interdependent problems) to meet each other and realize the merits of collaborating for their every day challenges.

Cities' workshops were planned for a one-day duration in each city, Barcelona, Bristol and Lisbon (Figure 3). Overall, 24 to 38 stakeholders attended each of the sessions, from 13 to 24 different organizations. Stakeholders were pinpointed in each city: 4 to 5 entities from each RESCCUE service and others from crosscutting

sectors – urban planning, green infrastructures management, civil protection, security, meteorological services and cultural heritage. In these workshops, it was possible to get stakeholders' opinion on the RAF components, namely regarding their relevance and applicability to their own city, on the possibility of each entity to contribute to certain answers of the RAF and on suggestions for RAF improvement.

Barcelona, 7th November 2018

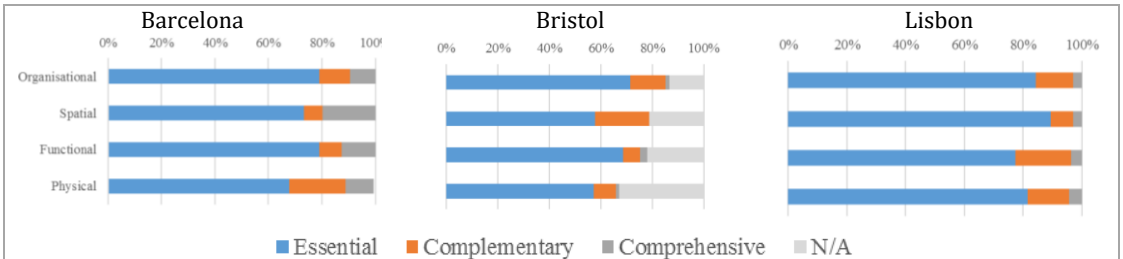
Bristol, 11th October 2018

Lisbon, 17th May 2018

Figure 3 - Workshop in each RESCCUE city

In every session, participants were required to share their opinion on different points of view to assess urban resilience. Points of view are the perspectives that may be considered for the assessment. To illustrate, the organisational aspect of city leadership, may be assessed from the decision-making point of view as well as from the stakeholder engagement point of view. In a first session, combined brainstorming of mixed–teams covered the city overall resilience topics related with organisational and spatial aspects. In a second session, sectoral brainstorming covered each RESCCUE service, addressing both the functional aspect of the services and the respective physical infrastructures. As an overall summary (Figure 4 and Figure 5):

- most of the identified points of view included in the assessment were considered essential;
- there were differences between the cities, which were taken into account regarding cities' context and stakeholder diversity;
- for all the resilience aspects considered for assessment in the city, and depending on the points of view included in each one, between 2 and 12 stakeholders expressed availability of information to contribute to quantify (through assessment metrics) the proposed points of view.



Essential: required to any city or service
Complementary: specific aspects of city or services
Comprehensive: in-depth analysis of city or services

Figure 4 - Workshop results: assignment of relevance level to the metrics

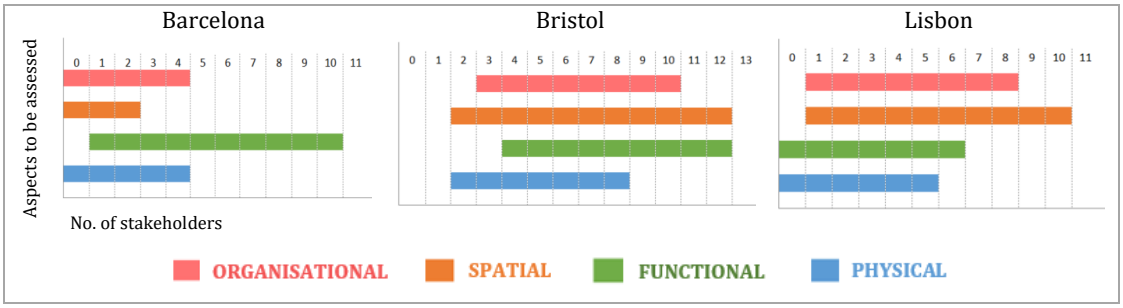


Figure 5 - Workshop results: number of stakeholders that may contribute to assess each aspect in the city considering different points of view

The results of these sessions enabled improvement in the description of the metrics, namely regarding the formulated questions, answers and additional explanations; supported the decision on whether or not to keep each metric in the RAF and sustained the assignment of the relevance of each metric. It was also possible to collect stakeholders' opinion on the relevance of a city's properties for resilience – such as redundancy, flexibility, adaptation capacity, self-reliance or autonomy, reliability, recovery capacity, capacity for continuous improvement and emergency response capacity – to ensure that the RAF addresses all of the most relevant concerns.

Attendees were also questioned on their insights on the measures their city should implement to become more resilient, such as to empower the community, improve local government autonomy, naturalize public areas, reduce tidal exposure and vulnerability, collaborate with neighbouring municipalities, adopt native plant species, adapt urban furniture to strong wind or reduce greenhouse gas emissions. These insights contributed as a first input to a list of possible strategies to incorporate in the cities' resilience action plans. In this case, surveys were again a valuable tool to get stakeholders' opinion throughout the workshops.

In **activity 3,** the RAF testing involved the application of the RAF by the RESCCUE cities and services, providing a preliminary version of the cities resilience assessment, in three stages. The 1st stage addressed the current situation in the city specific organisational and spatial resilience aspects; the 2nd stage regarded the current situation in the services' specific resilience aspects; and the 3rd stage focused on the scenarios' assessment in all these resilience aspects. In each stage, the results and the RAF applicability were analysed, supporting the identification of improvement opportunities both for RAF improvement (introduced before proceeding to the next stage) and for city and services resilience improvement.

The purpose of the testing was to ensure coherence, feasibility and effectiveness of the approach, and of its contribution to the RAP development in the RESCCUE cities. Both the final compilation of data and the analysis of results were carried out using the RAF App (see section 4.4).

RAF sharing was implemented along the project, in alignment with the introduction of data by the cities. It provided an opportunity for the cities to realize the growing impact of their efforts and of the contributions of the different sectors to the city resilience. The RAF App, developed later on during the project,

demonstrated to be a very helpful tool for the cities, since it facilitates the use of the RAF in terms of answering, integrating the information, analysing and visualizing the results. In addition, it provides support to the implementation of the RAF for cities having different resilience maturity levels.

Regarding the cities' testing, RAF developers undertook periodic assessment, sharing the results by presenting the following aspects, in line with the three stages:

- identification of answered and unanswered metrics;
- clarification of the reason why metrics were not answered (i.e. whether they were not applicable to the city, there was no data available for calculation or data would still be available during the project's timeline);
- preliminary city and service assessments.

Based on the cities' testing, it was possible to identify the RAF components that benefited from additional improvements and those that less fitted the cities' available information, thus supporting revisions. As expected, a clear improvement in the results was evident with the progression of the project, naturally because several project results have also contributed to the metrics answers in the RAF.

In Figure 6, the overall of three cities testing results is presented regarding the percentage of metrics that were answered (Answered) and not answered (NAnswered) for each identified resilience aspect to be assessed in the cities.

The physical aspects are more difficult to assess, when compared to the functional, possibly due to the lack of information on infrastructures.

It is important to acknowledge that involving stakeholders in the validation of the RAF preliminary version was a very relevant, fruitful and valuable process. It allowed coproduction of the framework and raised awareness on their contribution to city resilience. The final version of the RAF, described in sections 4 and 5, is a result of implementing this approach.

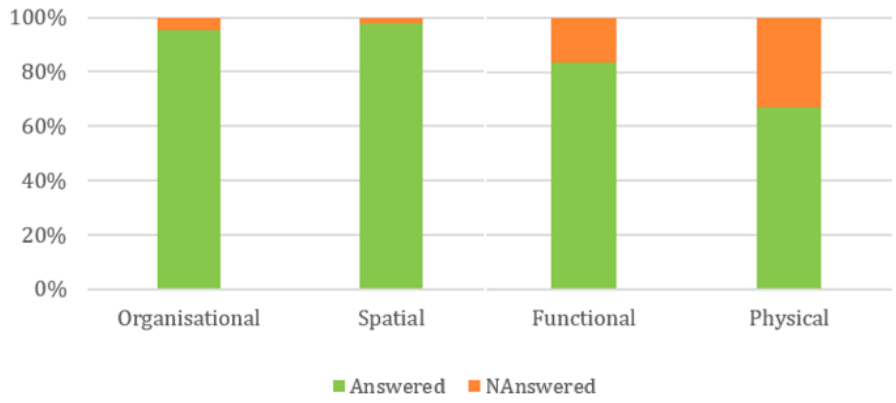


Figure 6 - Testing results: overall of the three cities regarding answering to the metrics

3. Literature review

3.1. Resilience assessment

Recognition of the resilience assessment relevance (see section 1.2) resulted in the development of several tools and frameworks for assessing resilience, by a wide variety of stakeholders in different fields of study. Some of the those worth mentioning are the ones created by ICLEI 2010, UN-Habitat CRPT 2013, Rockefeller&Arup 2014, World Bank 2015, UNISDR 2015, EPA 2017 among others (Patel and Nosal, 2016; UNISDR, 2017a,b; Summers et al., 2017; EPA, 2017). They present substantial variation in their structure, content and complexity. It is important to mention that UNISDR updated its designation to UNDRR (https://www.unisdr.org/). However, within this document it is used the original reference (UNISDR) that effectively supported the work presented herein.

Assessment tools provide a decision support to city and urban services' managers, planners and decision makers by identifying aspects that need to be enhanced, to establish priorities for intervention, to identify resilience strategies, to develop resilience action plans and to predict and monitor effectiveness and efficiency of their implementation (Sharifi, 2016, Cardoso et al., 2018). The development and implementation of the assessment process in collaboration with different stakeholders promotes their empowerment and enhance their role in decision-making process (Cox and Hamlen, 2014), as well as in the implementation of improvement solutions.

Extensive literature reviews characterizing existing frameworks for assessing resilience are presented in Lavelle et al. (2015), Schipper and Langston, (2015), Patel and Nosal (2016), Sharifi (2016), Summers et al. (2016), Tafidis et al., (2016) and UN-Habitat (2018). From these, for assessing resilience, it is important to take into account that cities are multi-dimension entities and, therefore, urban resilience needs to consider multidisciplinary insights. Additionally, resilience of a city is determined by diverse interacting systems and their relationships. For this reason, resilience also depends on the overall performance and capacity of its systems, not solely on its ability to cope with specific natural hazards or to adapt targeted areas to the impacts of climate change (Brugmann, 2012). Thus, it is essential to address interdependencies and cascading effects (Vallejo, L. and M. Mullan, 2017). Another relevant aspect is that it needs to include both sudden crises as well as interacting long-term stressors.

To undertake assessments, the frameworks use both quantitative methods, based on numerical data, and qualitative methods based on perceptions and experts' judgements, who have a better knowledge of needs, weaknesses and strengths of their own city (Kwasinski et al., 2016). Different types of metrics are used, such as in scorecards, to obtain performance values against each criterion in the resilience assessment tools. These values can be provided by answers to dichotomous or multiple-choice questions (Rowcliffe et al., 2000), calculated from statistical values (e.g. counts, percentages, medians, means, rates) (Peacock et al., 2010; Rowcliffe et al., 2000), or using judgements or perceptions (Rowcliffe et al., 2000).

When using judgements for the assessment, scaled questions are often used to quantify the qualitative feedback. Resilience metrics need to be simple and well documented (i.e. clearly defined and explained), address multiple hazards, be usable by others to ensure replicability, characterize a specific geographic extent, consider physical dimensions, involve community members and be adaptable and scalable to different communities and changing circumstances (Kwasinski et al., 2016).

Noteworthy work developed assumes that resilience is structured in terms of dimensions, while different dimensions are considered depending on the themes under assessment. Many frameworks also consider required qualities or characteristics for resilience that should be taken into account while developing resilience assessment. These are: ability to learn (Reflective); well-conceived, constructed and managed physical assets, and performing properly (Robust); can easily repurposes resources (Resourceful); has alternative strategies (Flexible); has backup capacity (Redundant); includes broad consultation, communication and joint vision (Inclusive); and has systems working together (Integrated), (Rockefeller&Arup, 2014, Schipper and Langston, 2015, World Bank, 2015, UN-Habitat, 2018).

Table 1 presents relevant resilience assessment frameworks, in the scope of climate change with focus on water, and synthetizes the themes and indicators considered in each framework (Schipper and Langston, 2015, Patel and Nosal, 2016, Summers et al., 2017, Rockefeller&Arup 2014, UN-Habitat, 2018).

Summers et al. (2017) identified the five most common dimensions as environmental, social, economic, built environment and infrastructure, and institutional. Each dimension was then divided into sub-dimensions, with several resilience criteria distributed among them. They noted that, on average, the institutional dimension was the most common, followed by social, built environment, economic, and environmental dimensions. In spite of the acknowledgment of its importance for building resilience, given the evidence that resource management, ecosystem protection, and presence of natural assets is essential for shock absorption and accelerate recovery, the environmental dimension has been relatively less developed in most of the studies.

Table 1 – Synthesis of resilience assessment frameworks for climate change

Framework	Themes addressed						Sectors addressed							No. of metrics	Reference
	Governance	Social	Spatial	Built environment	Economy	Natural Environment	Water	Wastewater	Stormwater	Waste	Energy	Mobility	Other(s) *		
EPA conceptual framework	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	163	EPA (2017)
City Resilience Framework	✓	✓	✓										✓	156	Rockefeller&ARUP (2014)
UNISDR Disaster Resilience	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	47 preliminary	UNISDR (2017a,b)

Scorecard for cities													117 detailed	
City Resilience Index to Sea Level Rise	✓	✓		✓	✓	✓	✓					✓	13	Abdrabo and Hassaan (2014)
Climate Disaster Resilience Index	✓	✓		✓	✓	✓					✓	✓	120	Joerin and Shaw (2011)
Climate Disaster Resilience Index	✓	✓		✓	✓	✓					✓	✓	82	Peacock et al. (2010)
Climate Resilience Screening Index	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	117	Summers et al. (2017)
Flood Resilience Index	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	91	Batica (2015)
Resilience Factor Index	✓	✓		✓	✓							✓	17	Ainuddin and Routray (2012)
Community disaster resilience	✓	✓		✓	✓	✓						✓	24	Yoon et al. (2016)
NIST Community Resilience Assessment Methodology	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	-	Kwasinski et al. (2016)
UKWIR						✓	✓	✓	✓				73	UKWIR (2017)
UN-Habitat City Resilience Profiling Tool (UN-Habitat CRPT)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	148	UN-Habitat (2018)

*e.g. Telecommunications, healthcare, education, people, medical, time

The relevance of the temporal scale also has been identified as an essential component of resilience (Norris et al., 2008). Findings show that about one fourth of the analyzed tools have taken all temporal phases of the temporal continuum into account, a similar proportion of the tools have referred to only past and existing conditions, and about 6% have considered only present and future conditions (Schipper and Langston, 2015). These authors also refer that about 42% of the tools have only focused on the present conditions and their output can be described as "a snapshot in time" that is not sufficient to reflect the evolutionary and emergent nature of resilience. Ability to track changes along the temporal continuum is what makes resilience assessment comprehensive (Sharifi, 2016).

Urban conditions, including internal and external dynamics, are likely to change over time. Consequently, considering the uncertainty regarding future conditions is a fundamental challenge for resilience assessment (Frankenberger et al., 2013). This may be incorporated considering the most severe scenarios (UNISDR, 2017a,b). In the absence of disturbance, the use of scenarios provides a way to simulate performance in the occurrence of a disaster. Making scenarios and considering different situations allows for a better understanding of strengths and weaknesses of communities (Monaghan et al., 2014) and can also be used for urban areas.

There is a growing recognition that communities should be prepared to respond to a wide variety of hazards occurring in multiple. Acknowledging that resilience

against one type of hazard does not guarantee resilience against others (Frankenberger et al., 2013) is fundamental. An important finding of the referred study is that most resilience assessment approaches have failed to reflect adequately the dynamic nature of resilience, when addressing internal and external dynamics faced by the cities, over various geographic and temporal scales. Another important point is that these tools need to acknowledge better the dynamic process of resilience building. In addition to historical trends and baseline conditions, it is essential to monitor status at regular intervals and use modelling and projection tools to address constantly changing circumstances.

Larkin et al. (2015) identified the need to ensure a broader engagement of stakeholders in the development and implementation of assessment tools. They also emphasize that any assessment process should result in the development of an action plan, by highlighting weaknesses and prioritize interventions to addressing them. Another challenge identified is the development of assessment methods and tools that are flexible enough to be applicable to diverse locations, i.e. allowing adding or removing criteria and indicators according to specific needs and priorities.

There are frameworks considering a more detailed sectoral assessment such as the EPA or UKWIR conceptual frameworks. The EPA framework evaluates urban resilience to climate change, considering a multi-sector approach and uses both quantitative and qualitative information to assess resilience (EPA, 2017). It includes three measures of vulnerability (exposure, sensitivity and response capacity), as well as the process of initiating responsive action, learning from mistakes or ineffective responses, and building risk reduction capacity (reducing exposure and sensitivity, and increasing response capacity). The framework not only includes the concepts of vulnerability, exposure, and hazards that present risks to urban environments, but it also incorporates the concepts of feedbacks, learning over time, and evolving in the ability to adapt and respond to challenges presented by gradual and extreme climate change. The framework represents an ongoing process rather than a temporary state of response to external shocks. The EPA framework considers the following urban sectors and number of indicators: economy (15), energy (14), land use (23), natural environment (13), people (24), telecommunications (26), transportation (24), water (24).

UKWIR (2017) proposes a set of resilience performance measures for the water and wastewater sectors, aiming to consider resilience appropriately in business plans. The metrics describe how a system, or aspects of a system, respond to disruptive events. It considers that description of this response needs to be set in relation to the service normally provided by the system (e.g. a water supply above a minimal pressure) and how the event acts to disrupt that service. These events lead to service failure that are categorized in five types, namely: (A) abnormal supply restrictions, (B) large scale interruptions to supply, (C) water supply quality incidents, (D) damage caused by unplanned discharge of wastewater and (F) environmental damage from failure of wastewater treatment.

Other relevant global assessment frameworks and tools exist related to urban resilience having sustainability in the core. Since they present indicators closely

related to resilience, reference is made to the monitoring of Sustainable Energy and Climate Action Plan from the Covenant of Mayors for Climate and Energy (Bertoldi P., 2018). This brings together local and regional authorities voluntarily committing to implementing the European Union's climate and energy objectives on their territory. Signatory local authorities share a vision for making cities decarbonised and resilient, where citizens have access to secure, sustainable and affordable energy (Kona et al., 2015, Neves et al., 2016). In addition, ISO 37120:2014, an international standard on sustainable development of communities, establishes definitions and methodologies for a set of city indicators for city services and quality of life for a holistic and an integrated approach to sustainable development and resilience. The indicators can be used to track and monitor a city's progress on city service performance and quality of life and assist cities in setting targets and monitoring achievements.

The City Resilience Framework (CRF) (Rockefeller&Arup 2015), UNISDR (UNISDR, 2015; UNISDR, 2017a,b) and UNHabitat CRPT (UN-Habitat 2013) frameworks are synthetized next by their relevance for the project, not only because the project-involved cities have already been applying some of them but also because of their wide-ranging application worldwide. These have directly supported the RAF development.

3.2. City Resilience, UNISDR and UN-Habitat CRPT frameworks

The **CRF** is a comprehensive and holistic framework that combines the physical aspects of cities with the less tangible aspects associated with human behaviour, that is relevant in the context of economic, physical and social disruption and that applies at the city scale rather than to individual systems within a city (Figure 7).

It is structured in four dimensions: health and wellbeing of individuals (people); urban systems and services (place); economy and society (organisation); and, finally, leadership and strategy (knowledge). A weakness in one area may compromise the city's resilience overall, unless it is compensated by a strength elsewhere. It is structured through 12 goals (3 per dimension), 52 indicators, 156 variables corresponding to prompt questions. The performance indicators describe the outcome of actions to build resilience, not the actions themselves. This acknowledges that resilience results from individual and collective action at various levels, delivered by multiple stakeholders ranging from households to municipal government. The indicators are complemented by qualities that distinguish a resilient city from one that is simply liveable, sustainable or prosperous. These qualities are considered important in preventing breakdown or failure; or enabling appropriate and timely action to be taken.

Figure 7 – City Resilience Framework structure

The Sendai Framework is the successor instrument to the Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters. The Sendai Framework focuses on disaster risks while the HFA focuses on disaster losses. The Framework expected outcome is the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.

The **UNISDR** Disaster Resilience Scorecard for cities aims to support the reporting and implementation of the Sendai Framework for Disaster Risk Reduction: 2015-2030, based on the Ten Essentials for Making Cities Resilient. Essentials 1 to 3 cover governance and financial capacity; Essentials 4 to 8 cover the many dimensions of planning and disaster preparation; Essentials 9 to 10 cover the disaster response itself and post-event recovery. It provides a set of assessments that will allow cities to understand how resilient they are to natural disasters.

The Scorecard is intended to enable cities to establish a baseline measurement of their current level of disaster resilience, to identify priorities for investment and action, and to track their progress in improving their disaster resilience over time. Level 1 (preliminary level) has 47 questions/indicators, each with a 0-3 score, and Level 2 (detailed assessment) has 117 indicator criteria, each with a score of 0-5.

The Ten Essentials for Making Cities Resilient used in the scorecard are: 1. Organise for disaster resilience; 2. Identify, understand and use current and future risk scenarios; 3. Strengthen financial, capability for resilience; 4. Pursue resilient urban development and design; 5. Safeguard natural buffers to enhance the protective functions offered by natural capital; 6. Strengthen institutional capacity for resilience; 7. Understand and strengthen societal capacity for resilience; 8. Increase infrastructure resilience; 9. Ensure effective disaster response; 10. Expedite recovery and build back better.

The **UN-Habitat** City Resilience Profiling Tool (CRPT) of the City Resilience Profiling Programme (CRPP) is a framework and approach to evaluate urban resilience that supports the definition of recommendations for actions for resilience and sustainability tailored to the cities. The CRPT uses a diagnostic methodology to reveal the strengths, weaknesses, capacities, and vulnerabilities of a determined city and establishes prioritised actions to reduce vulnerability, plan-out risk, and build-in resilience, allowing cities to capitalise on their existing data. The urban system approach used by the Programme considers five dynamic and interdependent dimensions common to all human settlements (UN-Habitat, 2018). The dimensions are the following: 1. Spatial attributes - all human settlements are geographically distributed somewhere on the planet, and it is a critical dimension for addressing risk/ hazard/ vulnerability/ (dis)continuity as a result of deficient spatial distribution of people, assets and processes; 2. Organisational attributes - all associations of people, where the smallest 'unit' is the individual, and the typology of 'organisation' includes everything from 'community', to corporate, or government institutions; 3. Physical attributes - all tangible features, both natural and constructed, comprise this dimension, regardless of typology, quantity, or qualitative state; 4. Functional attributes - all human settlements exist for a reason, and functions include the processes, flows and governance mechanisms present in all human settlements; and 5. Time - cities are not static, and undergo constant evolution.

The CRPT diagnostic methodology is made of four sets. Set 1 considers the overall picture of the city by gathering contextual information on various topics that give the city its unique identity, namely its historical background and spatial context, specifically in the aspects of climate, ecosystems, urban areas and physical assets. It introduces the city's administrative structure, characteristics and strategies, highlighting those related to resilience and describes the city's inhabitants through their composition, characteristics and dynamics, and outlines basic information on the economy and livelihoods. It provides an initial identification of the shocks, stresses and challenges that the city may face and risk reduction measures in place to counteract prioritised shocks. Set 2 is focused on all governance processes at the local level per thematic area of interest, and considers a broad variety of relevant stakeholders and their connectivity. Set 3 draws an overall mapping of the city's proneness to shocks, the stresses affecting the city's performance, the challenges the city is facing and their interrelations as well as highlights the events and pressures considered most serious in terms of their impacts. Finally, Set 4 provides an in-depth examination of the urban system's performance, categorised into urban elements. It includes all aspects essential in enabling life in the city, from the built environment to the broader scale of the ecology, and from different types of services provided for the inhabitants to characterising the city's economic state. Set 4 is looked through the lens of 8 elements divided into 49 components, with 148 indicators translated into a flexible amount of questions based on the context of the city considered.

From this review, it is clear that diverse existing frameworks were developed with different purposes, focusing on different themes and having distinct structures and formulations. From Table 1, the UN-Habitat CRPT includes all the themes

identified. From the review, gaps in the approaches were recognised allowing identification of several needs to bridge:

i) an objective driven resilience assessment to climate change with focus on water, integrating not only the city assessment but also specific assessment of urban services;
ii) explicit stakeholders involvement in the coproduction of the framework;
iii) support to resilience planning for both the city and the services decision making;
iv) wide availability of the complete framework to city and services managers;
v) free availability of a tool to support usage of the framework.

4. Resilience Assessment Framework overview

4.1. Main concepts and general structure

The emphasis of the RAF developed within RESCCUE is on city, services and infrastructure resilience. Aligned with this, the RAF considers **resilience dimensions** for assessment. As stated previously in section 2, the dimension is an important component of the city's resilience. The RAF **resilience dimensions** match those aspects of city resilience identified in section 2.2.4. When applicable, the dimensions unfold under sub-dimensions for each urban service under assessment.

For each dimension, resilience **objectives** are identified as the ambitions to be achieved in the medium-long term by the city and services. The objectives are described through specified key **criteria**, expressing the objectives' different points of view, such as analysed in section 2.2. **Metrics** are then defined consisting in questions, parameters or functions used to assess the criteria. By comparing the result of metrics with **reference values**, it is possible to assign a classification to the responses, reflecting the resilience maturity of the city or of the service under assessment for that specific assessment. It is important to note that the classification of a given individual metric is of little value on its own. By itself, a metric does not reflect the entire point of view of the criterion, which it belongs. The classification only allows an effective assessment when the metric is put into perspective within the criterion (i.e. linked to the corresponding criterion and objective), analysed together with the other metrics belonging to the same criterion, and framed by the context of the city and service under assessment.

It should be noted that resilience is by nature dependent on the specific context of each city and service. In this sense, the RAF considers the context of the city (**city profile**) and of the services (**service profile**) under analysis, focusing on the relevant context information that supports the interpretation of the metrics results. Those profiles summarise a set of features that provide a unique

characterization of the city and services (ERSAR, 2013). The main characterization themes considered in city profile are geography, climate, population, economy and governance, built environment and infrastructure and the identification of the climate-related hazards in the city. It is in the city profile that the services under evaluation are identified. These are then characterized in more detail in the service profile. All services are described in a similar way with regard to their context characterization, and in a specific way with regard to the characteristics of their infrastructures. The main characterization themes in service profile are utilities involved in the service provision and type of customers, assets description and the identification of the climate-related hazards for the services.

For each RAF metric, the classification is made by associating each answer to a resilience development level, related to the reference values mentioned above. The **resilience development levels** are classified as *incipient* (for results that are still non-existent or are at an early stage of development), *progressing* (for situations where significant steps have already been taken and the city or the service are still developing the specific aspect addressed by the metric), or *advanced* (for already consolidated results). The tree structure used in the RAF (Figure 8) allows getting information on the development level for each criterion, taking into account the various metrics that contribute to it. Likewise, it is possible to know the development level of a given objective or, more aggregately, of a given service or resilience dimension. It is important to highlight that lack of information is also evidenced in the assessment and that data reliability should be mentioned, whenever it may compromise the assignment of a development level.

In order to facilitate the application of the RAF, each metric is also assigned to a relevance degree and to an analysis level (Cardoso and Brito, 2019). Three degrees of **relevance** are considered: *essential*, including all metrics with higher relevance, required to integrate the resilience assessment of any city or service; *complementary*, additional metrics to be considered whenever integration of a city or service specific aspects' is sought, corresponding to a more detailed resilience assessment; *comprehensive*, additional metrics recommended whenever a more in-depth assessment is aimed, for a city or service with higher maturity in its resilience path. Conversely, depending on the resilience maturity, the city or service aiming to apply the RAF may select a given set of metrics, according to their relevance.

An **analysis level** is also assigned to each metric, either strategic or tactical (2.1). *Strategic* assessment is associated with a long-term view, spanning the entire city or service, and relates to a higher level of decision-making. *Tactical* assessment is targeted to the medium-term planning, to the materialization of the strategies established in strategic level, both geographically and temporally.

The RAF has a hierarchical tree structure. As stated above, for each dimension resilience objectives are defined. Only within the dimensions related to the urban services, they unfold firstly into sub-dimensions, representing for each sub-dimension one service to be assessed. Each objective is described by a set of criteria, which assemble the respective metrics. Figure 8 illustrates the presented

structure, from the dimension into objectives (Obj), criteria (Crit) and metrics (Met).

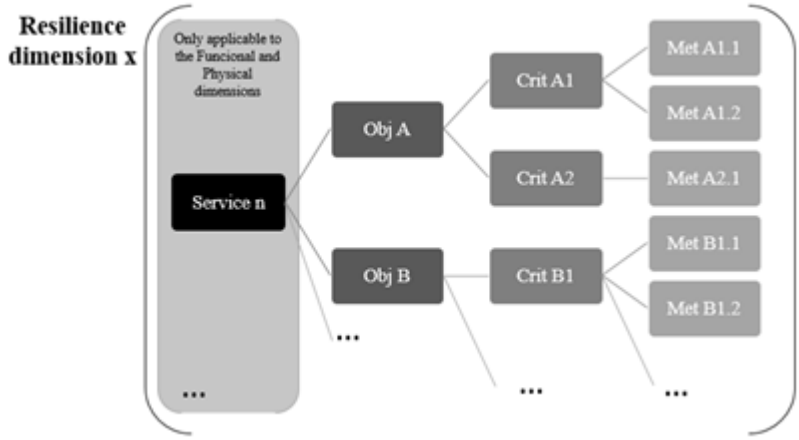


Figure 8 - RAF tree structure

4.2. RAF dimensions, objectives, assessment criteria and metrics

The RAF sought alignment with international frameworks for resilience assessment and made significant developments with regard to its scope and focus on urban services (see section 2.1). In total RAF includes 719 metrics, from which 433 are essential, 202 are complementary and 84 are comprehensive (see section 4.1). From this set, 60 metrics correspond directly to metrics from the UNISDR Disaster Resilience Scorecard and 29 are adapted from this framework (UNISDR, 2017a,b).

The RAF considers the UN-Habitat resilience dimensions (Pagani *et al*. 2018): organisational, spatial, functional and physical, while the time dimension is integrated as part of the analysis level and of the metrics implicitly addressing it, providing information about the city's ability to prepare for, respond to or recover from risk events or changes in circumstances.

The **organisational** dimension integrates top-down governance relations and urban population involvement, at the city level. The **spatial** dimension, also at the city level, refers to urban space and environment. The resilience of strategic services is assessed in the **functional** dimension, while the **physical** dimension focuses on the resilience of their infrastructure. The last two dimensions also allow integrating the contribution of each service to city's resilience (Cardoso and Brito, 2019). These four dimensions integrate all the diverse themes considered in other international frameworks that are relevant in this scope and focus (see section 3).

Given the scope of the RAF (see section 2.1), the organisational and spatial resilience dimensions unfold into objectives associated with the scope assessed. The objectives within the organisational dimension relate to collective citizen

engagement and awareness, to leadership and management and to city preparedness considering everyday life, overall disaster response and specifically climate change. The objectives within the spatial dimension relate to spatial risk management, regarding risk-related mapping and urban planning, spatial impacts of climate-related events and the existence of urban ecosystems and protective infrastructure in the city.

These objectives are presented and described through the criteria presented in Table 2, where the number of metrics associated with each criterion is also presented, as well as the number of metrics identified as essential. As an overall, the organisational dimension considers 74 metrics in total, from which 50 are *essential*, 16 are *complementary* and 8 are *comprehensive*. The spatial dimension considers 29 metrics in total, from which 22 are *essential*, 4 are *complementary* and 3 are *comprehensive*.

The functional and physical resilience dimensions similarly unfold into objectives, associated with the scope of the assessment. The objectives within the functional dimension relate to the need to develop and improve urban services resilience, promoting services that can respond to and absorb disruptions, learn from the past, adapt, transform and prepare for the future, by focusing on long-term balance and taking into account existing resources. The objectives considered for the physical dimension are related to the need to ensure that the infrastructures providing these services are effective, efficient and sustainable, considering their interdependencies, the contribution of the existing solutions to improve urban resilience to CC, that they are prepared for CC impact and to respond appropriately, adapting and recovering with the minimum damage.

Table 2 – Overview of the Organisational and Spatial resilience dimensions

ORGANISATIONAL OBJ. Criterion	No. PI	No. *essential* PI
COLLECTIVE ENGAGEMENT AND AWARENESS		
Citizens and communities engagement	5	3
Citizens and communities awareness and training	5	3
LEADERSHIP AND MANAGEMENT		
Government decision-making and finance	4	3
Coordination and communication with stakeholders	4	2
Resilience engaged city	19	13
CITY PREPAREDNESS		
City preparedness for disaster response	13	8
City preparedness for CC	7	6
City preparedness for recovery and build back	7	5

SPATIAL OBJ. Criterion	No. PI	No. *essential* PI
SPATIAL RISK MANAGEMENT		
General hazard and exposure mapping	5	5
Hazard and exposure for CC	3	3
Resilient urban development	7	4
Impacts of climate-related event	2	2
PROVISION OF PROTECTIVE INFRASTRUCTURES AND ECOSYSTEMS		
Protective infrastructures and ecosystems services	9	6
Dependence and autonomy regarding other services considering CC	3	2

ORGANISATIONAL OBJ. Criterion	No. PI	No. *essential* PI
Availability and access to basic services	10	7

SPATIAL OBJ. Criterion	No. PI	No. *essential* PI

These objectives are presented and described through the criteria presented in Table 3. The overall number of metrics associated with each criterion, as well as the number of *essential* metrics (which might vary, depending on the service) is also given. As an overall, depending on the services, the functional dimension considers between 42 and 69 metrics in total, from which between 24 and 39 are *essential*, between 5 and 28 are *complementary* and between 3 and 13 are *comprehensive*.

Similarly, the physical dimension considers between 36 and 49 metrics in total, from which between 18 and 31 are *essential*, between 5 and 16 are *complementary* and between 4 and 13 are *comprehensive*.

The metrics within each criterion present either a form filled to provide an answer or a list of predefined answers, of which: (i) only one may be selected; (ii) multiple answers may be selected. Depending on the metric's answer, a pre-defined resilience development level is assigned, based on the reference values (see section 4.1): *incipient* (between 0 and 1), *progressing* (between 1 and 2) or *advanced* (between 2 and 3). These individual values for the metrics allow providing information on the percentage of metrics in each development level to assess a criterion, objective or dimension. However, a specific development level of the several metrics integrating a criterion, objective or dimension is also possible, by using a simple average of the corresponding metrics.

Table 3 – Overview of the Functional and Physical resilience dimensions

FUNCTIONAL OBJ. Criterion	No. PI	No. *Essential* PI
SERVICE PLANNING AND RISK MANAGEMENT		
Strategic planning	5	5
Resilience engaged service	5-6	4-5
Risk management	7-12	2-7
Reliable service	6-11	1-5
Flexible service	4-6	1-4
AUTONOMOUS SERVICE		
Service importance to the city	2	1

PHYSICAL OBJ. Criterion	No. PI	No. *essential* PI
SAFE INFRASTRUCTURE		
Infrastructure assets criticality and protection	5	5
Infrastructure assets robustness	10-14	4-6
AUTONOMOUS AND FLEXIBLE INFRASTRUCTURE		
Infrastructure assets importance to and dependency on other services	3-4	3
Infrastructure assets autonomy	1-6	0-4
Infrastructure assets redundancy	1-3	0-3
INFRASTRUCTURE PREPAREDNESS		

FUNCTIONAL OBJ. Criterion	No. PI	No. *Essential* PI
Service inter-dependency with other services considering CC	2	0
SERVICE PREPAREDNESS		
Service preparedness for disaster response	0-4	0-4
Service preparedness for CC	6-8	4
Service preparedness for recovery and build back	0-15	0-8

PHYSICAL OBJ. Criterion	No. PI	No. *essential* PI
Contribution to city resilience	3-4	2-3
Infrastructure assets exposure to CC	3	0-3
Preparedness for CC	2	1
Preparedness for recovery and build back	7-9	2-4

The RAF is built upon the assumption that it is feasible to give an answer to every metric, what was validated by the testing (see section 2.2.4). However, in the case a metric is not applicable to a city, for some specific reason, then the RAF provides the possibility to explain that reason (e.g., if a metric relates to coastal aspects and the city under assessment is in the hinterland). Some metrics precede others, meaning that if the city does not answer to the first one, the latter automatically does not apply (e.g., if a city answers negatively to a metric asking whether a RAP is available, then any following metric concerning the contents of that RAP is not applicable).

In case the metric applies, but the city does not have an answer for it in the moment of the assessment, the reason why the metric is not answered should also be explained (e.g., if a metric relates to the impacts of an historical climate-related event and the city did not register the requested information).

Some metrics are scenario-specific, namely those that address preparedness for climate change, and that anticipate the city and services' exposure or vulnerability to future scenarios. While some metrics relate generally to climate change scenarios, others are specific for the most probable or the most severe scenarios. In this case, the city and services need to agree on those scenarios they want to be prepared for. From the CC projections, the city should define the most probable and most severe scenarios, in order to specify what it is being addressed in the assessment. The scenarios should be specified in the city and in each service characterization profile (see section 4.1), as they may be differ for the city and for the services.

It is important to emphasise that the scope and focus of the RAF (see section 2.1) do not integrate all potential resilience dimensions, all possible hazards that a city may face and all urban services available in the city. Additionally, there is the possibility that the city under consideration does not answer to all the metrics. Consequently, a city resilience overall development is not available, as it could be misrepresentative of the whole city's complexity. More than a tool to assign a resilience grade, the main purpose of the RAF is to identify the aspects where the city or services already achieved resilient practices and those still having opportunities to enhance resilience, thus supporting the definition of strategies and the development of resilience action plans. It is expected that the RAF

contributes to respond to the concerns identified in the literature review (see section 3).

4.3. RAF results

The RAF is designed to be answered for an integrated assessment of the city and its services, for a given time period and for a specific hazard (e.g. assessment for 2019 and flooding-related hazards) – this is considered as a study (study 2019/flooding). If a city intends, for example, to compare its progress between the current and a certain year in the past, then each one of these assessments corresponds to different studies (e.g. study 2014/flooding and study 2019/flooding). Similarly, when assessing more than one type of hazard, the assessment for each hazard corresponds to a different study (e.g. study 2019/flooding and study 2019/drought).

For each study, the RAF's tree structure provides the percentage of total metrics results corresponding to each development level for the whole city and it is possible to get these results for each dimension, objective and criteria. This information provides a progressively deeper insight into the city and services resilience strengths (provided by metrics with *advanced* results), opportunities for improvement (provided by metrics with *progressing* results) and major challenges to address (provided by metrics with *incipient* results).

Some metrics are hazard-specific. As referred to before, if a city or service intends to use the RAF to assess different hazards, a different RAF study needs to be created for each hazard. For instance, in order for a city to assess flooding, heat waves, drought and combined sewer overflows, 4 different studies need to be considered although they will only differ in the answers related to the CC scenarios metrics. It is possible then to compare and assess the resilience constraints associated to each hazard. If a given service has identified the same hazard as the city, the answers for the service should be given in the same study for that hazard, in order to contribute to the integrated assessment.

Additionally, for each hazard, the city may have different risk sources/variables associated. For example, flooding might be caused by rainfall or by sea level. When answering to the scenarios' metrics for flooding, if there are differences regarding the impacts or consequences that depend on the type of variable, then the answer should be done for the hazard/risk source that causes the most aggravated answer for the metric, and the variable should be specified as a comment to the result. In this situation, it is still possible to create a different study, if it deepens the assessment and facilitates the identification of solutions. However, it needs to be balanced in order to keep some parsimony.

4.4. RAF App

With the purpose to support the RAF usage, a tool – the RAF App – was developed (Figure 9) as a web-based platform (Lopes et al., 2019). The access to the tool is

only available to users with login credentials provided. A users' manual for the RAF App was developed and it is accessible on the platform.

While creating a new study for assessment, the user has to specify the dimensions to assess (organisational, spatial, functional and physical) and the services (water, wastewater, stormwater, waste, energy and mobility) to be evaluated within the functional and physical dimensions. For the selected dimensions and services, subsequent tabs will display the correspondent RAF structure (see section 4.1). Before getting into data input for resilience assessment, a section regarding the city and services profile is available to provide context.

In order to facilitate and plan the introduction of responses on each metric, for each dimension the platform provides a filter to only select a certain set of metrics, that may correspond to a given criteria, to an objective or to a given metrics' degree of relevance. The correspondent metrics are then displayed and, whenever applicable, the respective pre-defined answers and other inputs are presented (Figure 10).

The RESCCUE RAF App includes a module to graphically explore the results (see section 4.3), allowing for a user-friendly and dynamic visualization. This is also possible for the level of aggregation the user selects, such as for the whole city (Figure 11); for a given dimension, service (Figure 12), objective or criteria; or for a given level of metrics' degree of relevance or analysis level (Figure 13).

In every graph within the results tab, the colour translates what is under assessment. The blue corresponds to city integrated assessments, each different colour corresponds to a dimension (red for organisational, orange for spatial, bright green for functional and petroleum green for physical) where darker tones relate to the percentage of metrics with an *advanced* development level, medium tones to *progressing* and lighter to *incipient*. Dark grey relates to unanswered metrics and light grey to not applicable metrics.

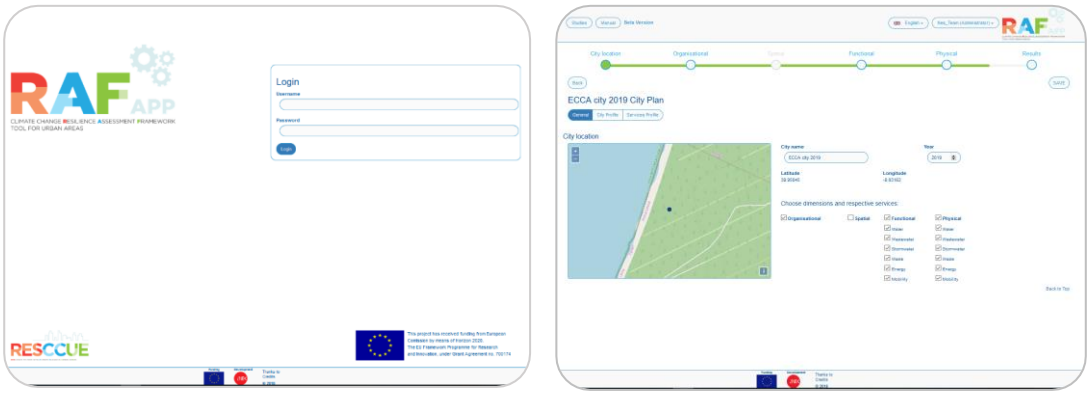


Figure 9 – City main page in the RAF App

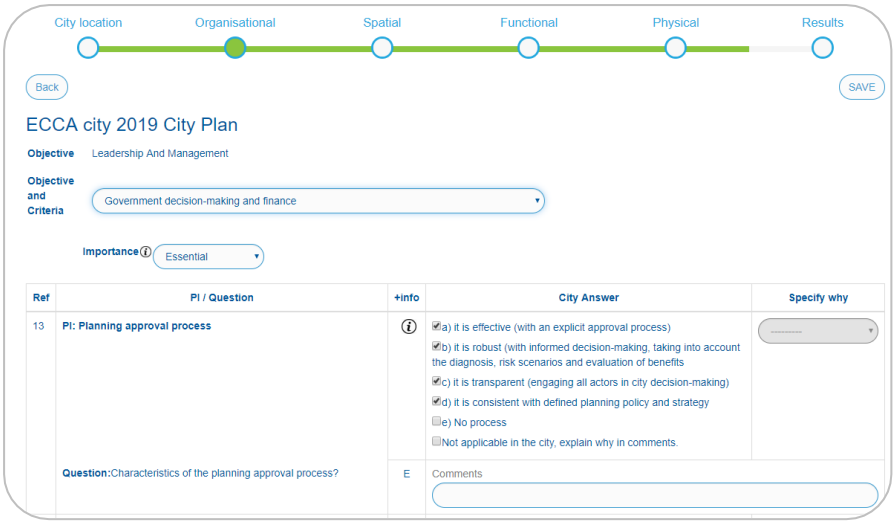


Figure 10 – Example of data insertion in the RAF App

a) Overall results: metrics integrated within each development level in the city

b) Development levels for each dimension in the city

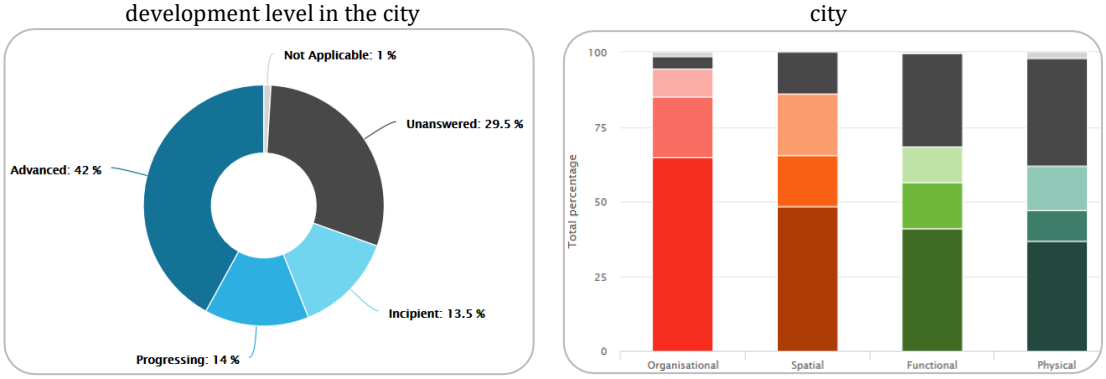


Figure 11 – RAF App results: example of a city integrated assessment

a) Metrics within each development level in the physical dimension

b) Development levels for each service in the physical dimension

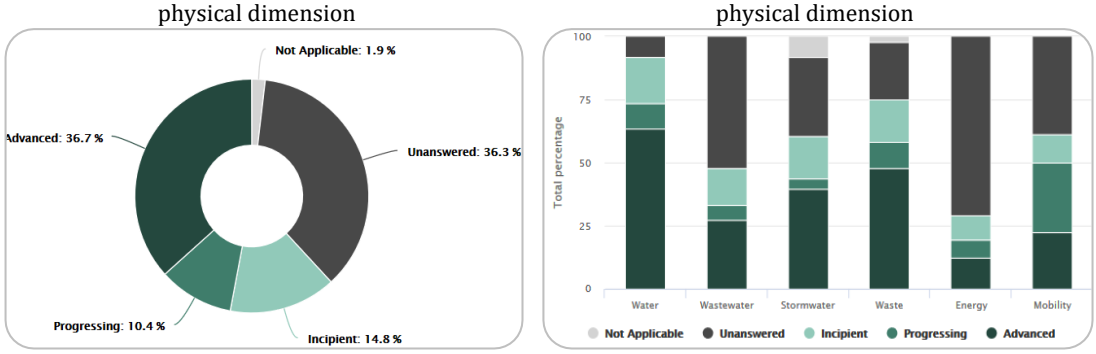
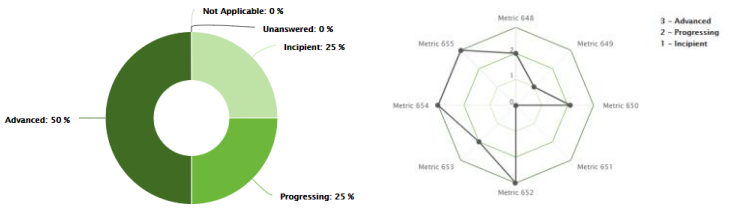


Figure 12 – RAF App results: example of a city disaggregated assessment

a) Energy service: metrics in the criterion "preparedness for CC"

b) Development level for each metric in this criterion

c) Metric within this criterion



Metric	PI
648	Service commitment with mitigation of climate change effects
649	Existence of agreed climate change scenarios and alignment with the city climate change scenarios
650	Knowledge of exposure and service vulnerability for climate change scenarios
651	Service planning for adaptation to climate change
652	Implemented measures to address climate change mitigation and adaptation
653	Planned measures to address climate change mitigation and adaptation
654	Equipment capacity of the service
655	Staffing capacity of the service

Figure 13 – RAF App results: example of a city detailed assessment

Visual comparison between different evaluation moments, for the same city, is available. RAF App allows monitoring resilience progress in a given time window, both by visually comparing the diagnosis in different years (Figure 14) and by identifying the progress through the variations of percentage in each development level.

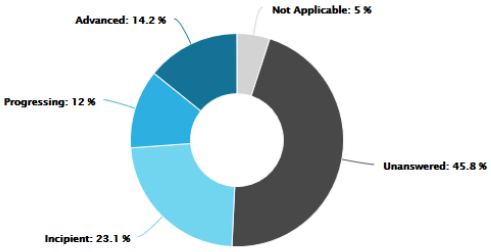
This tool also allows to visualise the expected resilience development level, if the measures adopted by the city are implemented in a given planning horizon, by graphically illustrating the effect on the result of the metrics that were affected by the resilience measures (in each criterion, objective, service or dimension).

Finally, the tool provides an output in the form of a pre-defined summary report, highlighting the most relevant graphs.

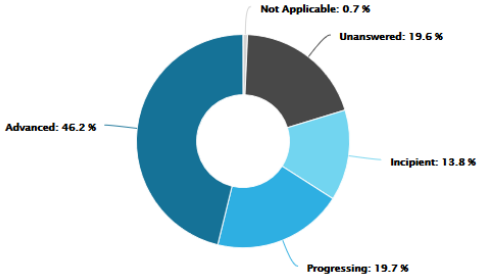
In summary, as a tool that explores RAF architecture, the RAF App:

- supports assessment, diagnosis and decision-making;
- monitors the progress of a city or service;
- compares different services;
- addresses the contribution of urban services to the city's resilience to climate change;
- acknowledges improvement opportunities to increase resilience;
- supports the development of resilience plans;
- facilitates communication between stakeholders.

a) 2014 assessment



b) 2019 assessment



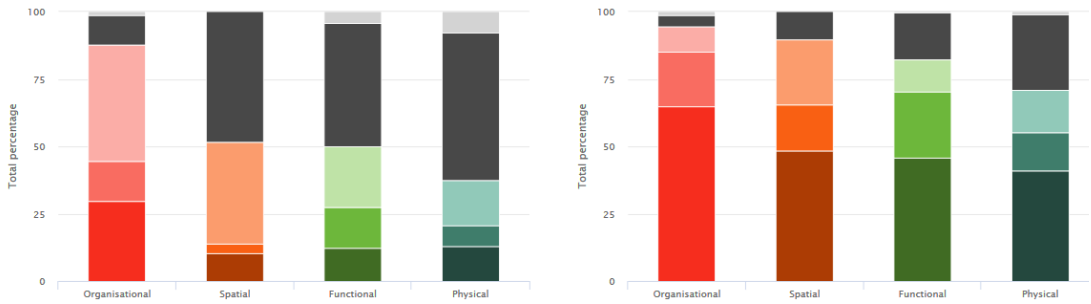


Figure 14 – RAF App results: example of a city integrated resilience progress on a given time interval

The RAF App demonstrated to be a worthy solution to uptake the contributions from the cities, since it is a user-friendly tool facilitating metrics' inputs and providing an easy visualization of results by graphical aggregation, as well as a first identification of resilience strengths, gaps and improvement opportunities.

5. Resilience Assessment Framework detailed description

5.1. General

As described in 2.2, the RAF development was grounded on the literature review, from where the recommendations highlighted were addressed. As mentioned in section 3.1, the CRF (Rockefeller&Arup 2015), UNISDR scorecard (UNISDR, 2015) and UNHabitat-CRPT (UN-Habitat 2013) frameworks have directly supported the RAF development. As mentioned, RAF is based in the UNHABITAT dimensions also incorporating the time, as well as in the CRF and UNISDR frameworks, since they are aligned both with the RAF scope and with these dimensions (see section 2.1). Besides, it is important to consider the previous work already developed by the cities using these frameworks.

During the RAF's development, several points of view that originated the criteria (see section 2.2.4) based on CRF were regrouped, selected and completed taking into account the RAF specific scope and focus (see section 2.1). The metrics mostly used are performance indicators (PI) which main source was the UNISDR scorecard framework – found to be the most adequate for the scope and focus of the RAF, completed with intensive new developments to cover the PI missing from that framework and relevant in RESCCUE. Questions were then assembled to the PI, based on direct or adapted questions from existing frameworks or newly developed. The reference values (see sections 4.1 and 4.2) considered to assign the development level were supported by information provided by other assessment frameworks and literature (see section 3), by specific services (ASCE, 2017) and respective regulatory recommendations (ERSAR, 2009; ERSAR, 2013, ERSAR 2018) and by discussions and sharing with several stakeholders. After validation of the preliminary version of the RAF (see section 2.2.4), a final version was produced incorporating all processed contributions. PI are presented in detail

in Annex 1, including their description, source if it is provided by an international framework, degree of relevance, level of analysis, metric type, rule to assess the development level and interdependency with other PI if applicable (see section 4.1). The table of interdependent metrics is presented in Annex 2.

Additionally, every city or urban service needs to operate in its own specific political, economic, geographical, climatic and cultural context. Considering the context information is fundamental in interpreting any assessment. Following this, a city and services' characterization profile were developed to integrate the RAF framework, regarding its scope and focus, supported in UNHabitat (2018) and Bertoldi P. (2018).

5.2. City and services characterization profiles

5.2.1. Overview

Every city or urban service has to operate in its own specific political, economic, geographical, climatic and cultural context. Schipper and Langston (2015) denote that resilience cannot be measured only through indicators but needs to address the city or service context characteristics. Indicators may not appear relevant or may be misleading, unless supplemented by qualitative or quantitative, contextual information, particularly for local or regional assessments. In this view, contextual information is fundamental to support diagnosis and selection of measures and strategies as it provides a description of the hazards and challenges that the city and services face, including those driven by climate change (UN-Habitat, 2018).

The climate-related hazards threatening each city, and correspondent climate variables, inherently depend on a set of geographic, historical, cultural, economic and governance factors, among others, which must be properly characterized for an appropriate interpretation of the RAF results and definition of an action plan. For example, a flat coastal city can be threatened by hazards related with coastal overtopping, windstorms and rising sea level while a mountainous continental city is not. However, the continental city can be more prone to cold waves and, for example, river flooding than the coastal city. Urban and regional planning and the city's infrastructure and governance, as well as its services, also play a key role in the resilience of the city.

Considering the RAF set of services (section 2.1), their interactions and contributions to the city's resilience, the characterization of each of these services, in addition to the characterization of the city, is also of the utmost importance. The following sections present the required information for characterizing the profiles of a city and each of the services. Characterization profiles follow a common structure for all services. In the RAF, climate change scenarios are focused on the following hazards: flooding, drought, heat waves, cold waves, windstorms and combined sewer overflows (CSO). The main related climate variables are temperature, rainfall, snowfall, wind and sea level. Nevertheless, the information structure allows for consideration of other hazards and other climate variables.

5.2.2. City profile

The city profile aims at describing the main characteristics of the city relevant to the RAF, divided into the following thematic groups: geography, climate, population, economy and governance, built environment and infrastructures, and assessment scope of the climate change scenarios. Climate change scenarios and related climate variables for the city are those referred in section 5.2.1. The information requested for city profile is presented in Table 4.

Table 4 – Resilience assessment framework: city profile

Theme Identification | description		Units
Geographical characteristics		
City name		(-)
Country name		(-)
Altitude	Range of altitudes.	(m)
Metropolitan area	Area of influence of the City in terms of economy and labour market.	(km^2)
Urban area	Area within the boundaries where your local government has jurisdiction. Ex.: Municipality area.	(km^2)
Geographical charac.	Select all applicable: Coastal area; Near or on a mountain; Near or on a waterbody; Other - specify.	(-)
Climate		
Climate type	According to the Köppen climate classification.	(-)
Climate and environment variables *The period considered for the average must be specified e.g. [1971 to year 2001]	Temperature *: Annual average; Average of the hottest month; Average of the coldest month	(ºC)
	Rainfall *: Annual average; Average of the wettest month; Average in the driest month	(mm)
	Snowfall *: Annual average; Average of the month with highest snowfall; Average duration of snow cover; Average snowmelt water equivalent	(cm)
	Wind *: Average yearly velocity; Average velocity of the month with the strongest wind; Average for the calmest month	(km/h)
	Sea level *: Annual average maximum tidal amplitude; Annual average local mean sea level	(m)
Extreme events	Frequency and average duration of heat waves.	(No./year) (day)
	Frequency and average duration of cold waves.	(No./year) (day)
	Number of consecutive days and nights without rainfall.	(days)
	Frequency and average duration of windstorms.	(No./year) (day)
	Other relevant climate-related information. (Months with characteristic phenomena. Ex.: Extreme temperatures, rainfall, drought, monsoon, etc.).	(-)
Hazards	Climate-related hazards. Select all applicable: Flooding; Drought; Heat wave; Cold wave; Windstorm; Combined Sewer Overflow (CSO); Other - specify. Please indicate significant hazards, and the year of last serious occurrence for each case (e.g., with impacts in city functioning, fatalities, severe injuries, displaced people, significant losses in economic activities or strategic services).	(-) and (year) for each hazard

Theme Identification **|** description		Units
Scenarios	Most probable scenario[1] characteristics (MP1, MP2,... MPi) Please indicate the characteristics of the most probable scenario for the relevant hazards, with the variables described in "Climate and environment variables". Value description: E.g. rainfall in mm, in the precipitation scenario that caused flooding. For each of the applicable scenarios, provide: - the Reference (MP1, MP2,... MPi); - the Hazard (Flooding; Drought; Heat wave; Cold wave; Wind storm; Combined Sewer Overflow (CSO); Other - specify); - the Variable (Temperature; Rainfall; Snowfall; Wind; Sea level; Other); - the Value description and - Comments.	(-)
	Most severe scenario[2] characteristics (MS1, MS2,... MSi). Please indicate the characteristics of the most severe scenario for the relevant hazards, with the variables described in "Climate and environment variables". For each of the applicable scenarios, provide: - the Reference (MS1, MS2,... MSi); - the Hazard (Flooding; Drought; Heat wave; Cold wave; Wind storm; Combined Sewer Overflow (CSO); Other - specify); - the Variable (Temperature; Rainfall; Snowfall; Wind; Sea level; Other); - the Value description and - Comments.	(-)
Population		
Urban population density	Inhabitants/Km^2.	(Inhabitants/ Km^2)
Urban population - permanent	Permanent residents. % of sensitive population groups (e.g. elderly (65+)/young (25-) people, lonely pensioner households, low-income/unemployed households) - compared to city population in year X.	(Inhabitants) and (%)
Urban population - floating	Tourists, students, seasonal workers, etc. Include high seasons, if applicable.	(Tourists/students…)
Urban population - commuters	Daily commuters.	(No.)
Total population of the metropolitan area	Include average growth rates for urban and metropolitan population.	(Inhabitants)
Other population relevant information	E.g. Percentage of population registered in the national health service, of school-aged population enrolled in schools (ISO 37120 2014: calculated as the number of school-aged population enrolled in primary and secondary levels in public and private schools (numerator) divided by the total number of the school-aged population (denominator). Express the result as a percentage.	(%)
Economy & governance		
GDP (city).		(€)

[1] Most probable scenario relates to a hazardous event that causes disruption, assessed by experts to be the most likely to occur (based on UNISDR, 2017a,b).

[2] Most severe scenario relates to a hazardous event that causes greater disruption, assessed by experts to be the worst case to plan for (based on UNISDR, 2017a,b).

Theme Identification | description		Units
GINI index and income of the bottom quintile	Please use local data, if available. Please specify.	(-)
City budget and revenue composition	Total value	(€)
Local government political cycle		(Years)
Local policies, plans and strategies	Identification of main local strategies, plans and policies.	(-)
Built environment & infrastructures		
Services in the city	Please select all these services available in the city: Water; Wastewater; Stormwater; Waste; Energy (Electricity); Mobility. If mobility is selected, select all available in the city: Road; Train; Water; Air; Other.	(-)
Other energy public service(s)	Specify whether the city has other energy public service(s) than electrical energy. E.g. gas, liquid fuel, solid fuel.	(-)
Protected areas	Please select the types of protected areas in the city: Ecologically or sensitive protected areas; Cultural or historical heritage protected areas.	(-)
Protective infrastructures	Please indicate relevant protective infrastructures existing in the city. Protective infrastructures such as sea walls, levees and flood barriers, shelters such as tornado/hurricane shelters.	(-)
Ecosystem services	Please indicate relevant ecosystem services available in the city. Functions or ecosystem services such as mitigation of flooding, heat waves and landslides, provision of food, water, raw material or medicinal resources, habitat services, carbon sequestration, air regulation, pollination, aesthetic value, mental and physical health benefits, cultural services, heat attenuation, food growing and fuel.	(-)
Assessment scope		
Area under assessment	Please specify: Metropolitan area; Urban area; Other - specify.	(-)
Climate change scenarios under assessment	Most probable. Insert the scenarios (hazards) that are being considering in the assessment, according to the most probable climate scenarios from the scenarios section	(-)
	Most severe. Insert the scenarios (hazards) that are being considering in the assessment, according to the most severe climate scenarios from the scenarios section	(-)
In the RAF metrics related broadly to climate change scenarios, the city should identify (in comments) the scenario considered in the answers (most probable/most severe).		

5.2.3. Services profile

5.2.3.1. Common profile

Each service profile has a first part of the characterization where the type of information required is identical to all services (Table 5). This part is followed by the specific metrics applicable to each service.

Table 5 – Resilience assessment framework: service profile – first part common to all services

SERVICE PROFILE		
Theme Identification | description		Units
Context characterization		
Number of utilities	Number of utilities providing the service to the entire area under assessment.	(No.)
Service relations between utilities	Select all applicable: They serve different populations/areas; They provide complementary services for the same population/area; They provide the service to another utility under a protocol/contract; They are in concurrence in the same area.	(-)
Identification of the utility	Name. (Utility 1, Utility 2, … Utility i).	(-)
Contracts duration	Range of contracts duration. (Utility 1, Utility 2, … Utility i)	(years)
Developed activities	Brief description of the activities developed by the utilities. (Utility 1, Utility 2, … Utility i)	(-)
Description of the area covered by services:		
Identification of the served areas	(Utility 1, Utility 2, … Utility i)	
Area	(Utility 1, Utility 2, … Utility i)	(km^2)
Inhabitants	(Utility 1, Utility 2, … Utility i)	(No.)
Other relevant information	(Utility 1, Utility 2, … Utility i)	
Environmental characterization (annual values):		
Energy consumption	Please specify the total energy consumption for the provision of the service. If relevant, distribute the largest consumptions by activities/processes. (Utility 1, Utility 2, … Utility i)	(kWh)
Greenhouse gas emissions	Please specify the total greenhouse gas emissions for the provision of the service. If relevant, distribute the largest emissions by activities/processes. (Utility 1, Utility 2, … Utility i)	($kgCO_2$/ton)
Sensitive customers	Please specify the type and number of sensitive customers. Sensitive customers are e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management.	(-)
Climate		
Climate-related hazards	Please indicate significant hazards, and the year of last serious occurrence for each case. Select all applicable: Flooding; Drought; Heat wave; Cold wave; Wind storm; Combined Sewer Overflow (CSO); Other - specify.	(-)
<u>Scenarios</u> Most probable scenario characteristics	Please indicate the characteristics of the most probable scenario for the relevant hazards, with the variables described in city profile. Value description: E.g. rainfall in mm, in the precipitation scenario that caused flooding. For each of the applicable scenarios, provide: - the Reference (MP1, MP2,... MPi); - the Hazard (Flooding; Drought; Heat wave; Cold wave; Wind storm; Combined Sewer Overflow (CSO); Other - specify); - the Variable (Temperature; Rainfall; Snowfall; Wind; Sea level; Other); - the Value description and - Comments.	(-)

SERVICE PROFILE		
Theme Identification | description		Units
Most severe scenario characteristics	Please indicate the characteristics of the most severe scenario for the relevant hazards, with the variables described in city profile. For each of the applicable scenarios, provide: - the Reference (MS1, MS2,... MSi); - the Hazard (Flooding; Drought; Heat wave; Cold wave; Wind storm; Combined Sewer Overflow (CSO); Other - specify); - the Variable (Temperature; Rainfall; Snowfall; Wind; Sea level; Other); - the Value description and - Comments.	
Assessment scope		
Area under assessment	Please specify: Metropolitan area; Urban area; Other - specify.	(-)
Climate change scenarios under assessment	Most probable. Insert the scenarios (hazards) that are being considering in the assessment, according to the most probable climate scenarios from the scenarios section	(-)
	Most severe. Insert the scenarios (hazards) that are being considering in the assessment, according to the most severe climate scenarios from the scenarios section	(-)
In the RAF, metrics related broadly to climate change scenarios, the service should identify (in comments) the scenario considered in the answers (most probable/most severe).		

5.2.3.2. Water specific

The service specific information requested for the characterization of the water service profile is presented in Table 6. In cities where the service is provided by more than one utility, the information needs to be filled for each utility. In these cases it is indicated in the table by "(Utility 1, Utility 2, … Utility i)".

Table 6 – Resilience assessment framework: service profile – water

WATER SERVICE PROFILE		
		Units
Total length of conduits	(Utility 1, Utility 2, … Utility i)	(km)
Groundwater abstractions in the city	(Utility 1, Utility 2, … Utility i)	(No.)
Surface water abstractions in the city	(Utility 1, Utility 2, … Utility i)	(No.)
Pumping stations in the city	(Utility 1, Utility 2, … Utility i)	(No.)
Water treatment plants in the city/metropolitan area	(Utility 1, Utility 2, … Utility i)	(No.)
Water storage tanks in the city	(Utility 1, Utility 2, … Utility i)	(No.)
Rechlorination stations in the city	(Utility 1, Utility 2, … Utility i)	(No.)
Other relevant facilities in the city/metropolitan area	(Utility 1, Utility 2, … Utility i)	(No.)

5.2.3.3. Wastewater specific

The service specific information that is requested for the characterization of the wastewater service profile is presented in Table 7. In cities where the service is

provided by more than one utility, the information needs to be filled for each utility. In these cases it is indicated in the table by "(Utility 1, Utility 2, … Utility i)".

Table 7 – Resilience assessment framework: service profile – wastewater

WASTEWATER SERVICE PROFILE		
		Units
Total length of separate domestic sewers	(Utility 1, Utility 2, … Utility i)	(km)
Total length of combined sewers	(Utility 1, Utility 2, … Utility i)	(km)
Pumping stations in the city	(Utility 1, Utility 2, … Utility i)	(No.)
Wastewater treatment plants in the city/metropolitan area	(Utility 1, Utility 2, … Utility i)	(No.)
Small collective systems of treatment	(Utility 1, Utility 2, … Utility i)	(No.)
Marine outfalls in the city/metropolitan area	(Utility 1, Utility 2, … Utility i)	(No.)
Combined sewer overflows	(Utility 1, Utility 2, … Utility i)	(No.)
Other relevant facilities in the city/metropolitan area	(Utility 1, Utility 2, … Utility i)	(No.)

5.2.3.4. Stormwater specific

The service specific information that is requested for the characterization of the stormwater service profile is presented in Table 8. In cities where the service is provided by more than one utility, the information needs to be filled for each utility. In these cases it is indicated in the table by "(Utility 1, Utility 2, … Utility i)".

Table 8 – Resilience assessment framework: service profile – stormwater

STORMWATER SERVICE PROFILE		
		Units
Total length of separate stormwater sewers	(Utility 1, Utility 2, … Utility i)	(km)
Total length of combined sewers	(Utility 1, Utility 2, … Utility i)	(km)
Pumping stations in the city	(Utility 1, Utility 2, … Utility i)	(No.)
Stormwater treatment plants in the city/metropolitan area	(Utility 1, Utility 2, … Utility i)	(No.)
SUDS/LIDs components in the city/metropolitan area	(Utility 1, Utility 2, … Utility i)	(No.)
Marine outfalls in the city/metropolitan area	(Utility 1, Utility 2, … Utility i)	(No.)
Combined sewer overflows	(Utility 1, Utility 2, … Utility i)	(No.)
Other relevant facilities in the city/metropolitan area	(Utility 1, Utility 2, … Utility i)	(No.)

5.2.3.5. Waste specific

The service specific information that is requested for the characterization of the waste service profile is presented in Table 9. In cities where the service is provided by more than one utility, the information needs to be filled for each utility. In these cases it is indicated in the table by "(Utility 1, Utility 2, … Utility i)".

Table 9 – Resilience assessment framework: service profile – waste

WASTE SERVICE PROFILE		
		Units
Waste containers (specify the number by type and capacity of the containers)	(Utility 1, Utility 2, … Utility i)	(No.)
Installed capacity of waste containers	(Utility 1, Utility 2, … Utility i)	(m^3)
Waste collection vehicles	(Utility 1, Utility 2, … Utility i)	(No.)
Installed capacity of waste collection vehicles	(Utility 1, Utility 2, … Utility i)	(m^3/year)
Length travelled by the collection vehicles	(Utility 1, Utility 2, … Utility i)	(km)
Household waste recycling centres	(Utility 1, Utility 2, … Utility i)	(No.)
Transfer stations (selection plants)	(Utility 1, Utility 2, … Utility i)	(No.)
Composting plants in the city/metropolitan area	(Utility 1, Utility 2, … Utility i)	(No.)
Incinerators in the city/metropolitan area	(Utility 1, Utility 2, … Utility i)	(No.)
Sanitary landfills in the city/metropolitan area	(Utility 1, Utility 2, … Utility i)	(No.)
Includes management of hazardous waste (yes/no)	(Utility 1, Utility 2, … Utility i)	(-)
Other types of disposal sites	(Utility 1, Utility 2, … Utility i)	(-)

5.2.3.6. Energy

The information service specific that is requested for the characterization of the energy service profile is presented in Table 10. In cities where the service is provided by more than one utility, the information needs to be filled for each utility. In these cases it is indicated in the table by "(Utility 1, Utility 2, … Utility i)".

Table 10 – Resilience assessment framework: service profile – energy

ENERGY SERVICE PROFILE		
		Units
Total length of the aerial HT distribution network	(Utility 1, Utility 2, … Utility i)	(km)
Total length of the aerial MT distribution network	(Utility 1, Utility 2, … Utility i)	(km)
Total length of the aerial LT distribution network	(Utility 1, Utility 2, … Utility i)	(km)
Total length of the subterranean HT distribution network	(Utility 1, Utility 2, … Utility i)	(km)
Total length of the subterranean MT distribution network	(Utility 1, Utility 2, … Utility i)	(km)
Total length of the subterranean LT distribution network	(Utility 1, Utility 2, … Utility i)	(km)
Power stations in the city/metropolitan area	(Utility 1, Utility 2, … Utility i)	(No.)
Power substations in the city	(Utility 1, Utility 2, … Utility i)	(No.)
Transformers in the city	(Utility 1, Utility 2, … Utility i)	(No.)
Installed power in the city	(Utility 1, Utility 2, … Utility i)	(MVA)

5.2.3.7. Mobility

The service specific information that is requested for the characterization of the mobility service profile is presented in Table 11. In cities where the service is provided by more than one utility, the information needs to be filled for each utility. In these cases it is indicated in the table by "(Utility 1, Utility 2, … Utility i)".

Table 11 – Resilience assessment framework: service profile – mobility

MOBILITY SERVICE PROFILE			
	Explanations		Units
Total length of the road network in the city	Specify. If the assessment does not apply to the total network, please specify the network considered (e.g., the primary network, first order network, ...)	(Utility 1, Utility 2, … Utility i)	(km)
Density of the road network in the city	Specify. If the assessment does not apply to the total network, please specify the network considered (e.g., the primary network, first order network, ...)	(Utility 1, Utility 2, … Utility i)	(km/m^2)
Total length of the train network in the city	Specify. If the assessment does not apply to the total network, please specify the network considered (e.g., the primary network, first order network, ...)	(Utility 1, Utility 2, … Utility i)	(km)
Total length of the subway (metro) network in the city	Specify. If the assessment does not apply to the total network, please specify the network considered (e.g., the primary network, first order network, ...)	(Utility 1, Utility 2, … Utility i)	(km)
Total length of the bus network in the city (bus routes)	Specify. If the assessment does not apply to the total network, please specify the network considered (e.g., the primary network, first order network, ...)	(Utility 1, Utility 2, … Utility i)	(km)
Total length of cycling network in the city	Specify. If the assessment does not apply to the total network, please specify the network considered (e.g., the primary network, first order network, ...)	(Utility 1, Utility 2, … Utility i)	(km)
Total length of other transport network in the city	Specify. If the assessment does not apply to the total network, please specify the network considered (e.g., the primary network, first order network, ...)	(Utility 1, Utility 2, … Utility i)	(km)
Number of airports inside the city		(Utility 1, Utility 2, … Utility i)	(No.)
Total number of passengers handled by all airports inside the city		(Utility 1, Utility 2, … Utility i)	(No./year)
Number of airports in the city metropolitan area		(Utility 1, Utility 2, … Utility i)	(No.)
Total number of passengers handled by all airports in the city metropolitan area		(Utility 1, Utility 2, … Utility i)	(No./year)
Total number of multi-modal transport interfaces in the city		(Utility 1, Utility 2, … Utility i)	(No.)
Total number of train interfaces in the city		(Utility 1, Utility 2, … Utility i)	(No.)
Total number of subway (metro) interfaces in the city		(Utility 1, Utility 2, … Utility i)	(No.)
Total number of bus interfaces in the city	Short-distance bus interfaces	(Utility 1, Utility 2, … Utility i)	(No.)
Total number of coach interfaces in the city	Long-distance bus interfaces	(Utility 1, Utility 2, … Utility i)	(No.)
Total number of water-based interfaces in the city		(Utility 1, Utility 2, … Utility i)	(No.)

MOBILITY SERVICE PROFILE			
	Explanations		Units
Total number of other transport interfaces in the city	Please specify.	(Utility 1, Utility 2, … Utility i)	(No.)
Mobility services in the city that are assessed in this framework	Please select all applicable: • Road • Train • Water • Air • Other (specify)	(-)	(-)

5.3. Organisational dimension

As described in 4.2, the **organisational** dimension integrates top-down governance relations and urban population involvement, at the city level. In this dimension, resilience objectives aim to ensure that the city is adequately organised, particularly regarding climate change and water focus aspects.

The first objective addressed is the appropriate collective citizen and communities engagement and awareness with focus on Disaster Risk Reduction (DRR), namely in pre-event planning and post-event response from several groups, including NGOs and vulnerable groups such as the elderly, disabled, children, non-native language s speakers (UNISDR, 2017a,b). It also considers whether different engagement techniques are in place, such as social media, radio, newspaper, mobile devices and e-mail to citizens. Another concern included is to ensure that campaigns, training and drills reach the public.

This dimension also reports the leadership and management in the city considering different perspectives. It includes the government decision-making and finance, looking particularly at the planning process, how is promoted the coordination and communication with stakeholders, what is the level of engagement of the city regarding resilience, mostly through planning and by including relevant resilience aspects. These aspects include hazard assessment and risk, interdependencies of the city with utility services' providers and regional agencies, climate change and resilience scenarios, integration of resilience with other key city functions (e.g. planning, finance, emergency management), data sharing, critical infrastructures, understanding of the cascading impacts between the city and services' infrastructures and learning and knowledge sharing with other cities.

The city preparedness is another objective considered. This regards not only the preparedness to everyday life, by considering availability and access in the city to basic services, herein considered only those within the RESCCUE focus (water, wastewater, waste, energy and mobility), but also the preparedness to overall disaster response, recovery and build-back and specifically to climate change.

Table 12 presents the organisational dimension, according to the RAF structure (see section 4.1), and PI are presented in detail in Annex 1.

Table 12 – Resilience assessment framework: organisational dimension

OBJECTIVE Criterion PI		PI unit[3]
Obj.O1- COLLECTIVE ENGAGEMENT AND AWARENESS		
Citizens and communities engagement		
O01	Community or "grassroots" organizations, networks and training	(-)
O02	Civil society links	(-)
O03	Engagement of vulnerable groups of the population	(-)
O04	Citizen engagement techniques	(-)
O05	Use of mobile and e-mail "systems of engagement" to enable citizens to receive and give updates before and after a disaster	(-)
Citizens and communities awareness and training		
O06	Public education and awareness	(-)
O07	Training delivery	(-)
O08	Drills	(-)
O09	Social networks	(-)
O10	Validation of effectiveness of education	(-)
Obj.O2 - LEADERSHIP AND MANAGEMENT		
Government decision-making and finance		
O11	Consultative planning process	(-)
O12	Planning approval process	(-)
O13	Public finances	(-)
O14	Financial plan and budget for resilience, including contingency funds	(-)
Coordination and communication with stakeholders		
O15	Co-ordination with other government bodies	(-)
O16	Multi-stakeholder collaboration	(-)
O17	Access and use of digital services	(-)
O18	Collaboration mechanisms	(-)
Resilience engaged city		
O19	City Master Plan making and implementation	(-)
O20	City Master Plan monitoring and review	(-)
O21	Hazard Assessment	(-)
O22	Damage and loss estimation	(-)
O23	Shared understanding of infrastructure risk	(-)
O24	Plan for resilience	(-)
O25	Plan for resilience and Climate Change	(-)
O26	Plan integration in the City Master Plan	(-)
O27	External support for the resilience plan	(-)
O28	Robustness of resilience plan	(-)
O29	Resilience Plan monitoring and review	(-)

[3] (-) means without unit or dimensionless

OBJECTIVE Criterion PI		PI unit[3]
O30	Knowledge of resilience scenarios	(-)
O31	Data sharing	(-)
O32	Integration	(-)
O33	Organization, coordination and participation	(-)
O34	Critical infrastructure as a priority	(-)
O35	Critical infrastructure plan overview	(-)
O36	Cascading impacts	(-)
O37	Learning from others	(-)
Obj.O3 - CITY PREPAREDNESS		
City preparedness for disaster response		
O38	Early warning	(-)
O39	Reach of warning	(-)
O40	Communications	(-)
O41	Event management plans	(-)
O42	Staffing / responder needs	(-)
O43	Equipment and relief supply needs	(-)
O44	Definition of human resources, equipment and supply needs, and availability of equipment	(-)
O45	Existence of agreements	(-)
O46	Health care	(-)
O47	Food, shelter, staple goods and fuel supply	(-)
O48	Interoperability and interagency working	(-)
O49	Existence of civil society focal points for citizens	(-)
O50	Social connectedness and neighbourhood cohesion	(%)
City preparedness for climate change		
O51	Management plans for climate-related events	(-)
O52	Implementation of management plans for climate-related events	(-)
O53	Management plans for climate-related events monitoring and review	(-)
O54	Knowledge of exposure and vulnerability for climate change scenarios	(-)
O55	City status when addressing contribution to climate change	(-)
O56	City commitment with mitigation of climate change effects	(%)
O57	Planning for mitigation of climate change effects	(-)
City preparedness for recovery and build back		
O58	Post event recovery planning – pre event	(-)
O59	Coordination of post event recovery	(-)
O60	Lessons learnt	(-)
O61	Learning loops	(-)
O62	Insurance	(-)
O63	Damage and loss post-event assessment	(-)
O64	Current post-event assessment system	(-)
Availability and access to basic services		
O65	Water supply	(%)
O66	Wastewater collection	(%)

OBJECTIVE Criterion PI		PI unit[3]
O67	Wastewater treatment	(-)
O68	Urban waste collection	(%)
O69	Urban waste treatment	(-)
O70	Urban electrical energy network	(%)
O71	Urban electrical energy alternative source	(%)
072	Urban gas energy network	(%)
O73	Urban mobility accessing collective transportation	(%)
O74	Urban cycling mobility	(-)

5.4. Spatial dimension

As described in section 4.2, the **spatial** dimension refers to the urban space and environment, at the city level. In this dimension, resilience objectives aim to ensure that the city space is managed adequately, particularly regarding climate change and water focus aspects.

The first objective addressed is the appropriate spatial risk management, namely regarding the general hazard and exposure mapping existence and updating, considering risk scenarios and damage and loss consequences. It also includes hazard and exposure of population, urban footprint and economic activities to climate change as well as the knowledge of these impacts caused by climate-related events. An additional concern included is to ensure a resilient urban development by adopting instruments such as land use and zoning, building codes and resilient design solutions.

The provision of protective infrastructures and ecosystems is another objective addressed, particularly regarding best practices in design, construction and maintenance of protective infrastructures, adequate identification of ecosystems and of their services (e.g. as mitigation of flooding, heat waves and landslides, provision of food), their proper maintenance as well as promotion of green and blue areas on urban developments. It also includes the knowledge on the dependence and autonomy of these infrastructures and ecosystems regarding other services considering climate change and if these are identified in transboundary agreements, if they exist, for their protection and management.

Table 13 presents the spatial dimension, according to the RAF structure (see section 4.1), and PI are presented in detail in Annex 1.

Table 13 – Resilience assessment framework: spatial dimension

OBJECTIVE Criterion PI		PI unit
Obj.S1 - SPATIAL RISK MANAGEMENT		
General hazard and exposure mapping		
S01	Presentation process for risk information	(-)
S02	Update process for risk information	(-)
S03	Knowledge of exposure and vulnerability	(-)
S04	Scenarios and update process for risk information	(-)
S05	Damage and loss estimation	(-)
Hazard and exposure for climate change		
S06	Potential population at risk of displacement for climate change scenarios	(-)
S07	Urban footprint at risk for climate change scenarios	(-)
S08	Economic activity at risk for climate change scenarios	(-)
Resilient urban development		
S09	Land use zoning and planning	(-)
S10	Land use plan monitoring and review	(-)
S11	Land use zoning implementation	(-)
S12	New urban development	(-)
S13	Urban design solutions that increase resilience	(-)
S14	Building codes and standards	(-)
S15	Application of building codes	(-)
Impacts of climate-related event		
S16	Human loss in the last events	(-)
S17	Damages in urban footprint in the last events	(%)
Obj.S2 - PROVISION OF PROTECTIVE INFRASTRUCTURES AND ECOSYSTEMS		
Protective infrastructures and ecosystems services		
S18	Existing protective infrastructure	(-)
S19	New protective infrastructure	(-)
S20	Maintenance of protective infrastructure	(-)
S21	Awareness and understanding of ecosystem services / functions	(-)
S22	Awareness of the role that assets that provide ecosystem services play in the city's resilience	(-)
S23	Trends in ecosystem services health	(-)
S24	Maintenance of ecosystem services	(-)
S25	Availability of green and blue infrastructures	(m^2/inhabitant)
S26	Integration of green and blue infrastructure into city policy and projects	(-)
Dependence and autonomy regarding other services considering climate change		
S27	Critical services dependence of protective infrastructures and ecosystems under climate change scenarios	(-)
S28	Autonomy from other services under climate change scenarios	(-)
S29	Transboundary environmental issues	(-)

5.5. Functional dimension

5.5.1. General

As described in 4.2, the **functional** dimension refers to the strategic urban services considered in the RAF, i.e. water, wastewater, stormwater, waste, electrical energy and mobility. In this dimension, the resilience objectives aim to ensure that the services are appropriately planned and managed, their autonomy is guaranteed and they are prepared for CC challenges. This dimension also allows knowing the contribution of each service to city's resilience. The infrastructural aspect, which is assessed in the physical dimension (section 5.6), complements the assessment.

A service is managed appropriately when strategic planning is effective, it exchanges information, aligns with the city master plan and complies with land use zoning. Furthermore, it is engaged with resilience when planning considers resilience objectives and climate change, has a budget allocated, a business continuity plan, and coordinates with and learns from other organizations providing the same service. Besides, the service planning includes risk management, damage and loss estimation is in place, and the service impacts from climate-related hazards are known and planned for CC scenarios. Additionally, the service is flexible, appropriately managed and its everyday quality of service (evaluated through a recent one-year service assessment) is adequate.

An autonomous service acknowledges its importance to the city, namely through its stakeholders perception and the cascading effects with others. Besides, the other services have minor dependence on it and it has major autonomy from other services.

A service is prepared when it has planned for its disaster response, there is an emergency operation centre, early warning systems are operational and drills are carried out. A prepared service is committed with mitigation of CC effects; it knows the exposure of others due to expected service failure for climate-related hazards, and plans for CC scenarios. Besides, several measures to prepare, mitigate and respond to CC are both implemented and envisaged and adequate resources are provided. Additionally, the service plans for recovery, it has a system in place to provide post-disaster needs assessment and records on service recovery and build back, after an historical severe climate-related event, and it considers learning loops as well as insurance.

The functional dimension is to be applied to each urban service under assessment. In case of combined sewer systems, both wastewater and stormwater services need to be answered, for the applicable metrics, and those metrics that are not applicable have to be duly identified. While the same objectives apply to all the services, some metrics are tailored to each service specificities. The following sections, from 5.5.2 to 5.5.7, present the list of metrics considered in the RAF functional dimension, for each service. Annex 1 presents a detailed description of the metrics, including the pre-defined set of answers.

5.5.2. Water

The application of the functional resilience assessment to the water service is specifically tailored with regard to service reliability (namely concerning water losses) and to service flexibility (concerning water uses and water sources). Another specific aspect that is more emphasised in this sub-dimension is the water quality that crosses several criteria, namely risk management, reliable service and service preparedness for recovery and build back. The objectives, assessment criteria and metrics for the water service are indicated in Table 14.

Table 14 – Resilience assessment framework: functional dimension for the Water Service

OBJECTIVE Criterion PI		PI unit
Obj.FW1 - WATER SERVICE PLANNING AND RISK MANAGEMENT		
Strategic planning		
FWts01	Water service strategic plan making and implementation	(-)
FWts02	Plan alignment with the City Master Plan	(-)
FWts03	Service plan monitoring and review	(-)
FWts04	Exchange of information to the city	(-)
FWts05	Land use zoning compliance	(-)
Resilience engaged service		
FWts06	Resilience in water service strategy and alignment with City Master Plan	(-)
FWts07	Service strategic plan for resilience and CC	(-)
FWts08	Service financial plan and budget for resilience	(-)
FWts09	Water service business continuity	(-)
FWts10	Co-ordination with other water services in the city	(-)
FWts11	Learning from other water services	(-)
Risk management		
FWts12	Risk information related to the water service	(-)
FWts13	Damage and loss estimation	(-)
FWts14	Expected water supply interruptions, not caused by water quality problems, in the city area according to CC scenarios	(% city area)
FWts15	Expected water supply interruptions caused by water quality problems, in the city area according to CC scenarios	(% city area)
FWts16	Expected water supply interruptions, not caused by water quality problems, for sensitive customers according to CC scenarios	(% sensitive customers)
FWts17	Expected water supply interruptions caused by water quality problems, for sensitive customers according to CC scenarios	(% sensitive customers)
FWts18	Expected water supply interruptions, not caused by water quality problems, for other services according to CC scenarios	(% customers other services)
FWts19	Expected water supply interruptions caused by water quality problems, for other services according to CC scenarios	(% customers other services)
FWts20	Expected water supply interruptions, not caused by water quality problems, for households according to CC scenarios	(% households)
FWts21	Expected water supply interruptions caused by water quality problems, for households according to CC scenarios	(% households)
FWts22	Expected total duration of water supply interruption, not caused by water quality problems, according to CC scenarios	(Days)
FWts23	Expected total duration of water supply interruption, caused by water quality problems, according to CC scenarios	(Days)
Reliable service		

OBJECTIVE Criterion PI		PI unit
FWts24	Water supply interruptions, not caused by water quality problems, in the city area last year	(% city area)
FWts25	Water supply interruptions caused by water quality problems, in the city area last year	(% city area)
FWts26	Water supply interruptions, not caused by water quality problems, for sensitive customers last year	(% sensitive customers)
FWts27	Water supply interruptions caused by water quality problems, for sensitive customers last year	(% sensitive customers)
FWts28	Water supply interruptions, not caused by water quality problems, for other services last year	(% customers other services)
FWts29	Water supply interruptions caused by water quality problems, for other services last year	(% customers other services)
FWts30	Water supply interruptions, not caused by water quality problems, for households last year	(% households)
FWts31	Water supply interruptions caused by water quality problems, for households last year	(% households)
FWts32	Total duration of water supply interruption, not caused by water quality problems, last year	(Days)
FWts33	Total duration of water supply interruption, caused by water quality problems, last year	(Days)
FWts34	Water losses last year	(m^3/(km.day))
Flexible service		
FWts35	Water uses	(% drinking water)
FWts36	Water sources	(-)
FWts37	Water sources location	(-)
FWts38	Service management	(-)
Obj.FW2 - AUTONOMOUS WATER SERVICE		
Service importance to the city		
FWts39	Stakeholders perception	(-)
FWts40	Cascading impacts	(-)
Service inter-dependency with other services considering climate change		
FWts41	Critical services dependence on water service according to CC scenarios	(-)
FWts42	Water services autonomy from other critical services according to CC scenarios	(-)
Obj.FW3 - WATER SERVICE PREPAREDNESS		
Service preparedness for disaster response		
FWts43	Water service event management plans	(-)
FWts44	Water services interdepartmental collaboration for emergency	(-)
FWts45	Water services early warning	(-)
FWts46	Water service drills	(-)
Service preparedness for climate change		
FWts47	Service commitment with mitigation of CC effects	(% reduction GHG)
FWts48	Existence of agreed CC scenarios and alignment with the city CC scenarios	(-)
FWts49	Knowledge of exposure and service vulnerability for CC scenarios	(-)
FWts50	Service planning for adaptation to CC	(-)
FWts51	Implemented measures to address CC mitigation and adaptation	(-)
FWts52	Planned measures to address CC mitigation and adaptation	(-)
FWts53	Equipment capacity of the service	(-)
FWts54	Staffing capacity of the service	(-)

OBJECTIVE Criterion PI		PI unit
Service preparedness for recovery and build back		
FWts55	Water service CC recovery planning	(-)
FWts56	Water service damage and loss post-event assessment	(-)
FWts57	Current post-event assessment system	(-)
FWts58	Water supply interruption, not caused by water quality problems, in the city area in the last relevant climate-related event	(% city area)
FWts59	Water supply interruptions caused by water quality problems, in the city area, in the last relevant climate-related event	(% city area)
FWts60	Water supply interruptions, not caused by water quality problems, for sensitive customers in the last relevant climate-related event	(% sensitive customers)
FWts61	Water supply interruptions caused by water quality problems, for sensitive customers in the last relevant climate-related event	(% sensitive customers)
FWts62	Water supply interruptions, not caused by water quality problems, for other services in the last relevant climate-related event	(% customers other services)
FWts63	Water supply interruptions caused by water quality problems, for other services in the last relevant climate-related event	(% customers other services)
FWts64	Water supply interruptions, not caused by water quality problems, for households in the last relevant climate-related event	(% households)
FWts65	Water supply interruptions caused by water quality problems, for households in the last relevant climate-related event	(% households)
FWts66	Total duration of water supply interruption, caused by water quality problems, in the last relevant climate-related event	(Days)
FWts67	Total duration of water supply interruption, caused by water quality problems in the last relevant climate-related event	(Days)
FWts68	Water service lessons learnt and learning loops	(-)
FWts69	Insurance	(-)

5.5.3. Wastewater

The application of the functional resilience assessment to the wastewater service is tailored with regard to service reliability (namely concerning undue inflows) and to service flexibility (concerning treated wastewater uses and wastewater disposal). Another specific aspect that is more emphasised in this sub-dimension is the wastewater discharge that crosses several criteria, namely risk management, reliable service and service preparedness for recovery and build back. The objectives, assessment criteria and metrics for the wastewater service are indicated in Table 15.

Table 15 – Resilience assessment framework: functional dimension for Wastewater Service

OBJECTIVE Criterion PI		PI unit
Obj.FWW1 - WASTEWATER SERVICE PLANNING AND RISK MANAGEMENT		
Strategic planning		
FWwt01	Wastewater service strategic plan making and implementation	(-)
FWwt02	Plan alignment with the City Master Plan	(-)
FWwt03	Service plan monitoring and review	(-)
FWwt04	Exchange of information to the city	(-)
FWwt05	Land use zoning compliance	(-)

OBJECTIVE Criterion PI		PI unit
Resilience engaged service		
FWwt06	Resilience in wastewater service strategy and alignment with City Master Plan	(-)
FWwt07	Service strategic plan for resilience and CC	(-)
FWwt08	Service financial plan and budget for resilience	(-)
FWwt09	Wastewater service business continuity	(-)
FWwt10	Co-ordination with other wastewater services in the city	(-)
FWwt11	Learning from other wastewater services	(-)
Risk management		
FWwt12	Risk information related to the wastewater service	(-)
FWwt13	Damage and loss estimation	(-)
FWwt14	Expected wastewater flooding in the city area according to CC scenarios	(% city area)
FWwt15	Expected wastewater treatment failures in the city area according to CC scenarios	(% city area)
FWwt16	Expected wastewater flooding in sensitive customers according to CC scenarios	(% sensitive customers)
FWwt17	Expected wastewater discharges, due to failure in wastewater service to ecosystem services according to CC scenarios	(-))
FWwt18	Expected wastewater flooding in other services according to CC scenarios	(% customers other services)
FWwt19	Expected wastewater flooding in households according to CC scenarios	(% households)
FWwt20	Expected total duration of wastewater flooding period according to CC scenarios	(Days)
FWwt21	Expected total duration of wastewater treatment failure period according to CC scenarios	(Days)
Reliable service		
FWwt22	Wastewater flooding in the city area last year	(% city area)
FWwt23	Wastewater treatment failures in the city area in the city area last year	(% city area)
FWwt24	Wastewater flooding in sensitive customers last year	(% sensitive customers)
FWwt25	Wastewater discharges, due to failure in wastewater service, to ecosystem services last year	(-)
FWwt26	Wastewater flooding in other services last year	(% customers other services)
FWwt27	Wastewater effective treatment in the city area last year	(%)
FWwt28	Wastewater flooding in households last year	(% households)
FWwt29	Total duration of wastewater flooding period last year	(Days)
FWwt30	Total duration of wastewater treatment failure period last year	(Days)
FWwt31	Estimated undue inflows into wastewater system last year	(m^3/(km.day))
Flexible service		
FWwt32	Treated wastewater uses	(% treated wastewater)
FWwt33	Wastewater disposal	(-)
FWwt34	Wastewater disposal location	(-)
FWwt35	Service management	(-)
Obj.FWW2 - AUTONOMOUS WASTEWATER SERVICE		
Service importance to the city		
FWwt36	Stakeholders perception	(-)
FWwt37	Cascading impacts	(-)
Service inter-dependency with other services considering climate change		

OBJECTIVE Criterion PI		PI unit
FWwt38	Critical services dependence on wastewater service according to CC scenarios	(-)
FWwt39	Wastewater services autonomy from other critical services according to CC scenarios	(-)
Obj.FWW3 - WASTEWATER SERVICE PREPAREDNESS		
Service preparedness for disaster response		
FWwt40	Wastewater service event management plans	(-)
FWwt41	Wastewater services interdepartmental collaboration for emergency	(-)
FWwt42	Wastewater services early warning	(-)
FWwt43	Wastewater service drills	(-)
Service preparedness for climate change		
FWwt44	Service commitment with mitigation of CC effects	(% reduction GHG)
FWwt45	Existence of agreed CC scenarios and alignment with the city CC scenarios	(-)
FWwt46	Knowledge of exposure and service vulnerability for CC scenarios	(-)
FWwt47	Service planning for adaptation to CC	(-)
FWwt48	Implemented measures to address CC mitigation and adaptation	(-)
FWwt49	Planned measures to address CC mitigation and adaptation	(-)
FWwt50	Equipment capacity of the service	(-)
FWwt51	Staffing capacity of the service	(-)
Service preparedness for recovery and build back		
FWwt52	Wastewater service CC recovery planning	(-)
FWwt53	Wastewater service damage and loss post-event assessment	(-)
FWwt54	Current post-event assessment system	(-)
FWwt55	Wastewater flooding in the city area in the last relevant climate-related event	(% city area)
FWwt56	Wastewater treatment failures in the city area in the last relevant climate-related event	(% city area)
FWwt57	Wastewater flooding in sensitive customers in the last relevant climate-related event	(% sensitive customers)
FWwt58	Wastewater discharges, due to failure in wastewater service, to ecosystem services in the last relevant climate-related event	(-)
FWwt59	Wastewater flooding for other services in the last relevant event	(% customers other services)
FWwt60	Wastewater effective treatment in the city area in the last relevant climate-related event	(%)
FWwt61	Wastewater flooding in households in the last relevant climate-related event	(% households)
FWwt62	Total duration of wastewater flooding period in the last relevant climate-related event	(Days)
FWwt63	Total duration of wastewater treatment failure period in the last relevant climate-related event	(Days)
FWwt64	Wastewater service lessons learnt and learning loops	(-)
FWwt65	Insurance	(-)

5.5.4. Stormwater

The application of the functional resilience assessment to the stormwater service is tailored with regard to service reliability (namely concerning undue inflows) and to service flexibility (concerning treated stormwater uses and stormwater

disposal). The objectives, assessment criteria and metrics for the stormwater service are indicated inTable 16.

Table 16 – Functional resilience assessment framework of the Stormwater Service

OBJECTIVE Criterion PI		PI unit
Obj.FSW1 - STORMWATER SERVICE PLANNING AND RISK MANAGEMENT		
Strategic planning		
FSwt01	Stormwater service strategic plan making and implementation	(-)
FSwt02	Plan alignment with the City Master Plan	(-)
FSwt03	Service plan monitoring and review	(-)
FSwt04	Exchange of information to the city	(-)
FSwt05	Land use zoning compliance	(-)
Resilience engaged service		
FSwt06	Resilience in stormwater service strategy and alignment with City Master Plan	(-)
FSwt07	Service strategic plan for resilience and CC	(-)
FSwt08	Service financial plan and budget for resilience	(-)
FSwt09	Stormwater service business continuity	(-)
FSwt10	Co-ordination with other stormwater services in the city	(-)
FSwt11	Learning from other stormwater services	(-)
Risk management		
FSwt12	Risk information related to the stormwater service	(-)
FSwt13	Damage and loss estimation	(-)
FSwt14	Expected stormwater flooding in the city area according to CC scenarios	(% city area)
FSwt15	Expected stormwater flooding in sensitive customers according to CC scenarios	(% sensitive customers)
FSwt16	Expected stormwater flooding in other services according to CC scenarios	(% customers other services)
FSwt17	Expected stormwater flooding in households according to CC scenarios	(% households)
FSwt18	Expected total duration of stormwater flooding period according to CC scenarios	(Days)
Reliable service		
FSwt19	Stormwater flooding in the city area last year	(% city area)
FSwt20	Stormwater flooding in sensitive customers last year	(% sensitive customers)
FSwt21	Stormwater flooding in other services last year	(% customers other services)
FSwt22	Stormwater flooding in households last year	(% households)
FSwt23	Total duration of stormwater flooding period last year	(Days)
FSwt24	Estimated undue inflows into stormwater system last year	(m^3/(km.day))
Flexible service		
FSwt25	Treated stormwater uses	(% treated stormwater)
FSwt26	Stormwater disposal	(-)
FSwt27	Stormwater disposal location	(-)
FSwt28	Service management	(-)
Obj.FSW2 - AUTONOMOUS STORMWATER SERVICE		
Service importance to the city		
FSwt29	Stakeholders perception	(-)
FSwt30	Cascading impacts	(-)

OBJECTIVE Criterion PI		PI unit
Service inter-dependency with other services considering climate change		
FSwt31	Critical services dependence on stormwater service according to CC scenarios	(-)
FSwt32	Stormwater services autonomy from other critical services according to CC scenarios	(-)
Obj.FSW3 - STORMWATER SERVICE PREPAREDNESS		
Service preparedness for disaster response		
FSwt33	Stormwater service event management plans	(-)
FSwt34	Stormwater services interdepartmental collaboration for emergency	(-)
FSwt35	Stormwater services early warning	(-)
FSwt36	Stormwater service drills	(-)
Service preparedness for climate change		
FSwt37	Service commitment with mitigation of CC effects	(% reduction GHG)
FSwt38	Existence of agreed CC scenarios and alignment with the city CC scenarios	(-)
FSwt39	Knowledge of exposure and service vulnerability for CC scenarios	(-)
FSwt40	Service planning for adaptation to CC	(-)
FSwt41	Implemented measures to address CC mitigation and adaptation	(-)
FSwt42	Planned measures to address CC mitigation and adaptation	(-)
FSwt43	Equipment capacity of the service	(-)
FSwt44	Staffing capacity of the service	(-)
Service preparedness for recovery and build back		
FSwt45	Stormwater service CC recovery planning	(-)
FSwt46	Stormwater service damage and loss post-event assessment	(-)
FSwt47	Current post-event assessment system	(-)
FSwt48	Stormwater flooding in the city area in the last relevant climate-related event	(% city area)
FSwt49	Stormwater flooding in sensitive customers in the last relevant climate-related event	(% sensitive customers)
FSwt50	Stormwater flooding in other services in the last relevant climate-related event	(% customers other services)
FSwt51	Stormwater flooding in households in the last relevant climate-related event	(% households)
FSwt52	Total duration of stormwater flooding in the last relevant climate-related event	(Days)
FSwt53	Stormwater service lessons learnt and learning loops	(-)
FSwt54	Insurance	(-)

5.5.5. Waste

The application of the functional resilience assessment to the waste service is tailored with regard to service reliability (namely concerning undue wastes) and to service flexibility (concerning treated solid waste recovered and solid waste disposal). The objectives, assessment criteria and metrics for the waste service are indicated in Table 17.

Table 17 – Resilience assessment framework: functional dimension for Waste Service

OBJECTIVE Criterion PI		PI unit
Obj.FWT1 - WASTE SERVICE PLANNING AND RISK MANAGEMENT		
Strategic planning		
FSlw01	Waste service strategic plan making and implementation	(-)
FSlw02	Plan alignment with the City Master Plan	(-)
FSlw03	Service plan monitoring and review	(-)
FSlw04	Exchange of information to the city	(-)
FSlw05	Land use zoning compliance	(-)
Resilience engaged service		
FSlw06	Resilience in waste service strategy and alignment with City Master Plan	(-)
FSlw07	Service strategic plan for resilience and CC	(-)
FSlw08	Service financial plan and budget for resilience	(-)
FSlw09	Waste service business continuity	(-)
FSlw10	Co-ordination with other waste services in the city	(-)
FSlw11	Learning from other waste services	(-)
Risk management		
FSlw12	Risk information related to the waste service	(-)
FSlw13	Damage and loss estimation	(-)
FSlw14	Expected solid waste collection interruption in the city area according to CC scenarios	(% city area)
FSlw15	Expected solid waste treatment failure in the city area according to CC scenarios	(% city area)
FSlw16	Expected solid waste collection interruption of sensitive customers according to CC scenarios	(% sensitive customers)
FSlw17	Expected solid waste collection interruption for other services according to CC scenarios	(% customers other services)
FSlw18	Expected solid waste collection interruption in households according to CC scenarios	(% households)
FSlw19	Expected total duration of solid waste collection interruption period according to CC scenarios	(Days)
FSlw20	Expected total duration of solid waste treatment failure period according to CC scenarios	(Days)
Reliable service		
FSlw21	Solid waste collection interruption in the city area last year	(% city area)
FSlw22	Solid waste effective treatment failure in the city area last year	(% city area)
FSlw23	Solid waste collection interruption for sensitive customers last year	(% sensitive customers)
FSlw24	Solid waste collection interruption for other services, last year	(% customers other services)
FSlw25	Solid waste effective treatment in the city area last year	(% safely treated solid waste)
FSlw26	Solid waste collection interruption in households, last year	(% households)
FSlw27	Total duration of solid waste collection interruption period last year	(Days)
FSlw28	Total duration of solid waste treatment failure period last year	(Days)
FSlw29	Estimated undue wastes into solid waste system last year	(-)
Flexible service		
FSlw30	Treated solid waste recovered	(% treated solid waste being recovered)
FSlw31	Solid waste disposal	(-)
FSlw32	Solid waste disposal location	(-)
FSlw33	Service management	(-)

OBJECTIVE Criterion PI		PI unit
Obj.FWT2 - AUTONOMOUS WASTE SERVICE		
Service importance to the city		
FSlw34	Stakeholders perception	(-)
FSlw35	Cascading impacts	(-)
Service inter-dependency with other services considering climate change		
FSlw36	Critical services dependence on solid waste service according to CC scenarios	(-)
FSlw37	Solid waste services autonomy from other critical services according to CC scenarios	(-)
Obj.FWT3 - WASTE SERVICE PREPAREDNESS		
Service preparedness for disaster response		
FSlw38	Solid waste service event management plans	(-)
FSlw39	Solid waste services interdepartmental collaboration for emergency	(-)
FSlw40	Solid waste services early warning	(-)
FSlw41	Solid waste service drills	(-)
Service preparedness for climate change		
FSlw42	Service commitment with mitigation of CC effects	(% reduction GHG)
FSlw43	Existence of agreed CC scenarios and alignment with the city CC scenarios	(-)
FSlw44	Knowledge of exposure and service vulnerability for CC scenarios	(-)
FSlw45	Service planning for adaptation to CC	(-)
FSlw46	Implemented measures to address CC mitigation and adaptation	(-)
FSlw47	Planned measures to address CC mitigation and adaptation	(-)
FSlw48	Equipment capacity of the service	(-)
FSlw49	Staffing capacity of the service	(-)
Service preparedness for recovery and build back		
FSlw50	Solid waste service CC recovery planning	(-)
FSlw51	Solid waste service damage and loss post-event assessment	(-)
FSlw52	Current post-event assessment system	(-)
FSlw53	Solid waste collection interruption in the city area in the last relevant climate-related event	(% city area)
FSlw54	Solid waste effective treatment failure in the city area in the last relevant climate-related event	(% city area)
FSlw55	Solid waste collection interruption in sensitive customers in the last relevant climate-related event	(% sensitive customers)
FSlw56	Solid waste collection interruption for other services in the last relevant climate-related event	(% customers other services)
FSlw57	Solid waste effective treatment in the city area in the last relevant climate-related event	(% solid waste safely treated)
FSlw58	Solid waste collection interruption in households in the last relevant climate-related event	(% households)
FSlw59	Total duration of solid waste collection interruption in the last relevant climate-related event	(Days)
FSlw60	Total duration of solid waste treatment failure in the last relevant climate-related event	(Days)
FSlw61	Solid waste service lessons learnt and learning loops	(-)
FSlw62	Insurance	(-)

5.5.6. Energy

The application of the functional resilience assessment to the energy service is tailored with regard to service reliability (referring to energy outage and energy losses) and to service flexibility (concerning energy sources and the use of renewable energy). The objectives, assessment criteria and metrics for the energy service are indicated in Table 18.

Table 18 – Resilience assessment framework: functional dimension for the Energy Service

OBJECTIVE Criterion PI		PI unit
Obj.FE1 - ENERGY SERVICE PLANNING AND RISK MANAGEMENT		
Strategic planning		
FEne01	Energy service strategic plan making and implementation	(-)
FEne02	Plan alignment with the City Master Plan	(-)
FEne03	Service plan monitoring and review	(-)
FEne04	Exchange of information to the city	(-)
FEne05	Land use zoning compliance	(-)
Resilience engaged service		
FEne06	Resilience in energy service strategy and alignment with City Master Plan	(-)
FEne07	Service strategic plan for resilience and CC	(-)
FEne08	Service financial plan and budget for resilience	(-)
FEne09	Energy service business continuity	(-)
FEne10	Co-ordination with other energy services in the city	(-)
FEne11	Learning from other energy services	(-)
Risk management		
FEne12	Risk information related to the energy service	(-)
FEne13	Damage and loss estimation	(-)
FEne14	Expected energy outage in the city area according to CC scenarios	(% city area)
FEne15	Expected energy outage for sensitive customers according to CC scenarios	(% sensitive customers)
FEne16	Expected energy outage for other services according to CC scenarios	(% customers other services)
FEne17	Expected energy outage for households according to CC scenarios	(% households)
FEne18	Expected total duration of energy outage period according to CC scenarios	(Days)
Reliable service		
FEne19	Energy outage in the city area last year	(% city area)
FEne20	Energy outage for sensitive customers last year	(% sensitive customers)
FEne21	Energy outage for other services last year	(% customers other services)
FEne22	Energy outage in households last year	(% households)
FEne23	Total duration of energy outage period last year	(Days)
FEne24	Energy losses last year	(-)
Flexible service		
FEne25	Alternative energy sources	(% energy from renewable sources)
FEne26	Energy sources	(-)
FEne27	Energy sources location	(-)
FEne28	Service management	(-)
Obj.FE2 - AUTONOMOUS ENERGY SERVICE		

OBJECTIVE Criterion PI		PI unit
Service importance to the city		
FEne29	Stakeholders perception	(-)
FEne30	Cascading impacts	(-)
Service inter-dependency with other services considering climate change		
FEne31	Critical services dependence on energy service according to CC scenarios	(-)
FEne32	Energy services autonomy from other critical services according to CC scenarios	(-)
Obj.FE3 - ENERGY SERVICE PREPAREDNESS		
Service preparedness for disaster response		
FEne33	Energy service event management plans	(-)
FEne34	Energy services interdepartmental collaboration for emergency	(-)
FEne35	Energy services early warning	(-)
FEne36	Energy service drills	(-)
Service preparedness for climate change		
FEne37	Service commitment with mitigation of CC effects	(% reduction GHG)
FEne38	Existence of agreed CC scenarios and alignment with the city CC scenarios	(-)
FEne39	Knowledge of exposure and service vulnerability for CC scenarios	(-)
FEne40	Service planning for adaptation to CC	(-)
FEne41	Implemented measures to address CC mitigation and adaptation	(-)
FEne42	Planned measures to address CC mitigation and adaptation	(-)
FEne43	Equipment capacity of the service	(-)
FEne44	Staffing capacity of the service	(-)
Service preparedness for recovery and build back		
FEne45	Energy service CC recovery planning	(-)
FEne46	Energy service damage and loss post-event assessment	(-)
FEne47	Current post-event assessment system	(-)
FEne48	Energy outage in the city area in the last relevant climate-related event	(% city area)
FEne49	Energy outage in sensitive customers in the last relevant climate-related event	(% sensitive customers)
FEne50	Energy outage in other services in the last relevant climate-related event	(% customers other services)
FEne51	Energy outage in households in the last relevant climate-related event	(% households)
FEne52	Total duration of energy outage in the last relevant climate-related event	(Days)
FEne53	Energy service lessons learnt and learning loops	(-)
FEne54	Insurance	(-)

5.5.7. Mobility

The application of the functional resilience assessment to the mobility service is tailored in a sense that mobility in a city is very complex, and several other services contribute to the overall city accessibility and mobility. Therefore, each one of the specific transport services (e.g. the subway service, the bus service, etc.) could have a dedicated resilience assessment. Bearing in mind the RAF scope (section 2.1), herein the functional assessment considers the mobility service from the city's comprehensive perspective, and not from each one of the utilities as service providers. This means that mobility addresses the provision by the city of the conditions for the citizens, city managers, services providers including

transport systems, other internal and external stakeholders to have access, move, communicate, trade and establish relationships in the city (WBCSD, 2015; Taifidis et al., 2016). Therefore, the mobility service planning and risk management objective is different from the other services.

In addition, most of the metrics related to everyday service provision, recovery and build back after a climate-related event and expected CC scenarios impact, were simplified and targeted to the modes of transport, namely road, train, air or water based overall mobility services.

Other metrics were also tailored to the types of mobility solutions in the city, both short and long distance, referring to the modal split and passenger transference. Some metrics are to be answered for the overall mobility in the city, while others require an answer for each of the mobility mode options existing in the city: road, train, air or water based. The objectives, assessment criteria and metrics for the mobility service are indicated in Table 19.

Table 19 – Resilience assessment framework: functional dimension for the Mobility Service

OBJECTIVE Criterion PI		PI unit
Obj.FM1 - MOBILITY SERVICE PLANNING AND RISK MANAGEMENT		
Strategic planning		
FMob01	Mobility service strategic plan making and implementation	(-)
FMob02	Characterization of mobility needs	(-)
FMob03	Mobility plan monitoring and review	(-)
FMob04	Routes hierarchy characterization	(-)
FMob05	Land use zoning compliance	(-)
Resilience engaged mobility		
FMob06	Resilience in Mobility service strategy	(-)
FMob07	Mobility plan for Climate Change	(-)
FMob08	Budget for resilience	(-)
FMob09	Co-ordination with other Mobility services in the city	(-)
FMob10	Learning from other Mobility services	(-)
Risk management		
FMob11	Risk information related to the Mobility service	(-)
FMob12	Damage and loss estimation	(-)
FMob13	Expected mobility interruption in the city area according to CC scenarios	(-)
FMob14	Expected mobility interruption in the higher flow routes according to CC scenarios	(-)
FMob15	Expected mobility interruption for population according to CC scenarios	(-)
FMob16	Expected mobility interruption for long-distance passengers according to CC scenarios	(-)
FMob17	Expected mobility interruption period according to CC scenarios	(-)
Reliable mobility		
FMob18	Public transport spatial coverage	(% city area)
FMob19	Public transport daily coverage	(Hours/day)
FMob20	Mobility interruption in the higher flow routes last year	(-)

OBJECTIVE Criterion PI		PI unit
FMob21	Mobility interruption in the city area last year	(-)
FMob22	Mobility interruption for population last year	(-)
FMob23	Mobility interruption for long-distance passengers last year	(-)
FMob24	Total duration of mobility interruption period last year	(-)
FMob25	Routes with restrictions to circulation of heavy vehicles	(-)
FMob26	Routes with restrictions to circulation of medical or emergency vehicles	(-)
Flexible mobility		
FMob27	Alternative mobility	(% everyday cycling mobility)
FMob28	City mobility solutions	(-)
FMob29	Modal split for city road based solutions	(% share)
FMob30	Long distance mobility solutions	(-)
FMob31	Mobility passenger transference	(-)
FMob32	Use of mobility management tools	(-)
Obj.FM2 - AUTONOMOUS MOBILITY		
Service importance to the city		
FMob33	Stakeholders perception of city mobility	(-)
FMob34	Cascading impacts	(-)
Service inter-dependency with other services considering climate change		
FMob35	Critical services dependence on mobility according to CC scenarios	(-)
FMob36	Mobility autonomy from other critical services according to CC scenarios	(-)
Obj.FM3 - MOBILITY PREPAREDNESS		
Mobility preparedness for climate change		
FMob37	Mobility commitment with mitigation of CC effects	(% reduction GHG)
FMob38	Mobility interruption in the city area in the last relevant climate-related event	(% city area)
FMob39	Mobility interruption in the higher flow routes in the last relevant climate-related event	(-)
FMob40	Mobility interruption for population in the last relevant climate-related event	(-)
FMob41	Mobility interruption for long-distance passengers in the last relevant climate-related event	(-)
FMob42	Mobility interruption period in the last relevant climate-related event	(-)

5.6. Physical dimension

5.6.1. General

As described in section 4.2, the **physical** resilience dimension focuses on the infrastructure of the strategic urban services considered in the RAF, i.e. water, wastewater, stormwater, waste, electrical energy and mobility. In this dimension, the resilience objectives aim to ensure that infrastructures providing the service are safe, autonomous and flexible and prepared for CC challenges. This dimension also allows knowing the contribution of each service's infrastructure to the resilience of both the respective service and of the city.

A safe infrastructure requires that its critical assets are properly identified, mapped and safeguarded by protective buffers, and this is acknowledged to city stakeholders. Furthermore, it needs to be robust, meaning that appropriate design codes and standards exist and are applied, it is properly maintained and it performs adequately in daily normal conditions.

For an autonomous infrastructure, it is fundamental to know its importance to other services, by identifying the cascading impacts with the infrastructure of other services. Besides, it requires the acknowledgment of dependency on others and the existence of a self-backup plan, considering energy self-production, and equipment. A flexible infrastructure needs to have redundant solutions, easily activated and covering most of its customers.

Infrastructure is prepared for climate change when it contributes to city resilience, by implementing resilient design solutions, reducing greenhouse gas emissions and contributing to the response in emergency situations. Besides, the exposure of its critical assets to climate-related hazards is known and planned for CC scenarios. Additionally, several measures to mitigate and adapt to CC are implemented and envisaged and it is ensured the recording of information on infrastructure recovery and build back after an historical severe climate-related event.

The physical dimension is to be applied to each urban service under assessment. In case of combined sewer systems, both wastewater and stormwater services need to be answered, for the applicable metrics, and those metrics that are not applicable have to be duly identified. Even though the same objectives apply to infrastructures of all the services, some metrics are tailored to each service infrastructure's specificities. The following sections (5.6.2 to 5.6.7) present the list of metrics in the RAF physical dimension, for each service. Annex 1 presents a detailed description of the metrics, including the pre-defined set of answers.

5.6.2. Water

The application of the physical resilience assessment to the water infrastructure is specifically tailored with regard to different types of assets under assessment (referring to water pumps, water service mains, water service connections, hydrants and water storage), water quality regulatory requirements, consideration of water losses and the typology of the design measures to mitigate and adapt to CC. The objectives, assessment criteria and metrics for the water service are indicated in Table 20.

Table 20 – Resilience assessment framework: physical dimension for the water infrastructure

OBJECTIVE Criterion PI		PI unit
Obj.PW1 - SAFE WATER INFRASTRUCTURE		
Infrastructure assets criticality and protection		
PWts01	Water infrastructure critical assets	(-)

OBJECTIVE Criterion PI		PI unit
PWts02	Component importance	(-)
PWts03	Water infrastructure critical assets mapping, review and update	(-)
PWts04	Exchange of information	(-)
PWts05	Protective buffers mapping and information to the city	(-)
Infrastructure assets robustness		
PWts06	Codes and standards for infrastructure	(-)
PWts07	Maintenance of infrastructure	(-)
PWts08	Water pump failures last year	(Days)
PWts09	Water mains bursts last year	(No./100 km)
PWts10	Water service connections bursts last year	(No./1000 connections)
PWts11	Hydrant failures last year	(No./1000 hydrants)
PWts12	Power failures last year	(Days)
PWts13	Water quality last year	(%)
PWts14	Level of failure of critical infrastructure asset last year	(%)
PWts15	Coverage of expenditure in infrastructure last year	(-)
PWts16	Time for restoration last year	(Days)
PWts17	Real water losses	(m^3/(km.day))
PWts18	Energy efficiency in pumping stations	(kWh/m^3.100m)
PWts19	Pollution prevention	(% appropriate sludge disposal)
Obj.PW2 - AUTONOMOUS AND FLEXIBLE WATER INFRASTRUCTURE		
Infrastructure assets importance to and dependency on other services		
PWts20	Cascading impacts	(-)
PWts21	Infrastructure of other services dependency on water infrastructure	(-)
PWts22	Dependency on infrastructures of other services	(-)
PWts23	Level of dependency	(% customers affected)
Infrastructure assets autonomy		
PWts24	Autonomy from infrastructures of other services	(% infrastructure)
PWts25	Level of autonomy	(% customers covered)
PWts26	Autonomy activation	(-)
PWts27	Autonomy period	(Days)
PWts28	Water storage autonomy	(Days)
PWts29	Energy self-production	(%)
Infrastructure assets redundancy		
PWts30	Redundancy	(-)
PWts31	Redundancy activation	(-)
PWts32	Level of redundancy	(% customers covered)
Obj.PW3 - WATER INFRASTRUCTURE PREPAREDNESS		
Contribution to city resilience		
PWts33	Use of design solutions to improve city resilience	(-)
PWts34	Greenhouse gas emission target	(-)
PWts35	Other contributions to city resilience	(-)
Infrastructure assets exposure to climate change		
PWts36	Level of exposure of critical infrastructure assets to the most probable scenario	(-)

OBJECTIVE Criterion PI		PI unit
PWts37	Coverage of expenditure in infrastructure for most probable scenario	(%)
PWts38	Time for restoration for most probable scenario	(Days)
Preparedness for climate change		
PWts39	Implemented infrastructural measures to address CC mitigation and adaptation	(-)
PWts40	Planned infrastructural measures to address CC mitigation and adaptation	(-)
Preparedness for recovery and build back		
PWts41	Water pump failures in the last relevant event	(Days)
PWts42	Water service mains failures in the last relevant event	(No./100 km)
PWts43	Water service connection mains bursts in the last relevant event	(No./1000 connections)
PWts44	Hydrant bursts in the last relevant event	(No./1000 hydrants)
PWts45	Power failures in the last relevant event	(Days)
PWts46	Water quality compliance in the last relevant event	(%)
PWts47	Level of failure of critical assets in the last relevant event	(%)
PWts48	Coverage of expenditure in infrastructure in the last relevant event	(%)
PWts49	Time for restoration in the last relevant event	(Days)

5.6.3. Wastewater

The application of the physical resilience assessment to the wastewater infrastructure is tailored with regard to different types of assets under assessment (referring to wastewater pumps, sewers, wastewater service connections, combined sewer overflows and wastewater treatment plants), wastewater quality regulatory requirements, undue inflows to wastewater systems and the typology of the design measures to mitigate and adapt to CC. The objectives, assessment criteria and metrics for the wastewater service are indicated in Table 21.

Table 21 – Resilience assessment framework: physical dimension for the wastewater infrastructure

OBJECTIVE Criterion PI		PI unit
Obj.PWW1 - SAFE WASTEWATER INFRASTRUCTURE		
Infrastructure assets criticality and protection		
PWwt01	Wastewater infrastructure critical assets	(-)
PWwt02	Component importance	(-)
PWwt03	Wastewater infrastructure critical assets mapping, review and update	(-)
PWwt04	Exchange of information	(-)
PWwt05	Protective buffers mapping and information to the city	(-)
Infrastructure assets robustness		
PWwt06	Codes and standards for infrastructure	(-)
PWwt07	Maintenance of infrastructure	(-)
PWwt08	Wastewater pump failures last year	(Days)
PWwt09	Wastewater sewer pipe collapses last year	(No./100 km)
PWwt10	Wastewater connection collapses last year	(No./1000 connections)

OBJECTIVE Criterion PI		PI unit
PWwt11	Power failures last year	(Days)
PWwt12	Combined sewer overflow failures last year	(CSO discharges/total CSO devices)
PWwt13	Wastewater quality last year	(%)
PWwt14	Level of failure of critical infrastructure assets last year	(%)
PWwt15	Coverage of expenditure in infrastructure last year	(-)
PWwt16	Time for restoration last year	(Days)
PWwt17	Real undue inflows into the wastewater infrastructure	(m^3/(km.day))
PWwt18	Energy efficiency in pumping stations	(kWh/m^3.100m)
PWwt19	Pollution prevention	(% appropriate sludge disposal)
Obj.PWW2 - AUTONOMOUS AND FLEXIBLE WASTEWATER INFRASTRUCTURE		
Infrastructure assets importance to and dependency on other services		
PWwt20	Cascading impacts	(-)
PWwt21	Infrastructure of other services dependency on wastewater infrastructure	(-)
PWwt22	Dependency on infrastructures of other services	(-)
PWwt23	Level of dependency	(% customers affected)
Infrastructure assets autonomy		
PWwt24	Autonomy from infrastructures of other services	(% infrastructure)
PWwt25	Level of autonomy	(% customers covered)
PWwt26	Autonomy activation	(-)
PWwt27	Autonomy period	(Days)
PWwt28	Energy self-production	(%)
Infrastructure assets redundancy		
PWwt29	Redundancy	(-)
PWwt30	Redundancy activation	(-)
PWwt31	Level of redundancy	(% customers covered)
Obj.PWW3 - WASTEWATER INFRASTRUCTURE PREPAREDNESS		
Contribution to city resilience		
PWwt32	Use of design solutions to improve city resilience	(-)
PWwt33	Greenhouse gas emission target	(-)
PWwt34	Other contributions to city resilience	(-)
Infrastructure assets exposure to climate change		
PWwt35	Level of exposure of critical infrastructure assets to the most probable scenario	(-)
PWwt36	Coverage of expenditure in infrastructure for most probable scenario	(%)
PWwt37	Time for restoration for most probable scenario	(Days)
Preparedness for climate change		
PWwt38	Implemented infrastructural measures to address CC mitigation and adaptation	(-)
PWwt39	Planned infrastructural measures to address CC mitigation and adaptation	(-)
Preparedness for recovery and build back		
PWwt40	Wastewater pump failures in the last relevant event	(Days)
PWwt41	Wastewater sewer pipe collapses in the last relevant event	(No./100km)
PWwt42	Wastewater connection collapses in the last relevant event	(No./100km)

OBJECTIVE Criterion PI		PI unit
PWwt43	Combined sewer overflow failures in the last relevant event	(CSO discharges/total CSO devices)
PWwt44	Power failures in the last relevant event	(Days)
PWwt45	Wastewater quality compliance in the last relevant event	(%)
PWwt46	Level of failure of critical assets in the last relevant event	(%)
PWwt47	Coverage of expenditure in infrastructure in the last relevant event	(%)
PWwt48	Time for restoration in the last relevant event	(Days)

5.6.4. Stormwater

The application of the physical resilience assessment to the stormwater infrastructure is tailored with regard to different types of assets under assessment (referring to stormwater pumps, stormwater sewers, stormwater inlets, combined sewer overflows and stormwater treatment plants or facilities), stormwater quality regulatory requirements, undue inflows to stormwater systems and the typology of the design measures to mitigate and adapt to CC. The objectives, assessment criteria and metrics for the wastewater service are indicated in Table 22.

Table 22 – Resilience assessment framework: physical dimension for the stormwater infrastructure

OBJECTIVE Criterion PI		PI unit
Obj.PSW1 - SAFE STORMWATER INFRASTRUCTURE		
Infrastructure assets criticality and protection		
PSwt01	Stormwater infrastructure critical assets	(-)
PSwt02	Component importance	(-)
PSwt03	Stormwater infrastructure critical assets mapping, review and update	(-)
PSwt04	Exchange of information	(-)
PSwt05	Protective buffers mapping and information to the city	(-)
Infrastructure assets robustness		
PSwt06	Codes and standards for infrastructure	(-)
PSwt07	Maintenance of infrastructure	(-)
PSwt08	Stormwater pump failures last year	(Days)
PSwt09	Stormwater sewer pipe collapses last year	(No./100 km)
PSwt10	Stormwater connection collapses last year	(No./1000 connections)
PSwt11	Inlet failures last year	(No./1000 inlets)
PSwt12	Power failures last year	(Days)
PSwt13	Stormwater quality last year	(%)
PSwt14	Level of failure of critical infrastructure assets last year	(%)
PSwt15	Coverage of expenditure in infrastructure last year	(-)
PSwt16	Time for restoration last year	(Days)
PSwt17	Real undue inflows into the stormwater infrastructure	(m^3/(km.day))
PSwt18	Energy efficiency in pumping stations	(-)

OBJECTIVE Criterion PI		PI unit
PSwt19	Pollution prevention	(% appropriate sludge disposal)
Obj.PSW2 - AUTONOMOUS AND FLEXIBLE STORMWATER INFRASTRUCTURE		
Infrastructure assets importance to and dependency on other services		
PSwt20	Cascading impacts	(-)
PSwt21	Infrastructure of other services dependency on stormwater infrastructure	(-)
PSwt22	Dependency on infrastructures of other services	(-)
PSwt23	Level of dependency	(% customers affected)
Infrastructure assets autonomy		
PSwt24	Autonomy from infrastructures of other services	(% infrastructure)
PSwt25	Level of autonomy	(% customers covered)
PSwt26	Autonomy activation	(-)
PSwt27	Autonomy period	(Days)
PSwt28	Capacity for zero floods	(Years)
PSwt29	Energy self-production	(%)
Infrastructure assets redundancy		
PSwt30	Redundancy	(-)
PSwt31	Redundancy activation	(-)
Obj.PSW3 - STORMWATER INFRASTRUCTURE PREPAREDNESS		
Contribution to city resilience		
PSwt32	Use of design solutions to improve city resilience	(-)
PSwt33	Greenhouse gas emission target	(-)
PSwt34	Other contributions to city resilience	(-)
Infrastructure assets exposure to climate change		
PSwt35	Level of exposure of critical infrastructure assets to the most probable scenario	(-)
PSwt36	Coverage of expenditure in infrastructure for most probable scenario	(%)
PSwt37	Time for restoration for most probable scenario	(Days)
Preparedness for climate change		
PSwt38	Implemented infrastructural measures to address CC mitigation and adaptation	(-)
PSwt39	Planned infrastructural measures to address CC mitigation and adaptation	(-)
Preparedness for recovery and build back		
PSwt40	Stormwater pump failures in the last relevant event	(Days)
PSwt41	Stormwater sewer pipe collapses in the last relevant event	(No./100 km)
PSwt42	Stormwater connection collapses in the last relevant event	(No./1000 connections)
PSwt43	Inlets failures in the last relevant event	(No./1000 inlets)
PSwt44	Power failures in the last relevant event	(Days)
PSwt45	Stormwater quality compliance in the last relevant event	(%)
PSwt46	Level of failure of critical assets in the last relevant event	(%)
PSwt47	Coverage of expenditure in infrastructure in the last relevant event	(%)
PSwt48	Time for restoration in the last relevant event	(Days)

5.6.5. Waste

The application of the physical resilience assessment to the waste infrastructure is tailored with regard to different types of assets under assessment (referring to waste collection, service locations, fleet, containers and waste treatment plants), solid waste quality regulatory requirements and the typology of the design measures to mitigate and adapt to CC. The waste infrastructure has the specificity of not being continuous. The objectives, assessment criteria and metrics for the wastewater service are indicated in Table 23

Table 23 – Resilience assessment framework: physical dimension for the waste infrastructure

OBJECTIVE Criterion PI		PI unit
Obj.PWT1 - SAFE WASTE INFRASTRUCTURE		
Infrastructure assets criticality and protection		
PSlw01	Solid waste infrastructure critical assets	(-)
PSlw02	Component importance	(-)
PSlw03	Solid waste infrastructure critical assets mapping, review and update	(-)
PSlw04	Exchange of information	(-)
PSlw05	Protective buffers mapping and information to the city	(-)
Infrastructure assets robustness		
PSlw06	Codes and standards for infrastructure	(-)
PSlw07	Maintenance of infrastructure	(-)
PSlw08	Waste collection infrastructure components failures last year	(Days)
PSlw09	Waste management service facilities unavailable last year	(% facilities)
PSlw10	Waste management fleet failures last year	(-)
PSlw11	Waste containers dumped or displaced last year	(% containers)
PSlw12	Power failures interrupting service last year	(Days)
PSlw13	Laboratory analysis compliance	(%)
PSlw14	Level of failure of critical infrastructure assets last year	(%)
PSlw15	Coverage of expenditure in infrastructure last year	(-)
PSlw16	Time for restoration last year	(Days)
PSlw17	Pollution prevention	(% appropriate leachate disposal)
Obj.PWT2 - AUTONOMOUS AND FLEXIBLE WASTE INFRASTRUCTURE		
Infrastructure assets importance to and dependency on other services		
PSlw18	Cascading impacts	(-)
PSlw19	Infrastructure of other services dependency on solid waste infrastructure	(-)
PSlw20	Dependency on infrastructures of other services	(-)
PSlw21	Level of dependency	(% customers affected)
Infrastructure assets autonomy		
PSlw22	Autonomy from infrastructures of other services	(% infrastructure)
PSlw23	Level of autonomy	(% customers covered)
PSlw24	Autonomy activation	(-)
PSlw25	Autonomy period	(Days)
PSlw26	Waste storage autonomy	(Days)
PSlw27	Energy self-production	(%)
Infrastructure assets redundancy		
PSlw28	Redundancy	(-)

OBJECTIVE Criterion PI		PI unit
PSlw29	Redundancy activation	(-)
PSlw30	Level of redundancy	(% customers covered)
Obj.PWT3 - WASTE INFRASTRUCTURE PREPAREDNESS		
Contribution to city resilience		
PSlw31	Use of design solutions to improve city resilience	(-)
PSlw32	Recovered material from waste treatment	(% recovered material)
PSlw33	Greenhouse gas emission target	(-)
PSlw34	Other contributions to city resilience	(-)
Infrastructure assets exposure to climate change		
PSlw35	Level of exposure of critical infrastructure assets to the most probable scenario	(-)
PSlw36	Coverage of expenditure in infrastructure for most probable scenario	(%)
PSlw37	Time for restoration for most probable scenario	(Days)
Preparedness for climate change		
PSlw38	Implemented infrastructural measures to address CC mitigation and adaptation	(-)
PSlw39	Planned infrastructural measures to address CC mitigation and adaptation	(-)
Preparedness for recovery and build back		
PSlw40	Waste collection infrastructure components failures last relevant event	(Days)
PSlw41	Waste management service facilities unavailable in the last relevant event	(% facilities)
PSlw42	Waste management fleet failures in the last relevant event	(-)
PSlw43	Waste containers dumped or displaced in the last relevant event	(% containers)
PSlw44	Power failures in the last relevant event	(Days)
PSlw45	Laboratory analysis compliance in the last relevant event	(%)
PSlw46	Level of failure of critical assets in the last relevant event	(%)
PSlw47	Coverage of expenditure in infrastructure in the last relevant event	(%)
PSlw48	Time for restoration in the last relevant event	(Days)

5.6.6. Energy

The application of the physical resilience assessment to the energy infrastructure is tailored with regard to different types of assets under assessment (referring to power stations, substations, sectional and transformation power stations, distribution network and public lightning installations), the use of cooling waters and the typology of the design measures to mitigate and adapt to CC. The objectives, assessment criteria and metrics for the energy service are indicated in Table 24.

Table 24 – Resilience assessment framework: physical dimension for the energy infrastructure

OBJECTIVE Criterion PI		PI unit
Obj.PE1 - SAFE ENERGY INFRASTRUCTURE		
Infrastructure assets criticality and protection		
PEne01	Energy infrastructure critical assets	(-)

OBJECTIVE Criterion PI		PI unit
PEne02	Component importance	(-)
PEne03	Energy infrastructure critical assets mapping, review and update	(-)
PEne04	Exchange of information	(-)
PEne05	Protective buffers mapping and information to the city	(-)
Infrastructure assets robustness		
PEne06	Codes and standards for infrastructure	(-)
PEne07	Maintenance of infrastructure	(-)
PEne08	Power station failure last year	(Days)
PEne09	Power substation failure last year	(Days)
PEne10	Power distribution network failures last year	(-)
PEne11	Local power installations failures last year	(-)
PEne12	Level of failure of critical infrastructure assets last year	(%)
PEne13	Coverage of expenditure in infrastructure last year	(-)
PEne14	Time for restoration last year	(Days)
PEne15	Use of cooling waters	(l/kWh)
Obj.PE2 - AUTONOMOUS AND FLEXIBLE ENERGY INFRASTRUCTURE		
Infrastructure assets importance to and dependency on other services		
PEne16	Cascading impacts	(-)
PEne17	Infrastructure of other services dependency on energy infrastructure	(-)
PEne18	Dependency on infrastructures of other services	(-)
PEne19	Level of dependency	(% customers affected)
Infrastructure assets autonomy		
PEne20	Autonomy from infrastructures of other services	(% infrastructure)
PEne21	Level of autonomy	(% customers covered)
PEne22	Autonomy activation	(-)
PEne23	Autonomy period	(Days)
Infrastructure assets redundancy		
PEne24	Redundancy	(-)
PEne25	Redundancy activation	(-)
PEne26	Level of redundancy	(% customers covered)
Obj.PE3 - ENERGY INFRASTRUCTURE PREPAREDNESS		
Contribution to city resilience		
PEne27	Use of design solutions to improve city resilience	(-)
PEne28	Greenhouse gas emission target	(-)
PEne29	Other contributions to city resilience	(-)
Infrastructure assets exposure to climate change		
PEne30	Level of exposure of critical infrastructure assets to the most probable scenario	(-)
PEne31	Coverage of expenditure in infrastructure for most probable scenario	(%)
PEne32	Time for restoration for most probable scenario	(Days)
Preparedness for climate change		
PEne33	Implemented infrastructural measures to address CC mitigation and adaptation	(-)
PEne34	Planned infrastructural measures to address CC mitigation and adaptation	(-)
Preparedness for recovery and build back		

OBJECTIVE Criterion PI		PI unit
PEne35	Power stations failure in the last relevant event	(Days)
PEne36	Power substation failure in the last relevant event	(Days)
PEne37	Power distribution network failures in the last relevant event	(-)
PEne38	Local power installation failures in the last relevant event	(-)
PEne39	Level of failure of critical assets in the last relevant event	(%)
PEne40	Coverage of expenditure in infrastructure in the last relevant event	(-)
PEne41	Time for restoration in the last relevant event	(Days)

5.6.7. Mobility

As for the functional dimension, in the case of mobility, most metrics are to be answered for the overall mobility in the city, while others require an answer for each of the mobility mode options existing in the city: road, train, air or water based.

The objectives, assessment criteria and metrics for mobility are as indicated inTable 25.

Table 25 – Resilience assessment framework: physical dimension for the mobility infrastructure

OBJECTIVE Criterion PI		PI unit
Obj.PM1 - SAFE MOBILITY INFRASTRUCTURE		
Infrastructure assets criticality and protection		
PMob01	Mobility infrastructure critical assets	(-)
PMob02	Component importance for city mobility	(-)
PMob03	Mobility infrastructure critical assets mapping, review and update	(-)
PMob04	Protective buffers mapping and information to the city	(-)
Infrastructure assets robustness		
PMob05	Codes and standards for infrastructure	(-)
PMob06	Maintenance of infrastructure	(-)
PMob07	Road and rail routes failures last year	(-)
PMob08	Transport interfaces failures last year	(Hours)
PMob09	Power related failures in road and rail routes last year	(-)
PMob10	Power related failures in transport interfaces last year	(Hours)
PMob11	Flooding related failures in road and rail routes last year	(-)
PMob12	Flooding related failures in transport interfaces last year	(Hours)
PMob13	Coverage of expenditure in infrastructure last year	(-)
PMob14	Time for restoration last year	(-)
PMob15	Clean fuel public transport	(-)
Obj.PM2 - AUTONOMOUS AND FLEXIBLE MOBILITY INFRASTRUCTURE		
Infrastructure assets importance to and dependency on other services		
PMob16	Cascading impacts	(-)
PMob17	Infrastructure of other services dependency on mobility infrastructure	(-)
PMob18	Dependency on infrastructures of other services	(-)
Infrastructure assets autonomy and redundancy		
PMob19	Energy self-production	(%)

OBJECTIVE Criterion PI		PI unit
PMob20	Redundancy	(-)
Obj.PM3 - MOBILITY INFRASTRUCTURE PREPAREDNESS		
Contribution to city resilience		
PMob21	Use of design solutions to improve city resilience	(-)
PMob22	Greenhouse gas emission target	(-)
PMob23	Other contributions to city resilience	(-)
Infrastructure assets exposure to climate change		
PMob24	Level of exposure of mobility infrastructure to the most probable scenario	(-)
PMob25	Coverage of expenditure in infrastructure for most probable scenario	(-)
PMob26	Time for restoration for most probable scenario	(-)
Preparedness for climate change		
PMob27	Implemented infrastructural measures to address CC mitigation and adaptation	(-)
PMob28	Planned infrastructural measures to address CC mitigation and adaptation	(-)
Preparedness for recovery and build back		
PMob29	Road and rail routes failures in the last relevant event	(-)
PMob30	Transport interfaces failures in the last relevant event	(Hours)
PMob31	Power related failures in road and rail routes in the last relevant event	(-)
PMob32	Power related failures in transport interfaces in the last relevant event	(-)
PMob33	Flooding related failures in road and rail routes in the last relevant event	(Hours)
PMob34	Flooding related failures in transport interfaces in the last relevant event	(Hours)
PMob35	Coverage of expenditure in infrastructure in the last relevant event	(-)
PMob36	Time for restoration in the last relevant event	(-)

6. Results of the Resilience Assessment Framework to support diagnosis

6.1. How RAF can support diagnosis

The main purpose of the RAF application is to identify the real needs of the cities and services to enhance urban resilience, since it directs and facilitates a structured resilience diagnosis of the cities and strategic urban sectors. A structured organization of the key results is beneficial for obtaining a comprehensive view of the diagnosis. This is the basis for the cities and services to know where they stand, outlining a path for the development of RAPs by supporting decision-making in the selection of resilience measures to adopt, and the development of strategies to enhance resilience, thus planning in the long, medium and short terms and assessing progress (see sections 1.2 and 2.1). Besides, it also facilitates communication among the diverse stakeholders involved in this process.

Therefore, the RAF contributes to ensure a sustained path to enhance the resilience of cities, since the investment to be realized in the knowledge of the

cities resilience may be translated by concrete benefits, resulting in the implementation of the appropriate measures and strategies to enhance resilience.

The summary of the resilience diagnosis results, together with context factors, can be undertaken using a SWOT analysis. This procedure can be applied per dimension, per objective or globally.

For the SWOT, the following aspects should be taken into account from a resilience assessment perspective:

- **Strengths** (positive, internal): positive characteristics, attributes or conditions currently present in the city, which are strong points from a resilience perspective (Which are the city advantages? What does the city do well? What relevant resources does the city have?) ;
- **Weaknesses** (negative, internal): characteristics or issues that limit the current or future resilience of the city in terms of climate change (What is not functioning in the city? Which resources are limited? What can be improved? What should be avoided? Which are the main vulnerabilities?)
- **Opportunities** (positive, external): areas where external conditions are favourable to further promote resilience and development of the city (What are the good prospects for the city? What are the interesting trends (changes in government policy, in social patterns, population profiles, lifestyles, economic development, etc.)? National or international programs supporting resilience development?);
- **Threats** (negative, external): trends that threaten resilience and local development conditions, including local and global changes (What are the obstacles the city faces? Are there threats to the resilience of the city from climate change? What is happening in other cities? How is the economic situation changing? How is the (inter)national policy environment or political situation changing? How is demography changing?).

In a further planning step, the SWOT may be complemented by TOWS allowing foreseeing strategies globally beneficial for the city, as follows:

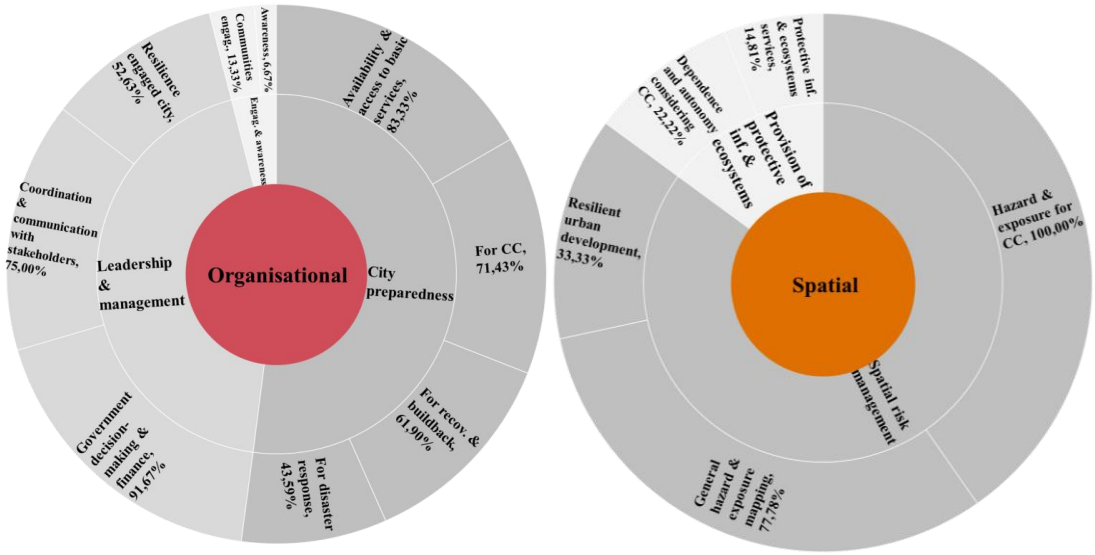
- **Strengths versus opportunities** (SO): strategies that use strengths to exploit opportunities;
- **Strengths versus threats** (ST): strategies that use strengths to avoid or face threats;
- **Weaknesses versus opportunities** (WO): strategies that overcome weaknesses by taking advantage of opportunities;
- **Weaknesses versus threats** (WT): strategies that minimise weaknesses and avoid threats.

6.2. An example from RAF testing

The RAF was applied to Barcelona, Lisbon and Bristol by their cities and strategic services managers, during the RAF testing (see sections 1.1 and 2.2), and it provided results that may support a SWOT analysis. An overall of the three cities assessment results for each dimension is presented in Annex 3. Figures A1 and A2 from this annex show that, for each objective, in the organisational (O.Org.) and spatial (O.S.) dimensions, between 90%-100% of the metrics were answered. For the functional (O.F.) and physical (O.P.) dimensions, above 80% and above 65% were answered, respectively. As also presented in section 2.2.4, regarding the RAF applicability, it is possible to conclude that all the objectives in the RAF can be evaluated by the cities and for the organisational and spatial dimensions, no relevant difficulties were identified. In the responses to the physical dimension, greater difficulty is evident even compared to the functional, what may eventually be associated with less existing information.

In Figure 15, to illustrate the results an overall of the three cities testing results (due to confidentiality results are not individually presented) for the organisational and spatial dimensions is presented. Figure 15a presents the organisational dimension (inner circle) main strengths, identifying the resilience objectives (middle circle) and criteria (outer circle) where the cities present metrics with an *advanced level* of development. It is indicated the percentage of total metrics in *advanced level* for these criteria, and the size of the graphic sectors is proportional to this percentage. The cities are well developed regarding *leadership and management* (O.Org.2) and *city preparedness* (O.Org.3) and present some relevant developments on *collective engagement and awareness* (O.Org.1). Similarly, Figure 15b presents the spatial dimension main weaknesses, identifying the resilience objectives and criteria where the cities have metrics with *incipient level* of development. It is possible to identify that the main opportunities for development are those related to the *provision of protective infrastructure and ecosystems* (O.S.2) as well as the *spatial risk management* (O.S.1) from the points of view of *the resilient urban development* and *hazard and exposure mapping*, although there are already significant developments in the cities in this dimension of resilience.

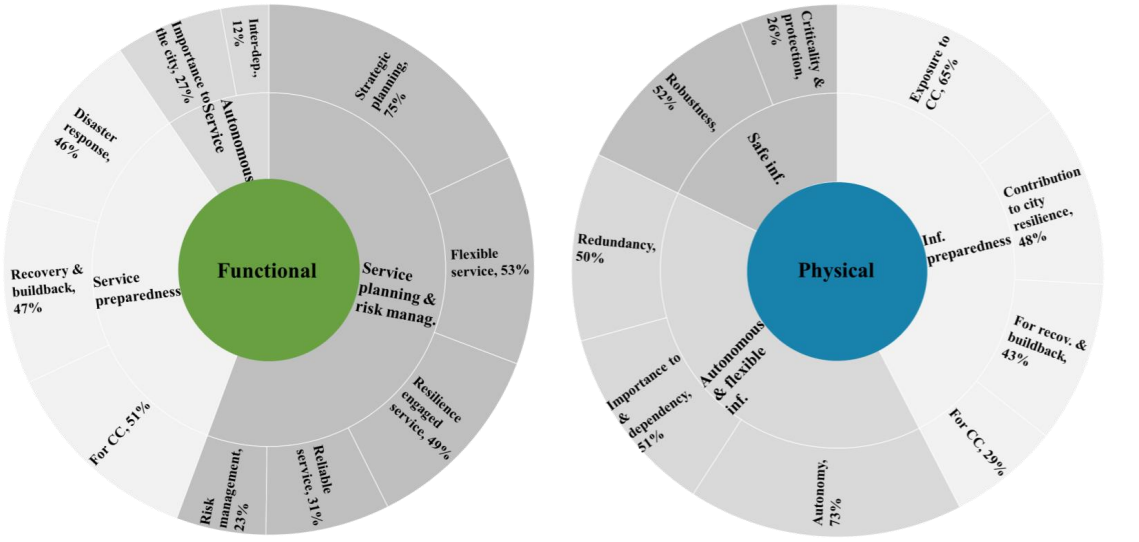
In Figure 16, also to illustrate the testing results, an overall of the three cities testing results for the functional and physical dimensions is presented. Figure 16a presents the main strengths for the functional dimension (inner circle), identifying the resilience objectives (middle circle) and criteria (outer circle) where the cities present metrics with *advanced level* of development. The cities are well developed regarding *service planning and risk management* (O.F.1) followed by *service preparedness* (O.F.3) and present some relevant developments on *autonomous service* (O.F.2).



a) % of advanced metrics

b) % of incipient metrics

Figure 15 – Overall of three cities testing | organisational and spatial dimensions: development level



a) % of advanced metrics

b) % of incipient metrics

Figure 16 – Overall of three cities testing | functional and physical dimensions: development level

Figure 16b presents the main weaknesses of the physical dimension, identifying the resilience objectives and criteria where the cities have metrics with *incipient level* of development. The main opportunities for development are those related with the *safe infrastructure* (O.P.1), *autonomous and flexible infrastructure* (O.P.2) as well as the *infrastructure preparedness* (O.S.3), although there are already significant developments in the cities in this dimension of resilience.

6.3. How can RAF support the evaluation of the impacts of strategies

The RAF allows to evaluate the impact of strategies on cities' resilience as well as monitoring the progress of a city or service over time, therefore tracking the progress of a RAP implementation. In order to support this evaluation the web-database of resilience strategies and measures that was developed in RESCCUE (Martínez-Gomariz et al., 2017; Martínez-Gomariz et al., 2019; Evans et al., 2020) was analyzed. This was the basis to identify the main links between each strategy and the assessment metrics of the RAF framework. This identification allows to indicate expected impacts of each strategy on the resilience assessment, as well as to evaluate the impact of the strategies considered in the RAPs developed by Barcelona, Bristol and Lisbon.

Since each strategy integrates one or more resilience measures, the link was mainly assigned through these measures, since they are more specific, thus allowing a better correspondence to the RAF criteria and metrics.

Considering the RAPs created in RESCCUE (Cardoso et al., 2020), four strategies were developed in the cases of Barcelona and Bristol and seven strategies in the case of Lisbon. In Table 26, Table 27 and

Table 28, respectively for Barcelona, Bristol and Lisbon, the strategies considered in each RAP are presented with the associated RAF metrics that can be impacted by their implementation, therefore contributing to an expectable enhancement of the city resilience. In Annex 4, this information is similarly presented for all the strategies of the web-based database, introduced by the three RESCCUE cities. The metrics presented are organized by RAF dimension and, in each dimension, by RAF objectives, referred to as in Table 12 to Table 25.

Table 26 – Link between Barcelona strategies and RAF metrics

	Organisational	**Spatial**	**Functional**	**Physical**
S001BCN Flood impacts reduction in a context of climate change **Measures** ▪ Improvements of surface drainage system (New inlets) ▪ Increase of sewer system capacity (I) (New pipes) ▪ Increase of sewer system capacity (II) (New detention tanks	**Obj. O2** – O23, 025, 026, 034 **Obj. O3** – 038, O46, O51, O52, O53, O54, O55, O57, O66, O70	**Obj. S1** – S01, S02, S03, S04, S05, S06, S07, S08, S09, S10 S11, S12, S13, S14, S15, S16, S17 **Obj. S2** – S18, S19, S22, S23, S25, S26	**Obj. FW1** – FWts05, FWts12, FWts13, FWts14, FWts15, FWts16, FWts17, FWts18, FWts19, FWts20, FWts21, FWts22, FWts23, FWts35, FWts36, FWts37 **Obj. FW3** – FWts47, FWts48, FWts49, FWts50, FWts51, FWts52, FWts53, FWts54 **Obj. FWW1** – FWwt01, FWwt02, FWwt03, FWwt04,	**Obj. PW1** – PWts01 PWts03, PWts06, PWts07, PWts17 **Obj. PW3** – PWts33 PWts35, PWts39, PWts40 **Obj. PWW1** – PWwt06, PWwt07 PWwt17 **Obj. PWW3** – PWwt32, PWwt34, PWwt38,PWwt39 **Obj. PSW1** – PSwt01, PSwt03 PSwt06, PSwt07

for flooding protection) ▪ SUDs (green roofs, infiltration trenches, detention basins) ▪ Early Warning System ▪ Self–healing algorithm implemented in the electrical distribution grid ▪ Ensure the stability of waste containers			FWwt05, FWwt07 FWwt12, FWwt13 FWwt14, FWwt15 FWwt16, FWwt17 FWwt18, FWwt19 FWwt20, FWwt21 FWwt32, FWwt33 **Obj. FWW3** – FWwt44, FWwt45 FWwt46, FWwt47 FWwt48, FWwt49 FWwt50, FWwt51 **Obj. FSW1** – FSwt01, FSwt02, FSwt03, FSwt04, FSwt05, FSwt07 FSwt12, FSwt14 FSwt15, FSwt16 FSwt17, FSwt18 FSwt25, FSwt26 **Obj. FSW2** – FSwt31,FSwt32 **Obj. FSW3** – FSwt35,FSwt37, FSwt38, FSwt39, FSwt40, FSwt41, FSwt42, FSwt43, FSwt44 **Obj. FWT1** – FSlw12, FSlw13 FSlw14, FSlw15 FSlw16, FSlw17 FSlw18, FSlw19 FSlw20 **Obj. FWT3** – FSlw42, FSlw43, FSlw44, FSlw45, FSlw46, FSlw47, FSlw48, FSlw49 **Obj. FE1** – FEne12, FEne13, FEne14, FEne15, FEne16, FEne17, FEne18 **Obj. FE3** – FEne37 FEne38, FEne39 FEne40, FEne41 FEne42, FEne43 FEne44 **Obj. FM1** –FMob11 FMob12, FMob13,	PSwt17 **Obj. PSW2** – PSwt28 **Obj. PSW3** – PSwt32, PSwt34 PSwt35, PSwt38 PSwt39 **Obj. PWT1** – PSlw06, PSlw07 PSlw11, PSlw13 **Obj. PWT3** – PSlw31, PSlw34, PSlw38, PSlw39 **Obj. PE1** –PEne06, PEne07 **Obj. PE3** – Ene27, PEne29, PEne33, PEne34 **Obj. PM1** – PMob05, PMob06 **Obj. PM3** – PMob21, PMob23 PMob27, PMob28

			FMob14, FMob15, FMob16, FMob17 **Obj. FM3** – Mob37	
S002BCN Environmental improvement of receiving water bodies **Measures** ▪ SUDS (green roofs, infiltration trenches, detention basins) ▪ Storage tanks for CSO prevention ▪ Improvements of the capacity of sewer interceptor and WWTP ▪ Early Warning System ▪ End of pipe CSO treatment		**Obj. S1** – S04, S05, S06, S07, S08, S09, S10, S11, S12, S13, S14, S15, S16, S17 **Obj. S2** – S18,S19,S20, S21 S22, S23, S24, S25, S26	**Obj. FW1** – FWts03, FWts07 FWts11, FWts12 FWts13, FWts14 FWts15, FWts16 FWts17, FWts18 FWts19, FWts20 FWts21, FWts22 FWts23, FWts35 FWts36, FWts37 FWts38 **Obj. FW2** – FWts40, FWts41, FWts42 **Obj. FW3** – FWts47, FWts48 FWts49, FWts50 FWts51, FWts52 FWts53, FWts56 FWts57, FWts68 **Obj. FWW1** – FWwt01, FWwt02, FWwt03, FWwt03, FWwt04, FWwt07, FWwt09, FWwt11, FWwt12, FWwt13, FWwt14, FWwt15, FWwt16, FWwt17, FWwt18, FWwt19, FWwt20, FWwt21, FWwt32, FWwt33, FWwt34, FWwt35 **Obj. FWW2** – FWwt37, FWwt38, FWwt39 **Obj. FWW3** – FWwt40, FWwt42 FWwt44, FWwt45, FWwt46, FWwt47, FWwt48, FWwt49, FWwt50, FWwt53, FWwt54, FWwt64	**Obj. PW1** – PWts06, PWts07 PWts17, PWts18 PWts19 **Obj. PW2** – PWts20, PWts21, PWts22, PWts23, PWts24, PWts25 **Obj. PW3** – PWts33, PWts35, PWts36, PWts37, PWts38, PWts39, PWts40 **Obj. PWW1** – PWwt03, PWwt06, PWwt07, PWwt17, PWwt18, PWwt19 **Obj. PWW2** – PWwt20, PWwt21, PWwt22, PWwt23, PWwt24, PWwt25 **Obj. PWW3** – PWwt32, PWwt34, PWwt35, PWwt36, PWwt37, PWwt38, PWwt39 **Obj. PSW1** – PSwt01, PSwt03 Pswt06, PSwt07, PSwt17 PSwt18, PSwt19 **Obj. PSW2** – PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25 PSwt28 **Obj. PSW3** – PSwt32, PSwt35, PSwt36, PSwt37, PSwt38 , PSwt39
S003BCN Not a single drop wasted. Alternative water resources **Measures**	**Obj. O1** – O01, O03, 006 **Obj. O2** – O15, 016, 018, 019, O20, O22, O23,	**Obj. S1** – S03, S05, S13, S15 **Obj. S2** – S26	**Obj. FW1** – FWts01, FWts02 FWts03, FWts04 FWts05, FWts06 FWts07, FWts08 FWts09, FWts12	**Obj. PW1** – PWts01, PWts02, PWts03, PWts06, PWts07, PWts17, PWts18, PWts19

▪ Optimize desalinization plant production ▪ Promote the use of grey water in new housing developments ▪ Continue reducing leakage in water distribution networks ▪ Study the feasibility of producing regenerated water at the Besòs WWTP to feed the Besòs aquifer, to maintain the river's ecological flows and feed the purification plant ▪ Exploit the Besòs aquifer resource as potable water and build a purification plant ▪ Utilise regenerated water from the River Llobregat for the industrial uses of the Zona Franca Consortium and for recharging the aquifer ▪ Promote rainwater collection and its reuse in buildings ▪ Inter–basins connections ▪ Increase the water cost for specific uses	O24, O25, O26, O27, O28, O29 **Obj. O3** – O41, O51, O52, O53, O54, O55, O56, O57, O65, O66, O67		FWts13, FWts14 FWts15, FWts16 FWts17, FWts18 FWts19, FWts20 FWts21, FWts22 FWts23, FWts35 FWts36, FWts37 FWts38 **Obj. FW2** – FWts41, FWts42 **Obj. FW3** – FWts43, FWts44, FWts45, FWts47, FWts48, FWts49, FWts50, FWts51, FWts52, FWts53, FWts54, FWts55, FWts56, FWts57 **Obj. FWW1** – FWwt01, FWwt02 FWwt03, FWwt04 FWwt05, FWwt06 FWwt07, FWwt08 FWwt09, FWwt12 FWwt13, FWwt14 FWwt15, FWwt16 FWwt17, FWwt18 FWwt19, FWwt20 FWwt32, FWwt33 FWwt34, FWwt35 **Obj. FWW3** – FWwt40, FWwt41, FWwt42, FWwt44, FWwt45, FWwt46, FWwt47, FWwt48, FWwt49, FWwt50, FWwt51, FWwt52 **Obj. FSW1** – FSwt01, FSwt02 FSwt03, FSwt04 FSwt05, FSwt06 FSwt07, FSwt08 FSwt09, FSwt12 FSwt13, FSwt14 FSwt15, FSwt16 FSwt17, FSwt18 FSwt25, FSwt26 FSwt27, FSwt28 **Obj. FSW2** – FSwt30, FSwt31, FSwt32 **Obj. FSW3** –	**Obj. PW2** – PWts20, PWts21, PWts22, PWts23, PWts24, PWts25 **Obj. PW3** – PWts33, PWts35 PWts37, PWts39 PWts40 **Obj. PWW1** – PWwt01, PWwt02, PWwt03, PWwt05, PWwt06, PWwt07 PWwt17, PWwt18 PWwt19 **Obj. PWW3** – PWwt32, PWwt34, PWwt36, PWwt38, PWwt39 **Obj. PSW1** – PSwt01,PSwt02 PSwt03, PSwt05, PSwt06, PSwt07 **Obj. PSW3** – PSwt32, PSwt34 PSwt36, PSwt38 PSwt39

			FSwt33, FSwt35 FSwt37, FSwt38 FSwt39, FSwt40 FSwt41, FSwt42 FSwt43	
S004BCN Guarantee security of services supply **Measures** ▪ Perform a Resilience Diagnosis of the city by using RESCCUE methodology and tools ▪ Elaborate a Resilience Action Plan for the city according to RESCCUE methodology ▪ To locate a control centre and a situation room	**Obj. O1** – O01, O02, O03, O04, O05, O06, O07, O08, O09, O10 **Obj. O2** – O11, O12,013, O14, O15, O16, O17, O18, O19, O20, O21, O22, O23, O24, O25, O26, O27, O28, O29, 031,036,037 **Obj. O3** – O38, O39, O40, O41, O42, O43, O44, O45, O46, O47, O48, O49, O50, O51, O52, O53, O54, O55, O56, O57,058,059,060, 061,063,064, O65, O66, O70	**Obj. S1** – S01, S02, S03, S04, S05, S06, S07, S08, S09, S10, S11, S12, S13, S14, S15, S16, S17 **Obj. S2** – S22 S23, S25, S26 S27	**Obj. FW1** – FWts01, FWts02 FWts03, FWts04 FWts05, FWts06 FWts07, FWts08 FWts09, FWts12 FWts13, FWts14 FWts15, FWts16 FWts17, FWts18 FWts19, FWts20 FWts21, FWts22 FWts23, FWts35 FWts36, FWts37 **Obj. FW2** – FWts41, FWts42 **Obj. FW3** – FWts43, FWts44 FWts45, FWts46 FWts50, FWts51 FWts52, FWts53 FWts54, FWts55 **Obj. FWW1** – FWwt01,FWwt02 FWwt03,FWwt04 FWwt05,FWwt06 FWwt07,FWwt08 FWwt09,FWwt12 FWwt13,FWwt14 FWwt15,FWwt16 FWwt17,FWwt18 FWwt19,FWwt20 FWwt21,FWwt32 FWwt33 **Obj. FWW2** – FWwt38, FWwt39 **Obj. FWW3** – FWwt40, FWwt41, FWwt42, FWwt43, FWwt47, FWwt48, FWwt49, FWwt50, FWwt51, FWwt52, FWwt53, FWwT54 **Obj. FSW1** – FSwt01, FSwt02 FSwt03, FSwt04 FSwt05, FSwt06 FSwt07, FSwt08 FSwt09, FSwt12	**Obj. PW1** – PWts03, PWts04 PWts05, PWts07 PWts17 **Obj. PW2** – PWts21, PWts22, PWts23, PWts24, PWts25, **Obj. PW3** – PWts33, PWts35 PWts39, PWts40 **Obj. PWW1** – PWwt03, PWwt04 PWwt05, PWwt06 PWwt07, PWwt17 **Obj. PWW2** – PWwt21, PWwt22 PWwt23, PWwt24 PWwt25 **Obj. PWW3** – PWwt32, PWwt34, PWwt38,PWwt39 **Obj. PSW1** – PSwt03, PSwt04 PSwt05, PSwt06 PSwt07, PSwt17 **Obj. PSW2** – PSwt21, PSwt22, PSwt23, PSwt24, PSwt25 **Obj. PSW3** – PSwt32, PSwt34, PSwt38, PSwt39 **Obj. PWT1** – PSlw03, PSlw04 PSlw05, PSlw06 PSlw07, PSlw13 **Obj. PWT2** – PSlw19, PSlw20 PSlw21, PSlw22 PSlw23

			FSwt13, FSwt14 FSwt15, FSwt16 FSwt17, FSwt18 FSwt25, FSwt26 **Obj. FSW2** – FSwt31, FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt35, FSwt36 FSwt40, FSwt41 FSwt42, FSwt43 FSwt44, FSwt45 **Obj. FWT1** – FSlw01, FSlw02 FSlw03, FSlw04 FSlw05, FSlw06 FSlw07, FSlw08 FSlw09, FSlw12 FSlw13, FSlw14 FSlw15, FSlw16 FSlw17, FSlw18 FSlw19, FSlw20 **Obj. FWT3** – FSlw36, FSlw37 FSlw38, FSlw39 FSlw40, FSlw41 FSlw45, FSlw46 FSlw47, FSlw48 FSlw49, FSlw50 **Obj. FE1** – FEne01, FEne02, FEne03, FEne04 FEne05, FEne06 FEne07, FEne08 FEne09, FEne12 FEne13, FEne14 FEne15, FEne16 FEne17, FEne18 **Obj. FE2** – FEne31, FEne32 **Obj. FE3** – FEne33, FEne34 FEne35, FEne36 FEne40, FEne41 FEne42, FEne43 FEne44, FEne45 **Obj. FM1** – FMob03, FMob04 FMob05, FMob06 FMob07, FMob08 FMob11, FMob12	**Obj. PWT3** – PSlw3, PSlw34, PSlw38, PSlw39 **Obj. PE1** – PEne03, PEne04 PEne05, PEne06 PEne07 **Obj. PE2** – PEne17, PEne18, PEne19, PEne20, PEne21 **Obj. PE3** – PEne27, PEne29 PEne33, PEne34 **Obj. PM1** – PMob03, PMob04 PMob05, PMob06 **Obj. PM2** – PMob17, PMob18 **Obj. PM3** – PMob21, PMob23 PMob27, PMob28

			FMob13, FMob14 FMob15, FMob16 FMob17 **Obj. FM2** – FMob35, FMob36	

Table 27 – Link between Bristol strategies and RAF metrics

	Organisational	**Spatial**	**Functional**	**Physical**
S008Bristol Develop community flood plans	**Obj. O1** – O01, O02, O03, O04, O05, O06, O07, O08, O09, O10 **Obj. O2** – O11, O12, O13, O14, O15, O16, O17, O18, O21, O22, O23, O24, O25, 027, O28, O29, O30, O31, O33, O34, O35, O36, O37 **Obj. O3** – 038, 039, 040, O41, O42, O43, O44, O46, O47, 050, 051, 052, O54, O57, O58, O60, O65, O66, O70	**Obj. S1** – S03, S06, S07, S16, S17 **Obj. S2** – S21, S22, S25	**Obj. FW1** – FWts1, FWts13, FWts14, FWts15, FWts16, FWts17, FWts18, FWts20, FWts21, FWts22, FWts23, **Obj. FW2** – FWts39, FWts40, FWts41, FWts42 **Obj. FW3** – FWts43, FWts44, FWts47, FWts49, FWts50, FWts51, FWts52, FWts56, FWts57, FWts68 **Obj. FWW1** – FWwt11, FWwt12 FWwt13, FWwt14 FWwt15, FWwt16 FWwt17, FWwt18 FWwt19, FWwt20 FWwt21 **Obj. FWW2** – FWwt37, FWwt38, FWwt39 **Obj. FWW3** – FWwt40, FWwt41 FWwt44, FWwt45 FWwt46, FWwt47 FWwt48, FWwt49 FWwt53, FWwt54 FWwt64 **Obj. FSW1** – FSwt03, FSwt11 FSwt12, FSwt13 FSwt14, FSwt15 FSwt16, FSwt17 FSwt18 **Obj. FSW2** –	**Obj. PW1**–PWts17 **Obj. PW2** – PWts20, PWts21, PWts22, PWts23, PWts24, PWts25 **Obj. PW3** – PWts36, PWts37, PWts38, PWts39, PWts40 **Obj. PWW1** – PWwt17 **Obj. PWW2** – PWwt20, PWwt21 PWwt22, PWwt23 PWwt24, PWwt25 **Obj. PWW3** – PWwt35, PWwt36, PWwt37, PWwt38, PWwt39 **Obj. PSW2** – PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25 **Obj. PSW3** – PSwt35, PSwt36 PSwt37, PSwt38 PSwt39 **Obj. PWT2** – PSlw18, PSlw19 PSlw20, PSlw21 PSlw22, PSlw23 **Obj. PWT3** – PSlw35, PSlw36 PSlw37, PSlw38 PSlw39 **Obj. PE2** – PEne16, PEne17

			FSwt29, FSwt30, FSwt31, FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt37, FSwt38 FSwt39, FSwt40 FSwt41, FSwt42 FSwt46, FSwt47 FSwt53 **Obj. FWT1** – FSlw11, FSlw12 FSlw13, FSlw14 FSlw15, FSlw16 FSlw17, FSlw18 FSlw19, FSlw20 **Obj. FWT2** – FSlw35, FSlw36 FSlw37, **Obj. FWT3** – FSlw38, FSlw39, FSlw42, FSlw43, FSlw44, FSlw45, FSlw47, FSlw51, FSlw52, FSlw61 **Obj. FE1** – FEne12 FEne13, FEne14 FEne15, FEne16 FEne17, FEne18 **Obj. FE2** – FEne30, FEne31 FEne32, **Obj. FE3** – FEne33, FEne34, FEne37, FEne38, FEne39, FEne40, FEne42, FEne45, FEne46, FEne47, FEne53 **Obj. FM1** – FMob11, FMob12, FMob13, FMob14, FMob15, FMob16, FMob17 **Obj. FM2** – FMob35, FMob36	PEne18, PEne19 PEne20, PEne21 **Obj. PE3** – PEne30, PEne31 PEne32, PEne33 PEne34 **Obj. PM2** – PMob16, PMob17 PMob18, **Obj. PM3** – PMob24,PMob25, PMob26,PMob27, PMob28
S009Bristol Build riverside flood defence walls		**Obj. S1** – S05, S06, S07, S08, S16, S17	**Obj. FW1** – FWts14, FWts15 FWts16, FWts17 FWts18, FWts19	**Obj. PW3** – PWts39, PWts40 **Obj. PWW3** –

		Obj. S2 – S18, S19, S20 S22, S27	FWts20, FWts21 FWts22, FWts23 **Obj. FW3** – FWts49, FWts51 **Obj. FWW1** – FWwt14, FWwt15 FWwt16, FWwt17 FWwt18, FWwt19 FWwt20, FWwt21 **Obj. FWW3** – FWwt46, FWwt48 **Obj. FSW1** – FSwt14, FSwt15 FSwt16, FSwt17 FSwt18, **Obj. FSW2** – FSwt39, FSwt41, FSwt42 **Obj. FWT1** – FSlw14, FSlw15, FSlw16, FSlw17, FSlw18, FSlw19, FSlw20, **Obj. FWT3** – FSlw44, FSlw46 **Obj. FE1** – FEne14, FEne15, FEne16, FEne17, FEne18 **Obj. FE3** – FEne39, FEne41 **Obj. FM1** – FMob13, FMob14, FMob15, FMob16, FMob17	PWwt38, PWwt39 **Obj. PSW3** – PSwt38, PSwt39
S007Bristol Keep identification of high-risk areas updated by conducting studies involving flood-modelling analysis	**Obj. O2** – O20, O21, O22, O23, O24, O25, O28, O29, O30, O34, O35, O36, O37 **Obj. O3** – O41, O42, O43, O44, O54, O57, O58, O60	**Obj. S1** – S01, S02, S03, S04, S05, S06, S07, S08, S09, S10, S11, S12, S13, S14, S15, S16, S17	**Obj. FW1** – FWts11, FWts12, FWts13, FWts14, FWts15, FWts16, FWts17, FWts18, FWts19, FWts20, FWts21, FWts22, FWts23, **Obj. FW2** – FWts40, FWts41, FWts42	**Obj. PW1** – PWts17 **Obj. PW2** – PWts20,PWts21, PWts22,PWts23, PWts24,PWts25, **Obj. PW3** – PWts36, PWts37, PWts38, PWts39, PWts40

			Obj. FW3 – FWts43, FWts44 FWts49, FWts50, FWts51, FWts52, FWts56, FWts57, FWts68 **Obj. FWW1** – FWwt12, FWwt13, FWwt14, FWwt15, FWwt16, FWwt17, FWwt18, FWwt19, FWwt20, FWwt21 **Obj. FWW2** – FWwt37, FWwt38, FWwt39 **Obj. FWW3** – FWwt40, FWwt41 FWwt44, FWwt45 FWwt46, FWwt47, FWwt49, FWwt53, FWwt54, FWwt64 **Obj. FSW1** – FSwt03, FSwt12, FSwt13, FSwt14, FSwt15 , Swt16, FSwt17, FSwt18, **Obj. FSW2** – FSwt30, FSwt31, FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt37, FSwt38 FSwt39, FSwt40 FSwt41, FSwt42 FSwt46, FSwt47 FSwt53 **Obj. FWT1** – FSlw12, FSlw13, FSlw14, FSlw15, FSlw16, FSlw17, FSlw18, FSlw19, FSlw20 **Obj. FWT2** – FSlw35, FSlw36 FSlw37 **Obj. FWT3** – FSlw38, FSlw39, FSlw42, FSlw43, FSlw44, FSlw45,	**Obj. PWW1** – PWwt17 **Obj. PWW2**– PWwt20,PWwt21, PWwt22,PWwt23, PWwt24, PWwt25 **Obj. PWW3** – PWwt35,PWwt36, PWwt37,PWwt38, PWwt39 **Obj. PSW2** – PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25 **Obj. PSW3** – PSwt35, PSwt36 PSwt37, PSwt38 PSwt39 **Obj. PWT2** – PSlw18, PSlw19 PSlw20, PSlw21 PSlw22, PSlw23 **Obj. PWT3** – PSlw35, PSlw36 PSlw37, PSlw38 PSlw39 **Obj. PE2** – PEne16, PEne17 PEne18, PEne19 PEne20, PEne21 **Obj. PE3** – PEne30, PEne31, PEne32, PEne33, PEne34 **Obj. PM2** – PMob16, PMob17 PMob18, PMob24 **Obj. PM3** – PMob25, PMob26 PMob27, PMob28

			FSlw46, FSlw47, FSlw51, FSlw52, FSlw61 **Obj. FE1** – FEne12, FEne13, FEne14, FEne15, FEne16, FEne17, FEne18 **Obj. FE2** – FEne30, FEne31 FEne32 **Obj. FE3** – FEne33, FEne34, FEne38, FEne39, FEne40, FEne41, FEne42, FEne45, FEne46, FEne47, FEne53 **Obj. FM1** – FMob10, FMob11 FMob12, FMob13 FMob14, FMob15 FMob16, FMob17 **Obj. FM2** – FMob34, FMob35 FMob36	
S012Bristol Adding rain gardens before sewer inlet points		**Obj. S1** – S12, S13, **Obj. S2** – S19, S25, S26		**Obj. PW3** – PWts33, PWts39 **Obj. PWW3** – PWwt32,PWwt38 **Obj. PSW3** – PSwt32, PSwt38 **Obj. PWT3** – PSlw31, PSlw38 **Obj. PE3** – PEne27, PEne33 **Obj. PM3** – PMob21, PMob27

Table 28 – Link between Lisbon strategies and RAF metrics

	Organisational	**Spatial**	**Functional**	**Physical**
S005Lisbon Adaptation of green infrastructure	**Obj. O3** – O52, O53, O54, O55, O56, O57	**Obj. S1** – S01, S02, S03, S04, S05, S06, S07, S08, S09, S10, S11, S12, S13,	**Obj. FW1 –** FWts12, FWts13 FWts14, FWts15 FWts16, FWts17 FWts18, FWts32,	**Obj. PW2** – PWts16,PWts17 PWts19

Measures ▪ Bioretention area ▪ Implementation of Rainwater Harvesting systems (RWH) ▪ Prioritize water allocation in a stress situation ▪ Build and promote urban forest and park		S14, S15, S16, S17 **Obj. S2** – S18 S19, S21, S22 S23, S24, S25 S26	FWts35, FWts36 **Obj. FW3 –** FWts47, FWts51, FWts2 **Obj. FSW1 –** FSwt12, FSwt13 FSwt14, FSwt15 FSwt16, FSwt17 FSwt18, FSwt25 FSwt26, FSwt27 FSwt28, **Obj. FSW2 –** FSwt31, FSwt32, **Obj. FSW3 –** FSwt37, FSwt38, FSwt39, FSwt40, FSwt41, FSwt42, FSwt43, FSwt44	**Obj. PSW1** – PSwt04, PSwt05, PSwt19 **Obj. PSW3** – PSwt32, PSwt33 PSwt34, PSwt38 PSwt39
S007Lisbon/ S016Lisbon Promote urban rehabilitation as a tool to increase resilience: sewer systems **Measures** ▪ Rehabilitate sewer pipes ▪ Inlets increase ▪ On-source sediment traps ▪ Construction of diversion tunnels ▪ Construction of anti-pollution basins	**Obj. O2** – O23 **Obj. O3** – O66		**Obj. FWW1** – FWwt12, FWwt13 FWwt14, FWwt15 FWwt16, FWwt17 FWwt18, FWwt19 FWwt20, FWwt21 **Obj. FWW3** – FWwt48, FWwt49 **Obj. FSW1** – FSwt12, FSwt13 FSwt14, FSwt15 FSwt16, FSwt17 FSwt18 **Obj. FSW3** – FSwt41, FSwt42	**Obj. PWW1** – PWwt06, PWwt07 PWwt17 **Obj. PWW3** – PWwt32,PWwt35, PWwt38,PWwt39 **Obj. PSW1** – PSwt06, PSwt07, PSwt17 **Obj. PSW3** – PSwt32, PSwt35, PSwt38, PSwt39
S008Lisbon Promote urban rehabilitation as a tool to increase resilience: facing climate change **Measures** ▪ Use of non-potable water in compatible uses ▪ Green roof ▪ Increase integration of renewable energy	**Obj. O2** – O15, O23 **Obj. O3** – O38 O39, O40, O41 O42, O43, O44 O45, O46, O47 O48, O49, O50 O51, O52, O53 O54, O55, O56 O57, O65, O66 O70	**Obj. S1** – S01, S02, S03, S04, S05, S06, S07, S08, S09, S10, S11, S12, S13, S14, S15, S16, S17 **Obj. S2** – S18, S19, S22, S23, S25, S26, S27, S28	**Obj. FWW1** – FWwt05, FWwt12 FWwt13, FWwt14 FWwt15, FWwt16 FWwt17, FWwt18 FWwt19, FWwt20 FWwt21, FWwt32 FWwt33, FWwt34 FWwt35, **Obj. FWW2** – FWwt38, FWwt39 **Obj. FWW3** –	**Obj. PWW1** – PWwt18, PWwt19 **Obj. PWW2** – PWwt21, PWwt22 PWwt23, PWwt24 PWwt25, PWwt26 PWwt27, PWwt28 PWwt29, PWwt30 PWwt31 **Obj. PWW3** – PWwt32,PWwt34 PWwt38,PWwt39

by Distributed Generation (DG) ▪ Restriction on land-use areas vulnerable to flooding events			FWwt40, FWwt41, FWwt42, FWwt43, FWwt44, FWwt45, FWwt46, FWwt47, FWwt48, FWwt49, FWwt50, FWwt51 **Obj. FSW1** – FSwt05, FSwt12 FSwt13, FSwt14 FSwt15, FSwt16 FSwt17, FSwt18 FSwt25, FSwt26 FSwt27, FSwt28 **Obj. FSW2** – FSwt31, FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt35, FSwt36 FSwt37, FSwt38 FSwt39, FSwt40 FSwt41, FSwt42 FSwt43, FSwt44 **Obj. FWT1** – FSlw05, FSlw12 FSlw13, FSlw14 FSlw15, FSlw16 FSlw17, FSlw18 FSlw19, FSlw20 FSlw30, FSlw31 FSlw32, FSlw33 **Obj. FWT2** – FSlw36, FSlw37 **Obj. FWT3** – FSlw38, FSlw39 FSlw40, FSlw41 FSlw42, FSlw43 FSlw44, FSlw45 FSlw46, FSlw47 FSlw48, FSlw49 **Obj. FE1** – FEne05, FEne12, FEne13, FEne14, FEne15, FEne16, FEne17, FEne18, FEne25, FEne26, FEne27, FEne28 **Obj. FE2** – FEne31, FEne32 **Obj. FE3** – FEne33, FEne34,	**Obj. PSW1** – PSwt18, PSwt19 **Obj. PSW2** – PSwt21, PSwt22 PSwt23, PSwt24 PSwt25, PSwt26 PSwt27, PSwt28 PSwt29, PSwt30 PSwt31 **Obj. PSW3** – PSwt32, PSwt34 PSwt38, PSwt39 **Obj. PWT1** – PSlw17 **Obj. PWT2** – PSlw19, PSlw20 PSlw21, PSlw22, PSlw23, PSlw24, PSlw25, PSlw26, PSlw27, PSlw28, PSlw29, PSlw30 **Obj. PWT3** – PSlw31, PSlw34 PSlw38, PSlw39 **Obj. PE1** – PEne15 **Obj. PE2** – PEne17, PEne18, PEne19, PEne20, PEne21, PEne22, PEne23, PEne24, PEne25, PEne26 **Obj. PE3** – PEne27, PEne29, PEne33, PEne34 **Obj. PM1** – PMob15 **Obj. PM2** – PMob17 PMob18, PMob19, PMob20 **Obj. PM3** – PMob21, PMob23, PMob27, PMob28

			FEne35, FEne36, FEne37, FEne38, FEne39, FEne40, FEne41, FEne42, FEne43, FEne44 **Obj. FM1** – FMob05, FMob11 FMob12, FMob13 FMob14, FMob15 FMob16, FMob17 FMob27, FMob28 FMob29, FMob30 FMob31, FMob32 **Obj. FM2** – FMob35, FMob36 **Obj. FM3** – FMob37	
S010Lisbon Strengthening collaboration within AML, Parishes and municipality departments **Measures** ▪ Increase commitment to develop risk management strategies ▪ Effective communication of risk, considering power relations among actors ▪ Training, exercises and education to transfer scientific and operational knowledge to practitioners ▪ Opportunities for citizens to participate in preparedness and response	**Obj. O1** – O01, O02, O03, O04, O05, O06, O07, O08, O09, O10 **Obj. O2** – O11, O12, O14, O15, O16, O17, O18, O19, O20, O21, O22, O23, O24, O25, O26, O27, O28, O29, O30, O31, O34, O35, O36, O37 **Obj. O3** – O39, O40, O41, O42, O43, O44, O45, O46, O47, O48, O49, O50, O51, O52, O53, O54, O57, O58 O60, O64	**Obj. S1** – S01, S02, S03 S04, S05, S06 S07, S08, S09 S10, S11, S12 S13, S14, S15 S16, S17 **Obj. S2** – S21 S27	**Obj. FW1 –** FWts04, FWts05 FWts06, FWts10, FWts11 **Obj. FW2 –** FWts36 **Obj. FW3 –** FWts44, FWts46 **Obj. FWW1 –** FWwt04, FWwt05 FWwt06, FWwt10, FWwt11 **Obj. FWW2 –** FWwt36 **Obj. FWW3 –** FWwt41 FWwt43 **Obj. FSW1 –** FSwt04, FSwt05 FSwt06, FSwt10, FSwt11, **Obj. FSW2** FSwt29 **Obj. FSW3 –** FSwt34, FSwt36 **Obj. FWT1 –** FSlw04, FSlw05,	**Obj. PWW1** – PWwt04,PWwt05 **Obj. PSW1** – PSwt04, PSwt05 **Obj. PWT1** – PSlw04 PSlw05, **Obj. PE1** – PEne04, PEne05 **Obj. PM1** – PMob04, PMob05

			FSlw06, FSlw10, FSlw11 **Obj. FWT2 –** FSlw34 **Obj. FWT3 –** FSlw39 FSlw41 **Obj. FE1 –** FEne03, FEne04, FEne05 **Obj. FE2 –** Fene29 **Obj. FE3 –** FEne34, Fene36 **Obj. FM1 –** FMob09, FMob10, FMob11 **Obj. FM2 –** FMob33	
S017Lisbon Lisbon drainage monitoring and early-warning system **Measures** ▪ Learn from real-life flooding by recording and investigating events ▪ Implement monitoring program and warning systems on drainage system ▪ Flood forecasting and warning	**Obj. O1** – O01, O02, O03, O04, O05, O06, O07, O08, O09, O10 **Obj. O2** – O11, O15, O16, O17, O18, O20, O21, O23, O24, O25, O28, O29, O30, O31, O34, O35, O36, O37 **Obj. O3** – O38, O39, O40, O41, O42, O43, O44, O46, O47, O50, O53 O54, O57, O58, O60, O61, O63, O64, O65, O66, O70	**Obj. S1** – S01, S02, S03, S04, S05, S06, S07, S08, S09, S10, S11, S12, S13, S14, S15, S16, S17 **Obj. S2** – S21 S22, S25	**Obj. FWW1** – FWwt03, FWwt04 FWwt07, FWwt11 FWwt12, FWwt13 FWwt14, FWwt15 FWwt16, FWwt17 FWwt18, FWwt19 FWwt20, FWwt21 **Obj. FWW2** – FWwt37, FWwt38 FWwt39 **Obj. FWW3** – FWwt40, FWwt41, FWwt42, FWwt44, FWwt45, FWwt46, FWwt47, FWwt48, FWwt49, FWwt50, FWwt51, FWwt53, FWwt54, FWwt64 **Obj. FSW1** – FSwt03, FSwt04 FSwt07, FSwt11 FSwt12, FSwt13 FSwt14, FSwt15 FSwt16, FSwt17 FSwt18,	**Obj. PWW1** – PWwt03,PWwt04 PWwt05,PWwt17 **Obj. PWW2** – PWwt20,PWwt21 PWwt22,PWwt23 PWwt24,PWwt25 **Obj. PWW3** – PWwt35,PWwt36 PWwt37,PWwt38 PWwt39 **Obj. PSW1** – PSwt03, PSwt04 PSwt05, PSwt17 **Obj. PSW2** – PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25 **Obj. PSW3** – PSwt35, PSwt36 PSwt37, PSwt38 PSwt39

			Obj. FSW2 – FSwt30, FSwt31, FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt35, FSwt37 FSwt38, FSwt39 FSwt40, FSwt41 FSwt42, FSwt43 FSwt44, FSwt46 FSwt47, FSwt53	
S019Lisbon Building protections for urban electrical infrastructure, exposed to estuarine flood **Measures** ▪ Install flood proof fencing ▪ Learn from real-life flooding by recording and investigating events ▪ Emergency response plans and procedures ▪ Build riverside flood defence walls	**Obj. O2** – O18, O19, O20, O22, O23, O24, O25, O26, O27, O28, O29, O30, O31, O34, O35, O36, O37 **Obj. O3** – O39, O40, O41 O42, O43, O44 O45, O46, O48 O49, O50, O51 O52, O53, O54 O57, O58, O60 O61, O63, O64 O65, O66, O70	**Obj. S1** – S01, S02, S03, S04, S05, S06, S07, S08, S09, S10, S11, S12, S13, S14, S15, S16, S17 **Obj. S2** – S18, S19, S20 S22, S27	**Obj. FWW1** – FWwt01, FWwt02 FWwt03, FWwt04 FWwt05, FWwt06 FWwt07, FWwt08 FWwt09, FWwt11 FWwt12, FWwt13 FWwt14, FWwt15 FWwt16, FWwt17 FWwt18, FWwt19 FWwt20, FWwt21 **Obj. FWW2** – FWwt37, FWwt38 FWwt39 **Obj. FWW3** – FWwt40, FWwt41, FWwt42, FWwt43, FWwt44, FWwt45, FWwt46, FWwt47, FWwt48, FWwt49, FWwt50, FWwt51, FWwt52, FWwt53, FWwt54, FWwt64 **Obj. FSW1** – FSwt01, FSwt02 FSwt03, FSwt04 FSwt05, FSwt06 FSwt07, FSwt08 FSwt09, FSwt11 FSwt12, FSwt13 FSwt14, FSwt15 FSwt16, FSwt17 FSwt18, **Obj. FSW2** – FSwt30, FSwt31, FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt35, FSwt36 FSwt37, FSwt39 FSwt40, FSwt41 FSwt42, FSwt43	**Obj. PWW1** – PWwt04,PWwt05 PWwt17 **Obj. PWW2** – PWwt20, PWwt21 PWwt22, PWwt23 PWwt24, PWwt25 **Obj. PWW3** – PWwt34, PWwt35, PWwt36, PWwt37, PWwt38, PWwt39 **Obj. PSW1** – PSwt04, PSwt05 PSwt17 **Obj. PSW2** – PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25 **Obj. PSW3** – PSwt34, PSwt35, PSwt36, PSwt37, PSwt38, PSwt39 **Obj. PE1** – PEne04, PEne05, PEne08, PEne09 PEne10, PEne011, PEne12 PEne13 PEne14 **Obj. PE2** – PEne16, PEne17 PEne18, PEne19 PEne20, PEne21 **Obj. PE3** – PEne29, PEne30 PEne31, PEne32 PEne33, PEne34

			FSwt44, FSwt45 FSwt46, FSwt47 FSwt53 **Obj. FE1** – FEne01, FEne02, FEne03, FEne04, FEne05, FEne06, FEne07, FEne08, FEne09, Fene10, FEne11, FEne12, FEne13, FEne14, FEne15, FEne16, FEne17, FEne18 **Obj. FE2** – FEne30 FEne31, FEne32 **Obj. FE3** – FEne33, FEne34, FEne35, FEne36, FEne37, FEne38, FEne39, FEne40, FEne41, FEne42, FEne43, FEne44, FEne45, FEne46, FEne47, FEne53	

Overall, it can be perceived that the strategies selected by the three RESCCUE cities have multiple impacts in several resilience dimensions, objectives and criteria. Therefore, spread effects on city resilience are expected, during and after strategies implementation period.

Annex 4 presents the links with RAF metrics for all the strategies developed in the web-database of strategies, introduced by the three RESCCUE cities. A total number of 39 strategies are therein considered, available for selection by any city. These links provide an overall expected impact on resilience that may be obtained through the selected strategies.

7. Approach for implementation of a city resilience assessment

7.1. Overview

The RAF provides the assignment of a degree of **relevance**: *essential*, *complementary*, and *comprehensive* to each metric, as already referred (see section 4.1). Based on this feature, the deeper insight assessment may be firstly carried out for the *essential* metrics, if a city is still initiating its path on resilience, then for the *complementary* metrics and further on for the *comprehensive* metrics. Therefore, the proposed RAF enables a tailored assessment of any city, regardless

of their resilience maturity, and supports the identification of a resilience development level for each dimension and for each service, addressing literature recommendations (see section 3.1).

Given the adopted structure, an effective and robust implementation requires the involvement of multiple parties, in a collaborative process allowing incorporation of the best available information. An inherent aspect in these collaborative processes is the recognition of the broad duties of each stakeholder, both in their specific roles as well as contributors to the city as a whole. Generally, objectives and perceptions of stakeholders differ according to their specific duties and aims. Assembling a multi-stakeholder team allows to take into account different points of view and to improve individual perceptions of the different resilience dimensions and interdependencies. Consequently, decision-making processes are better supported and opportunities arise for using information and resources in a more efficient way.

Coordination of the whole process is key for the successful implementation of the RAF as for subsequent steps in planning action and ensuring its implementation, monitoring and revision. Therefore, the implementation of the proposed framework incorporates a stepwise approach.

The resilience assessment, in this case to climate change and water-related, is a critical part of the management of the global resilience of a city. The RAF, being a flexible framework, allows inclusion of additional objectives, criteria and metrics, for the services already included.

7.2. RAF implementation step by step

Regardless of the specific arrangements of the city services responsible for resilience, the assessment is a key phase to establish a diagnosis and, subsequently, to define a plan for improvement. Therefore, a number of steps are required to ensure successful application of the RAF.

Overall, the following steps have to be undertaken:

1. Establishment of the scope of the assessment, namely, which hazards, services, infrastructures are included.
2. Stakeholder identification, commitment, assemble teams and responsibilities, and establishment of leading principles of collaboration, including setup of a coordination and supporting group (CSG).
3. Definition of context of application including period, level of application and analysis (strategic or tactical; essential, complementary or comprehensive), geographical units of analysis, as applicable.
4. Identification of data requirements and selection of analysis tools for supporting application for each dimension/service/type of infrastructure of the assessment.

5. Setting of a program for application of the RAF by each party of the team with responsibilities assigned. The tasks included in the program must provide opportunities for debating sessions and supporting actions by CSG.
6. Evaluation of preliminary assessment from results of RAF by CSG and feedback to parties.
7. Production of final version of the assessment from RAF results.

Feedback loops should be considered whenever applicable or deemed as necessary by team members.

8. Final remarks and further developments

The development, validation of the RAF and its application to the RESCCUE cities, together with the RAF App, have demonstrated that the RAF is a tool that provides support to a structured assessment of urban resilience to climate change with focus on water. Even though it was developed within RESCCUE and to support RESCCUE cities and services, replication was in its foundation. Given its different assessment levels, it may be used by any city, service or organization that intends to undertake a resilience assessment or to develop a RAP with these scope and focus, regardless of their resilience maturity. The RAF allows to align with the resilience path and integrate the work already in place in the cities and services, as well as to consider the information provided by diverse analysis approaches and tools, already in use or to be used by the city and services managers.

The RAF is a flexible framework allowing further inclusion of additional dimensions, such as social or economic, and of other objectives, criteria and metrics, for the services already addressed. Moreover, it may be strengthened with the incorporation of other services, such as telecommunication, education or health. Other development opportunities are the consideration of other hazards, such as earthquakes, or of other risks. These developments are encouraged to be included in the RAF App, to keep the user-friendliness of the RAF application.

Given the identified RAF future developments, together with the RAF App, and the fact of it being freely available, a significant potential for near future exploitation of the framework is foreseen. Taking also into account the internationally recognised concerns with urban resilience and with climate change challenges, and the numerous prospective users aiming to leverage or consolidate it, a broader interest in the RAF is anticipated, by city and service managers, consultants, the academia and researchers.

Bibliography

Abdrabo, M., and Hassaan, M. (2014). *Assessing Resilience of the Nile Delta Urban Centers to Sea Level Rise Impacts*, 5th Global Forum on Urban Resilience & Adaptation, pp. 29–31, Bonn, Germany.

Ainuddin, S., and Routray, J. K. (2012). *Earthquake hazards and community resilience in Baluchistan*, Nat. Hazards, 63(2), 909–937.

ASCE (2017). 2017 Infrastructure report card. American Society of Civil Engineers.

ARUP (2015). *City Resilience Framework*. 100 Resilient cities. The Rockefeller Foundation, ARUP.

Batica, J. (2015). *Methodology for flood resilience assessment in urban environments and mitigation strategy development*, PhD thesis, Universite Nice Sophia Antipolis, Nice, France. [Available at https://tel.archives-ouvertes.fr/tel-01159935/file/2015NICE4006.pdf.]

Bertoldi P. (2018). Bertoldi P. (editor) Guidebook 'How to develop a Sustainable Energy and Climate Action Plan (SECAP) – Part 1 - The SECAP process, step-by-step towards low carbon and climate resilient cities by 2030, EUR 29412 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-96847-1, doi:10.2760/223399, JRC112986.

Brito, R.S., Pereira, C.L., Lopes, P., Cardoso, M.A. (2019). *RESCCUE RAF App - Climate change Resilience Assessment Framework tool for urban areas*. ECCA 2019, European Climate Change Adaptation Conference, Lisbon, Portugal.

Brugmann, J. (2012). *Financing the resilient city*. Environment and Urbanization, 24(1), 215–232. https://doi.org/10.1177/0956247812437130

Cardoso, M.A., Almeida, M.C., Telhado, M.J., Morais, M., Brito, R.S. (2018). *Assessing the contribution of climate change adaptation measures to build resilience in urban areas. Application to Lisbon.* 8th International Conference on Building Resilience, ICBR, 14-16 November, Lisbon, Portugal.

Cardoso, M. A. & Brito, R. S. (2019). *Approach To Develop a Climate Change Resilience Assessment Framework*. Leading edge strategic asset management & performance indicators Conference, LESAM 2019, IWA Specialist Conference, Vancouver, Canada.

Cardoso, M. A., Brito, R.S., Pereira, C., Gabàs, A., González Gómez, A., Goodey, P., Lopes, R., Martínez, M., Russo, B., Telhado, M.J., Stevens, J., Velasco, M. (2020). *Resilience Action Plans of the RESCCUE cities*. D6.2 RESCCUE project (Public).

Cox, R.S., Hamlen, M., (2014). *Community disaster resilience and the rural resilience index*. Am. Behav. Sci. 59, 220–237.

EPA (2017). *Evaluating Urban Resilience to Climate Change: A Multi-Sector Approach*. U.S. Environmental Protection Agency, Washington, D.C., EPA/600/R-16/365F, January 2017, www.epa.gov/research.

ERSAR (2009). ERSAR and LNEC Editors. *System for assessment of the quality of service to the users of urban water and waste services. First Generation of the performance indicators' system to assess quality of service*. Technical guides series, nº 12, IRAR/LNEC, (175 pp.) ISBN: 978-989-95392-8-0.

ERSAR (2013). ESAR and LNEC Editors. *Guide for assessment of the quality of service to the users of urban water and waste services. Second Generation of the performance assessment system*. Technical guides series, nº 12, 241 pp., ISBN: 978-989-8360-11-3.

ERSAR (2018). Editor. *Guide for assessment of the quality of service to the users of urban water and waste services. Third Generation of the performance assessment system*. Technical guides series, nº 12, 352 pp..

Evans, B., Djordjevic, S., Chen, A.S., Webber, J., Russo, B., Forero Ortiz, E., Martinez, E., Guerrero Hidalga, M., Dominguez, J.L., Almeida, M.C., Telhado, M., Morais, M., Silva, I.C., Duarte, N., Stevens, J., Henderson, R., Goodey, P., Gonzalez Gomez, A., Rico, E., Sanches, D., Dominguez, J.L. (2020). Impact Assessments of Multiple Hazards In Case Study Areas (With Adaptation Strategies). D3.6 RESCCUE project (Confidential).

Frankenberger, T., Mueller, M., Spangler, T., Alexander, S. (2013). *Community Resilience: Conceptual Framework and Measurement Feed the Future Learning Agenda*. Westat, Rockville, MD.

ISO 37120:2014 – *Sustainable development of communities. Indicators for city services and quality of life*. International Organisation for Standardisation, Switzerland.

ISO 9001:2015 – *Quality management systems*. International Organisation for Standardisation, Switzerland.

Joerin, J., & Shaw, R. (2011). *Mapping climate and disaster resilience in cities*. In *Climate and Disaster Resilience in Cities* (Vol. 6, pp. 47-61). (Community, Environment and Disaster Risk Management; Vol. 6). https://doi.org/10.1108/S2040-7262(2011)0000006009

Kona, A., Melica, G., Rivas, S., Zancanella, P., Iancu, A., Gabrielaitiene, I., Saheb, Y., Janssens-Maenhout, G., Bertoldi, P. (2015). *The Covenant of Mayors in Figures and Performance Indicators: 6-year Assessment*. 10.2790/774700.

Kwasinski, A., Trainor, J., Wolshon, B., Lavelle, F. M. (2016). *A Conceptual Framework for Assessing Resilience at the Community Scale*. National Institute of Standards and Technology. NIST GCR 16-001.

Larkin, S., Fox-Lent, C., Eisenberg, D.A., Trump, B.D., Wallace, S., Chadderton, C., Linkov, I. (2015). *Benchmarking agency and organizational practices in resilience decision making*. Environ. *Syst. Decis.* 35, 185–195.

Lavelle, F. M., Ritchie, L. A., Kwasinski, A., Wolshon, B. (2015). *Critical Assessment of Existing Methodologies for Measuring or Representing Community Resilience of Social and Physical Systems.* National Institute of Standards and Technology. NIST GCR 15-1010

Lopes, P., Oliveira, A., Pereira, C., Brito, R.S., Cardoso, M. A., Martins, R., David, M., Gomes, J., Pina, J. (2019). *RESCCUE RAF app – an IT solution for digital interactive urban resilience assessment*. 10th Iberian Grid Conference, 23 September, Santiago de Compostela, Spain.

Martínez-Gomariz, E., Vela, S., García, L., Mendoza, E., Martínez, M., Stevens, J., Almeida, M.C., Telhado, M.J., Morais, M., Silva, I.C., Alves, R. and Pimentel, N. (2017). *Multisectorial resilience strategies framework and strategies database development.* D5.1 RESCCUE Project (Public).

Martínez-Gomariz, E., Guerrero, M., Martínez, M., Stevens, J., Almeida, M.C., Pereira, C., Morais, M., Telhado, M.J., Silva, I.C., Duarte, N., Pimentel, N., Alves, R., Lopes, R., Barreiro, J., Metelo, I., Pacheco, P., Lourenço, A.C., Coelho, L. (2019). Report on methodologies for the selection of resilience strategies. D5.2 RESCCUE Project (Public).

Monaghan, P., Ott, E., Fogarty, T. (2014). *Measuring Community Resilience using Online Toolkits.*

Neves, A., Blondel, L., Brand, K., Hendel Blackford, S., Rivas Calvete, S., Iancu, A., Melica, G., Koffi Lefeivre, B., Zancanella, P., Kona, A. (2016). *The Covenant of Mayors for Climate and Energy Reporting Guidelines*; EUR 28160 EN; doi:10.2790/586693

Norris, F.H., Stevens, S.P., Pfefferbaum, B., Wyche, K.F., Pfefferbaum, R.L. (2008). *Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness*. Am. J. Commun. Psychol. 41, 127–150.

Pagani, G., Fournière, H., Cardoso, M.A., Brito, R.S. (2018). *Report with the resilience diagnosis for each city*, D6.1 Project RESCCUE, 2018.

Panda, A. (2018). Foreward. 8th International Conference on Building Resilience, ICBR, 14-16 November, Lisbon, Portugal.

Patel, R., Nosal, L. (2016). *Defining the Resilient City. Working Paper 6*. United Nations University Centre for Policy Research.

Peacock, W. G., Brody, S., Seitz, W., Merrell, W., Vedlitz, A., Zahran, S., Harriss, R. and Stickney, R. (2010). *Advancing resilience of coastal localities: Developing, implementing, and sustaining the use of coastal resilience indicators: A final report*. Hazard Reduction and Recovery Center, Texas A&M University, College Station, Tex.

Rockefeller Foundation and Arup Group. (2014). *City Resilience Framework*, available at https://www.rockefellerfoundation.org/app/uploads/City-Resilience-Framework1.pdf

Rowcliffe, P., Lewis, M., Port, A. (2000). T*he Community Resilience Manual: A Resource for Rural Recovery & Renewal.* Centre for Community Enterprise.

Schipper, E. L. and Langston, L. (2015). *A comparative overview of resilience measurement frameworks – Analysing indicators and approaches*. Working paper 422, Overseas Development Institute.

Sharifi, A. (2016). *A critical review of selected tools for assessing community resilience*. Ecological Indicators. 69 (2016), 629-647. 10.1016/j.ecolind.2016.05.023.

Summers, J. K., Harwell, L. C. and Smith, L. M. (2016). *A model for change: An approach for forecasting well-being from service-based decisions*. Ecological Indicators 69(2016), 295–309.

Summers, J. K., Smith, L. M., Harwell, L. C., and Buck, K.D. (2017). *Conceptualizing holistic community resilience to climate events: Foundation for a climate resilience screening index*. *GeoHealth*, 1, 151–164, doi:10.1002/2016GH000047.

Tafidis, P., Sdoukopoulos, A., Pitsiava-Latinopoulou, M. (2017). *Sustainable urban mobility indicators: policy versus practice in the case of Greek cities*. Transportation Research Procedia, Volume 24, Pages 304-312, ISSN 2352-1465, https://doi.org/10.1016/j.trpro.2017.05.122.

UKWIR (2017). *Resilience – Performance measures, costs and stakeholder communication*. UK Water Industry Research, Report Ref. No. 17/RG/06/4.

UN-GA (2016). *Sustainable development: disaster risk reduction*. *Report of the open-ended intergovernmental expert working group on indicators and terminology relating to disaster risk reduction*. United Nations – General Assembly , Seventy-first session, agenda item 19.

UN-Habitat (2013). *City Resilience Profiling Programme Phase 2: CRP Tool 'Lite'*. UNISDR Steering Committee, 29-31 October 2013.

UN-Habitat City Resilience Profiling Programme (2018). *Guide to the City Resilience Profiling Tool*. United Nations Human Settlements Programme (UN-Habitat). Available at: http://urbanresiliencehub.org/wp-content/uploads/2018/07/CRPT-Guide-18.07-Pages.pdf

UNISDR (2015). *Sendai framework for disaster risk reduction 2015–2030*. Available at http://www.wcdrr.org/uploads/Sendai_Framework_for_Disaster_Risk_Reduction_2015-2030.pdf. United Nations International Strategy for Disaster Reduction.

UNIDSR (2017a). *Disaster resilience scorecard for cities. Preliminary level assessment*. United Nations Office for Disaster Reduction. United Nations International Strategy for Disaster Reduction.

UNIDSR (2017b). *Disaster resilience scorecard for cities. Detailed level assessment*. United Nations Office for Disaster Reduction. United Nations International Strategy for Disaster Reduction.

Vallejo, L. and M. Mullan (2017). *Climate-resilient infrastructure: Getting the policies right*, OECD Environment Working Papers, No. 121, OECD Publishing, Paris. http://dx.doi.org/10.1787/02f74d61-en

WBCSD (2015). *Methodology and indicator calculation method for Sustainable Mobility Project 2.0 (SMP2.0)*. World Business Council for Sustainable Development. ISBN: 978-2-940521-26-5.

WHO (2009). *The resilience of water supply and sanitation in the face of climate change*. World Health Organization. United Kingdom. Department for International Development (DFID), ISBN 978 92 4 159842 2.

World Bank Group (2015). *City Strength Diagnostic – Methodological Guidebook*. First edition, May 2015. City Strength Resilient Cities Program.

Yoon, D.K., Kang, J.E., & Brody, S.D. (2016). *A measurement of community disaster resilience in Korea*, Journal of Environmental Planning and Management, 59:3, 436-460, DOI: 10.1080/09640568.2015.1016142

Annexes

Annex 1 – Metrics description

ORGANISATIONAL

PI code	PI name	Unit*

O01 - Community or "grassroots" organizations, networks and training (-)

Are grassroots or community organizations participating in pre-event planning and post-event response for each neighbourhood in the city?

Dimension	Organisational
Subdimension	-
Resilience objective	Collective engagement and awareness
Criteria	Citizens and communities engagement
Source	UNISDR Scorecard P7.1
Importance	Essential
Level	Strategic
Metric type	Single choice

The types of grassroots organizations actively supporting disaster risk reduction (DRR) activities will vary by region and by city.

Development assessment rule	Development
Community organizations that cover a significant proportion of the city's population are actively participating in pre-event planning and post-event response right across the city	**3**
There is involvement in diverse grassroots organizations, either in some locations, or in some aspect of the planning or response, but it is it not comprehensive	**2**
There is awareness amongst key grassroots organizations of the importance of DRR, they support with awareness raising but not with active participation around response or planning	**1**
There is very little involvement from grassroots organizations in the city	**0**

O02 - Civil society links (-)

Are civil society organisations engaged?

Dimension	Organisational
Subdimension	-
Resilience objective	Collective engagement and awareness
Criteria	Citizens and communities engagement
Source	UNISDR Scorecard D4.1.4 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

Civil society organisations are engaged when, e.g city disaster risk reduction (DRR) stakeholders have in place agreements with various NGOs, with NGO role defined in providing support in response, relief and meeting resource demands; high volunteer capacity as required; regular planning and coordination meetings.

Development assessment rule	Development
Yes	**3**
The city works with NGOs or volunteers in some extent. Volunteer capacity below city needs	**2**
The city DRR stakeholders have started to engage NGO organisations and/or volunteers	**1**
No agreements / arrangements	**0**

* (-) without unit or dimensionless

O03 - Engagement of vulnerable groups of the population (-)

There is evidence of disaster resilience planning with or for the relevant groups of vulnerable population, and there is a confirmation from those groups of effective engagement?

Dimension	Organisational
Subdimension	-
Resilience objective	Collective engagement and awareness
Criteria	Citizens and communities engagement
Source	UNISDR Scorecard D7.2.2 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

As per UNISDR Scorecard definition, vulnerable groups of the population might include, as examples:
- Those in areas of high poverty;
- Transient or nomadic communities;
- The elderly;
- Physically or mentally sick or disabled;
- Children, especially those without parental care;
- Non-native language speakers.

Development assessment rule	Development
All vulnerable groups are regularly engaged	**3**
One or more major gaps in coverage or effective	**2**
Generalized failure to engage with vulnerable groups	**1**
No vulnerable groups specifically identified	**0**

O04 - Citizen engagement techniques (-)

How effective is the city at citizen engagement and communications in relation to disaster risk reduction (DRR)?

Dimension	Organisational
Subdimension	-
Resilience objective	Collective engagement and awareness
Criteria	Citizens and communities engagement
Source	UNISDR Scorecard P7.4
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Engagement through multiple media channels (e.g. social media, radio, email,newspaper, mobile device). Mobile used for inbound data flow, crowd management etc. Result is multiple contacts per citizen per year	**3**
Multiple media channels. No inbound data collection from mobiles. Majority of citizens reached several times per year	**2**
Some channels, semi-regular updates	**1**
Poor or no citizen engagement on DRR	**0**

O05 - Use of mobile and e-mail “systems of engagement” to enable citizens to receive and give updates before and after a disaster (-)

Use of mobile and social computing-enabled systems of engagement. All information before, during and after an event is supported by email, available on mobile devices, supported by alerts on social media, used to enable an in-bound “citizen to government” flow allowing crowd sourcing of data on events and issues?

Dimension	Organisational
Subdimension	-
Resilience objective	Collective engagement and awareness
Criteria	Citizens and communities engagement
Source	UNISDR Scorecard D7.4.2 (adapted)
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
All these are used in the city	**3**
Some use is made, but there are larger gaps in the information available by this means	**2**
Only rudimentary use of systems of engagement but interest in expanding this	**1**
No use of systems of engagement	**0**

O06 - Public education and awareness (-)

Existence and reach of a co-ordinated public relations and education campaign, with structured messaging and channels to ensure hazard, risk and disaster information is disseminated to the public?

Dimension	Organisational
Subdimension	-
Resilience objective	Collective engagement and awareness
Criteria	Citizens and communities awareness and training
Source	UNISDR Scorecard P6.2
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Fully co-ordinated campaigns and programmes exist to ensure proper dissemination of hazard, risk and disaster information. Key messages reach over 75% of the city population	**3**
Campaigns and programmes exist to ensure proper dissemination of hazard, risk and disaster information. Key messages reach over 50% of the city population	**2**
Some useful programmes / channels exist for disseminating hazard, risk and disaster information, but there is significant room for improvement to reach a greater proportion of the public. 25% of the city population is reached	**1**
Systems for disseminating critical information on disaster risk are wholly inadequate	**0**

O07 - Training delivery (-)

Existence and reach (to all sectors) of training courses covering risk and resilience issues?

Dimension	Organisational
Subdimension	-
Resilience objective	Collective engagement and awareness
Criteria	Citizens and communities awareness and training
Source	UNISDR Scorecard P6.4
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
There are training courses covering risk, resilience and disaster response offered across all sectors of the city including government, business, NGOs and community	**3**
The city has a track record of delivering resilience training to some sectors, but other sectors lack training and engagement	**2**
Some training modules are available. Coverage and content needs to be significantly improved	**1**
Little or no relevant training exists that is tailored for the city	**0**

O08 - Drills (-)

Do practices and drills involve both the public and professionals?

Dimension	Organisational
Subdimension	-
Resilience objective	Collective engagement and awareness
Criteria	Citizens and communities awareness and training
Source	UNISDR Scorecard P9.7
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Annual suite of drills validated by professionals to be realistic representation of “most severe” and “most probable” scenarios	**3**
Annual drills validated by professionals, limited test scenarios	**2**
Ad hoc partial exercises – not all scenarios tested, not realistic	**1**
No exercises (or no plans)	**0**

O09 - Social networks (-)

Are there regular training programmes provided to the most vulnerable and at need populations in the city?

Dimension	Organisational
Subdimension	-
Resilience objective	Collective engagement and awareness
Criteria	Citizens and communities awareness and training
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

As per UNISDR Scorecard definition, vulnerable groups of the population might include, as examples:
• Those in areas of high poverty;
• Transient or nomadic communities;
• The elderly;
• Physically or mentally sick or disabled;
• Children, especially those without parental care;
• Non-native language speakers.

Development assessment rule	Development
Once every six-months training programmes are conducted	**3**
Once a year training programmes are conducted	**2**
No training programmes. But mapping of socially vulnerable population is available	**1**
There is no mapping of socially vulnerable population	**0**

O10 - Validation of effectiveness of education (-)

Knowledge of “most probable” risk scenario and knowledge of key response and preparation steps is widespread throughout city, tested by sample survey

Dimension	Organisational
Subdimension	-
Resilience objective	Collective engagement and awareness
Criteria	Citizens and communities awareness and training
Source	UNISDR Scorecard D7.4.3 (adapted)
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Appears to be generally known by >90% of respondents	**3**
Known by 50-89% of respondents	**2**
Known by 10-49% of respondents	**1**
Known by less than 10% of responders, or no poll was implemented	**0**

O11 - Consultative planning process (-)

Existence and characteristics of formal planning consultative process?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Government decision-making and finance
Source	-
Importance	Complementary
Level	Strategic
Metric type	Multiple choice

If yes, please select all applicable answers. Sum of the selected options.

Development assessment rule	Development
a) It includes the identification of all stakeholders	**1**
b) it establishes procedures (including deadlines and means for public information and consultation)	**1**
c) it ensures transparent and inclusive dialogue with all relevant stakeholders	**1**
d) No process is in place	**0**

O12 - Planning approval process (-)

Characteristics of the planning approval process?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Government decision-making and finance
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

Please select all applicable answers. Sum of the selected options and a scale to 3 is made.

Development assessment rule	Development
a) It is effective (with an explicit approval process)	**1**
b) It is robust (with informed decision-making, taking into account the diagnosis, risk scenarios and evaluation of benefits	**1**
c) It is transparent (engaging all actors in city decision-making)	**1**
d) It is consistent with defined planning policy and strategy	**1**
e) No process	**0**

O13 - Public finances (-)

Are the objectives of the city Strategy and/or Planning portfolio matched by adequate public finances?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Government decision-making and finance
Source	UN-Habitat CRPT 4-7.2.6.8 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
No	**0**

O14 - Financial plan and budget for resilience, including contingency funds (-)

Does the city have in place a specific 'ring fenced' (protected) budget, the necessary resources and contingency fund arrangements for local disaster risk reduction (DRR) (mitigation, prevention, response and recovery)?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Government decision-making and finance
Source	UNISDR Scorecard P3.2
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
The city financial plan is comprehensive in relation to DRR, budgets are ring fenced and contingency plans are in place	**3**
The city financial plan allows for DRR activities, budgets are ring fenced	**2**
There are some plans in different agencies/organizations but they are not co-ordinated	**1**
No clear plan	**0**

O15 - Co-ordination with other government bodies (-)

Does the city have a formal mechanism (e.g., Office, Committee, National/Regional Platform) to coordinate actions between city and other international, national, regional or local governments, which ensures integrated and flexible communication and collaboration between them?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Coordination and communication with stakeholders
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
There are some difficulties or bureaucracy in the communication and collaboration with some entities	**2**
Regardless of whether there is a formal mechanism, communication and collaboration with some entities is either time-consuming or misaligned, or can fail critically in a emergency situation	**1**
Ad hoc or occasional coordination	**0**

O16 - Multi-stakeholder collaboration (-)

Does the city have a formal stakeholder engagement programme (including the most socially vulnerable and at need populations)?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Coordination and communication with stakeholders
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Socially vulnerable includes those more likely to suffer disproportionately because of their social circumstances (e.g. due to age, gender, race, medical illness, disability, literacy or social isolation). This metric conditions the metrics O17 and O18.

Development assessment rule	Development
Yes, a formal stakeholder engagement programme exist involving all stakeholders	**3**
Yes, it exists but is limited to some sectors and social groups; or the involvment is infrequent	**2**
No, but there is a process done on a regular basis ensuring engagement of all stakeholders	**1**
No stakeholder engagement programme; or too limited	**0**

O17 - Access and use of digital services (-)

In its stakeholder engagement programme, does the city encourage access and use of digital services?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Coordination and communication with stakeholders
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

This metric depends on metric O16.

Development assessment rule	Development
Yes	**3**
No	**0**

O18 - Collaboration mechanisms (-)

In its stakeholder engagement programme, does the city have mechanisms to ensure:

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Coordination and communication with stakeholders
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select all applicable answers. Sum of the selected options and a scale to 3 is made. This metric depends on metric O16.

Development assessment rule	Development
a) Regular, proactive and inclusive multi-stakeholder collaboration (including the most socially vulnerable and at need populations)	**1**
b) Cross-sectoral partnership	**1**
c) Dialogue and cooperation among scientific and technological communities (e.g. Expert Committee on Risk Information), other relevant stakeholders and policy makers (in order to facilitate a science-policy interface for effective public and private decision making)	**1**
d) Engagement with other cities (to learn lessons and exchange experience)	**1**
e) No process	**0**

O19 - City Master Plan making and implementation (-)

Does the city master plan (or relevant strategy/plan) include and localise and/or implement objectives of Agenda 2030?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

If yes, please select all applicable answers. Sum of the selected options and a scale to 3 is made.

Development assessment rule	Development
a) Objectives in line with the Sustainable Development Goals, Targets and Indicators	**1**
b) Climate objectives in line with COP21 Paris Agreement	**1**
c) Disaster risk reduction approaches in line with the Sendai Framework	**1**
d) Urban strategies in line with New Urban Agenda	**1**
e) The plan exists but none of the above applies, or no process exist	**0**

O20 - City Master Plan monitoring and review (-)

Is the City Master Plan periodically monitored and reviewed, ensuring it remains relevant and is properly operational?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes, at least once every 10 years	**3**
Yes, at least once every 20 years	**2**
The frequency exceeds once every 20 years, or the plan is not considered relevant or operational	**1**
No periodical monitoring and review	**0**

O21 - Hazard Assessment (-)

Existence of hazard assessment(s) (knowledge of key hazards that the city faces, including likelihood of occurrence)?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	UNISDR Scorecard P2.1 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes, hazard assessments exist. Hazards data is updated at agreed intervals	**3**
Yes, hazard assessments exist, but there are no agreed plans for updating this information	**2**
Partially, data exists on most of the main hazards	**1**
No hazard assessment and not enough information. Hazards are not well understood	**0**

O22 - Damage and loss estimation (-)

Does risk assessment include estimations of damage and loss from potential disasters, based on current development and future urban and population growth?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	UNISDR Scorecard D2.2.2 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Risk assessments focus mostly on spatial, physical assets at risk. Data is limited	**2**
There are plans to develop risk assessments	**1**
Risk assessments do not identify all risk areas or there are no plans to update them	**0**

O23 - Shared understanding of infrastructure risk (-)

Is there a shared understanding of risks between the city and various utility providers and other regional and national agencies that have a role in managing infrastructure such as power, water, roads and trains, of the points of stress on the system and city scale risks?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	UNISDR Scorecard P2.2
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
There is a shared understanding of risks between the city and various utility providers – the points of stress and interdependencies within the system / risks at the city scale are acknowledged	**3**
There is some sharing of risk information between the city and various utility providers and some consensus on points of stress	**2**
Individual system risks are known but there is no forum to share these or to understand cascading impacts	**1**
There is significant gaps in understanding risks, even at the level of individual systems (e.g. power, water, transport)	**0**

O24 - Plan for resilience (-)

Does the city have a municipally approved resilience plan (strategy or action plan)? And what is its timeframe?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	UN-Habitat CRPT 1-3.4.2 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metrics O25, O26, O27, O28 and O29.

Development assessment rule	Development
Yes approved. It considers short-, medium- and long-term	**3**
Yes approved. Its timeframe is not defined or considers only short-, medium- or long-term	**2**
It is under approval or under preparation. Timeframe is not yet finalised	**1**
No plan	**0**

O25 - Plan for resilience and Climate Change (-)

Does the resilience plan consider climate change (projection, scenarios, impacts, etc.)?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on metric O24.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

O26 - Plan integration in the City Master Plan (-)

Is the resilience plan integrated with the City Master Plan?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

This metric depends on metric O24.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

O27 - External support for the resilience plan (-)

Is the document being developed by the city alone or with support from INGOs/UN bodies working on the subject?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Single choice

This metric depends on metric O24.

Development assessment rule	Development
Developed by the city alone	**0**
Developed with partial support from INGOS/UN bodies	**1.5**
Developed with support from INGOS/UN bodies	**3**

O28 - Robustness of resilience plan (-)

How robust is the resilience plan?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select all applicable answers. Sum of the selected options. This metric depends on metric O24.

Development assessment rule	Development
a) It has a supporting legal, financial and institutional framework	**1**
b) It considers evidence-based decision-making (taking into account the diagnosis	**0.4**
c) It has been developed within a consultative process by engaging all city stakeholders	**0.4**
d) It defines priorities of action according to different timeframes (short-, medium- and long-term)	**0.4**
e) It includes considerations regarding the timeline of preparedness, response and recovery	**0.4**
f) It identifies all dedicated and appropriate resources for its implementation at all administrative	**0.4**
g) No process	**0**

O29 - Resilience Plan monitoring and review (-)

Is the resilience plan periodically monitored and reviewed, ensuring it remains relevant and operational?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

This metric depends on metric O24.

Development assessment rule	Development
Yes, at least once every 5 years	**3**
Yes, at least once every 10 years	**2**
The frequency exceeds once every 10 years, or the plan is not considered relevant or operational	**1**
No periodical monitoring and review	**0**

O30 - Knowledge of resilience scenarios (-)

Are there agreed scenarios for resilience (with relevant background information and supporting notes, updated at agreed intervals), setting out city-wide exposure and vulnerability from each hazard, or groups of hazards?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	UNISDR Scorecard P2.3 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

This metric conditions the metrics O36, O40, O46 and O48.

Development assessment rule	Development
Yes	**3**
A comprehensive suite of scenarios is available, but city-wide exposure and vulnerability are not available	**2**
Some scenario information is available	**1**
No scenario information is available	**0**

O31 - Data sharing (-)

Extent to which data on the city's resilience context is shared with other organizations involved with the city's resilience.

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	UNISDR Scorecard P6.3
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
The city has a portal (or other method) for bringing together/synthesising numerous city data sets, useful to build a picture of city resilience	**3**
The city has done a good job at synthesising and sharing some data layers to enhance resilience in a particular sector or area	**2**
Some but not all of the cities data layers are shared / accessible but the data is raw and requires interpretation	**1**
Little or no useful city data is available/shared	**0**

O32 - Integration (-)

Is resilience properly integrated with other key city functions/portfolios?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	UNISDR Scorecard P1.3
Importance	Complementary
Level	Strategic
Metric type	Single choice

Examples of key city functions / portfolios: planning, sustainability, investment case approval, finance and compliance, community engagement, emergency management, code compliance, infrastructure management, communications etc.

Development assessment rule	Development
Explicit or semi-explicit decision point for resilience in decision-making process(es), applied to all policy and budget proposals in all relevant functional areas	**3**
No formal process, but disaster resilience benefits are generally understood to be “helpful” to a proposal, in most functional areas	**2**
Applied ad hoc or occasionally	**1**
Not applied	**0**

O33 - Organization, coordination and participation (-)

Is there a multi-agency/sectoral mechanism with appropriate authority and resources to address resilience?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	UNISDR Scorecard P1.2 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

DRR - disaster risk reduction.

Development assessment rule	Development
All lead agency teams are well established, properly resourced and with proper authority to act across all DRR stages	**3**
All lead agency teams are well established, properly resourced and with authority to act, but there is inconsistency in resourcing across the key DRR stages	**2**
City teams have authority and convening power but do not have proper inter-agency support and / or are under resourced	**1**
Lead agencies lack proper authority and are under resourced	**0**

O34 - Critical infrastructure as a priority (-)

Is critical infrastructure resilience a city priority?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	UNISDR Scorecard P8.1 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
No	**0**

O35 - Critical infrastructure plan overview (-)

Does the city own and implement a critical infrastructure plan or strategy?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	UNISDR Scorecard P8.1 (adapted)
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes, in collaboration with other stakeholders	**3**
Yes, while sharing some information with other stakeholders	**2**
Yes, but it only considers some of the critical infrastructure	**1**
There is no plan or strategy	**0**

O36 - Cascading impacts (-)

Is there a collective understanding of potentially cascading failures between different city and infrastructure systems, under different scenarios, and a mapping of such cascading effects is available?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	UNISDR Scorecard P2.4 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

This metric depends on metric O30.

Development assessment rule	Development
Yes	**3**
Yes, but mapping is only partially available	**2**
Some understanding of cascading impacts under some disaster scenarios	**1**
No clear understanding of cascading impacts	**0**

O37 - Learning from others (-)

Is the city proactively seeking to exchange knowledge and learn from other cities facing similar challenges?

Dimension	Organisational
Subdimension	-
Resilience objective	Leadership and management
Criteria	Resilience engaged city
Source	UNISDR Scorecard P6.6 (adapted)
Importance	Comprehensive
Level	Strategic
Metric type	Multiple choice

If yes, please select one or more of the options provided as answers. Sum of the selected answers.

Development assessment rule	Development
a) Peer/sister cities platform	**1**
b) National resilience and emergency fora	**1**
c) City groups led by INGOs/UN bodies	**1**
d) There is no coordination body	**0**

O38 - Early warning (-)

Existence of Early Warning System for monitoring, forecasting and doing predictions on hazards (including climate change-related events)

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for disaster response
Source	UNISDR Scorecard P9.1 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metric O39.

Development assessment rule	Development
Yes	**3**
No	**0**

O39 - Reach of warning (-)

Percentage of population reachable by early warning systems

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for disaster response
Source	UNISDR Scorecard P9.1.1.1 (adapted)
Importance	Complementary
Level	Tactical
Metric type	Single choice

If not 100%, this metric allows to explain the reason in comments. This metric depends on metric O38.

Development assessment rule	Development
100% reached	**3**
90-99% reached	**2**
75-89% reached	**1**
Less than 75% reached	**0**

O40 - Communications (-)

Would a significant loss of service be expected for a significant proportion of the city in the ‘worst case’ scenario event?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for disaster response
Source	UNISDR Scorecard P8.6
Importance	Complementary
Level	Strategic
Metric type	Single choice

If yes, this metric allows to explain the reason in comments. This metric depends on metric O30.

Development assessment rule	Development
There would be no loss of service even from “most severe” scenario	**3**
Some loss of service would be experienced from the “most severe” scenario	**2**
Some loss of service would be experienced from the “most probable” scenario	**1**
Significant loss of service would be experienced from the “most probable” scenario	**0**

O41 - Event management plans (-)

Is there a disaster management/ preparedness / emergency response plan outlining city mitigation, preparedness and response to local emergencies?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for disaster response
Source	UNISDR Scorecard P9.2
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
There is a disaster management/preparedness/emergency response plan outlining city mitigation, preparedness and response to local emergencies	**3**
A comprehensive plan exists but it contains significant gaps in coverage for city mitigation, preparedness and response to local emergencies	**2**
Some plans exist, but they are not comprehensive or joined up	**1**
No known plan	**0**

O42 - Staffing / responder needs (-)

Does the responsible disaster management authority have sufficient staffing capacity to support first responder duties in surge event scenario?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for disaster response
Source	UNISDR Scorecard P9.3
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric allows to specify in comments the time range needed.

Development assessment rule	Development
Coverage of all neighbourhoods within 4 hours	**3**
Coverage of all neighbourhoods within 24-48 hours	**2**
Coverage of all neighbourhoods within 48-72 hours	**1**
No surge capacity identified	**0**

O43 - Equipment and relief supply needs (-)

Are equipment and supply needs, as well as the availability of equipment, clearly defined?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for disaster response
Source	UNISDR Scorecard P9.4
Importance	Essential
Level	Strategic
Metric type	Single choice

If the answer is no, this metric allows to explain the reason in comments.

Development assessment rule	Development
Needs defined, linked to disaster scenarios, and taking into account the role of volunteers	**3**
Needs defined, linked to disaster scenarios	**2**
Needs definition is essentially nominal or guesswork	**1**
No definition of needs	**0**

O44 - Definition of human resources, equipment and supply needs, and availability of equipment (-)

Has an estimated shortfall in human resources and equipment been identified?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for disaster response
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

If the answer is no, this metric allows to explain the reason in comments. This metric conditions the metric O45.

Development assessment rule	Development
Yes	**0**
No	**3**

O45 - Existence of agreements (-)

If yes, have MOUs - or several ones - been signed, regarding mutual agreements with other cities or private sector resources, in order to cover the detected shortfall?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for disaster response
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

This metric depends on metric O44.

Development assessment rule	Development
MOU/s signed with other cities	**1.5**
MOU/s signed with private sector organizations	**1.5**
MOU/s signed with both other cities and private sector organizations	**3**
No MOUs signed	**0**

O46 - Health care (-)

Would there be sufficient acute healthcare capabilities to deal with expected major injuries in ‘worst case’ scenario?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for disaster response
Source	UNISDR Scorecard P8.7
Importance	Essential
Level	Strategic
Metric type	Single choice

If the answer is no, this metric allows to provide in comments some details about the gap's proportion. This metric depends on metric O30.

Development assessment rule	Development
>90% of major injuries in “most severe” scenario, can be treated within 6 hours	**3**
>90% of major injuries in “most severe” scenario, can be treated within 24 hours	**2**
>90% of major injuries in “most severe” scenario, can be treated within 36 hours	**1**
Longer than 36 hours, or no emergency healthcare capability	**0**

O47 - Food, shelter, staple goods and fuel supply (-)

Would the city be able to continue to feed and shelter its population post-event?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for disaster response
Source	UNISDR Scorecard P9.5
Importance	Essential
Level	Strategic
Metric type	Single choice

If the answer is no, this metric allows to specify the reasons in comments. This metric depends on metric O30.

Development assessment rule	Development
In “most severe” scenario, supply of emergency food and basic relief items exceeds estimated need	**3**
In “most severe” scenario, supply of emergency food and basic relief items is equal to estimated need	**2**
In “most severe” scenario, supply of emergency food and basic relief items is less than estimated need by 2% or more	**1**
In “most severe” scenario, supply of emergency food and basic relief items is less than estimated need by 5% or more/food gap exceeds 24 hours	**0**

O48 - Interoperability and interagency working (-)

Is there an emergency operations centre, with participation from all agencies, automating standard operating procedures specifically designed to deal with “most probable” and “most severe” scenarios?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for disaster response
Source	UNISDR Scorecard P9.6
Importance	Essential
Level	Strategic
Metric type	Single choice

If the answer is no, this metric allows to specify the reasons in comments.

Development assessment rule	Development
Emergency operations centre exists with hardened / redundant communications, designed to deal with “most severe” scenario; all relevant agencies participate	**3**
Emergency operations centre exists with hardened / redundant communications, designed to deal with “most severe” scenario; core agencies only participate	**2**
Emergency operations centre designated but with vulnerable communications and/or one or more relevant agencies not participating	**1**
No emergency operations centre	**0**

O49 - Existence of civil society focal points for citizens (-)

Existence of volunteers and civil society organizations acting as focal points for citizens after an event, and regularly thereafter, to confirm safety issues, needs etc.

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for disaster response
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

If the answer is no, this metric allows to specify the reason in comments.

Development assessment rule	Development
Yes	**3**
No	**0**

O50 - Social connectedness and neighbourhood cohesion (%)

What is the estimated percentage of population that would be contacted by volunteers, within the 12 hours following an event and regularly thereafter?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for disaster response
Source	UNISDR Scorecard D7.2.1 (adapted)
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
91% - 100% contacted	**3**
51% - 90% contacted	**2**
50% or less contacted	**1**
No volunteers	**0**

O51 - Management plans for climate-related events (-)

Does the city have a plan addressing climate-related events, either consisting of a specific document or integrated into the city's planning portfolio?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metrics O52 and O53.

Development assessment rule	Development
Yes, a specific plan	**3**
Yes, integrated in the planning portfolio	**3**
No	**0**

O52 - Implementation of management plans for climate-related events (-)

If existing, is this document being implemented through defined standard operational procedures?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on metric O51.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

O53 - Management plans for climate-related events monitoring and review (-)

If existing, is this document being monitored and reviewed in less than a 5-year interval?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on metric O51.

Development assessment rule	Development
Yes	**3**
No	**0**

O54 - Knowledge of exposure and vulnerability for climate change scenarios (-)

Are there agreed climate change scenarios setting out city-wide exposure and vulnerability from each hazard, or groups of hazards?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for climate change
Source	UNISDR Scorecard P2.3 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

If the answer is yes, this metric allows to describe in comments the characteristics of "most severe scenario" and "most probable scenario" in terms of RCP scenarios (e.g., 2.6, 4.5, 6.0 or 8.5), probability of severity or risk (e.g., optimistic: 10 percentile, median: 50 percentile, severe: 90 percentile) and horizon of analysis (e.g. short: 2035, medium: 2071 or long-term: 2100).
If the answer is no, the reasons can also be explained in comments.
This metric conditions the metrics S06, S07, S08, S09, S16, S17, S27, S28, FMob12, FMob13, FMob14, FMob15, FMob16, FMob17, FMob35, FMob36, FMob38, FMob39, FMob40, FMob41 and FMob42.

Development assessment rule	Development
Yes	**3**
A comprehensive suite of scenarios is available, but city-wide exposure and vulnerability are not available	**2**
Some scenario information is available	**1**
No scenario information is available	**0**

O55 - City status when addressing contribution to climate change (-)

Comparing to the mean GHG emission per inhabitant that was considered to elaborate the official RCP scenarios, what are the current city's emissions?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

RCP - Representative Concentration Pathways. Scenarios that include time series of emissons and concentrations of the full suite of greenhouse gases (GHGs) and aerosols and chemically active gases, as well as land use/land cover (http://www.ipcc-data.org/guidelines/pages/glossary/glossary_r.html).

Development assessment rule	Development
Emissions similar or below the predicted by RCP2.6 scenario	**3**
Emissions are above RCP2.6 scenario and similar or below RCP4.5 scenario	**2**
Emissions are above RCP4.5 scenario and similar or below RCP8.5 scenario	**1**
Emissions are higher than RCP8.5 scenario or the city is not aware of where it stands	**0**

O56 - City commitment with mitigation of climate change effects (%)

Has the city signed any formal agreement in order to reach an established mitigation target for GHG reduction by 2050, when comparing to 1990 values?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

1990 GHG levels - according to the Council conclusions on the Paris Agreement and preparations for the UNFCCC meetings (Bonn, 6-17 November 2017).

Development assessment rule	Development
Yes, a 80% reduction or higher is the target	**3**
Yes, a 50% - 79% reduction is the target	**2**
Yes, a 20% - 49% reduction is the target	**1**
No compromise or the target is lower than 20%	**0**

O57 - Planning for mitigation of climate change effects (-)

Are the mitigation targets for GHG (emission reduction by 2050) being considered in the city plans and being enforced in new projects?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

If the answer is no, this metric allows to explain reasons in comments.

Development assessment rule	Development
Yes, and existing projects contribute to the target and compliance of future ones is assured	**3**
Yes, and some existing projects contribute to the target	**2**
Yes, but enforcement is not assured as some projects may compromise target accomplishment	**1**
There are no specifications on GHG emission in the city plan or in new projects	**0**

O58 - Post event recovery planning – pre event (-)

Is there a strategy or process in place for post-event recovery and reconstruction, including economic reboot, societal aspects etc.?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for recovery and build back
Source	UNISDR Scorecard P10.1
Importance	Essential
Level	Strategic
Metric type	Single choice

If the answer is no, this metric allows to explain reasons in comments. This metric conditions the metrics O59, O60 and O61.

Development assessment rule	Development
There is a strategy/process in place. It is robust and well-understood by relevant stakeholders	**3**
There is a strategy / process in place. It is well- understood by relevant stakeholders but has known weaknesses	**2**
Some plans / strategies exist but they are not comprehensive or joined up or understood by relevant stakeholders	**1**
No known plans	**0**

O59 - Coordination of post event recovery (-)

Is the coordinating body for all post-disaster processes identified and structured , including the distribution of roles and responsibilities between relevant organizations?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for recovery and build back
Source	UNISDR Scorecard D9.6.3 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

If the answer is no, this metric allows to explain reasons in comments. This metric depends on metric O58.

Development assessment rule	Development
There is a clear coordination. Roles and accountability are clearly defined	**3**
Coordination is not sufficient. There is currently no clear identification of roles and accountability	**2**
The city is currently starting a process to coordinate all post-response activities	**1**
There are currently no plans to coordinate post-response activities	**0**

O60 - Lessons learnt (-)

Do post-event assessment processes include failure analysis?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for recovery and build back
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

This metric depends on metric O58.

Development assessment rule	Development
Yes	**3**
No	**0**

O61 - Learning loops (-)

If yes, does this process allow to capture lessons learned, which then feed into design and delivery of rebuilding projects?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for recovery and build back
Source	UNISDR Scorecard P10.2 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

This metric depends on metric O58.

Development assessment rule	Development
Yes	**3**
No	**0**

O62- Insurance (-)

What level of insurance cover exists in the city, across all sectors - business and community?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for recovery and build back
Source	UNISDR Scorecard P3.3
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
The uptake for insurance products across all sectors / services is high	**3**
The level of insurance varies significantly by sector or by area. The city actively promotes insurance cover across all sectors	**2**
The level of insurance varies significantly by sector or by area. The city is not actively promoting greater uptake of insurance products	**1**
Little or no insurance cover exists in the city	**0**

O63 - Damage and loss post-event assessment (-)

Does the city has a system in place to provide Post-Disaster Needs Assessment?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric includes the assessment of losses, damages and needs, concerning economic losses, population affected, deaths, damaged housing, ecosystems and cultural heritage. Please specify in comments all those that apply. This metric conditions the metric O64.

Development assessment rule	Development
Yes	**3**
No	**0**

O64 - Current post-event assessment system (-)

If yes, has such system been defined, implemented, tested and historic data is registered?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	City preparedness for recovery and build back
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

This metric depends on metric O63.

Development assessment rule	Development
Yes	**3**
No	**0**

O65 - Water supply (%)

Percentage of households with access to safe drinking water distribution

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	Availability and access to basic services
Source	ERSAR 3G AA01
Importance	Essential
Level	Strategic
Metric type	Single choice

If the percentage is not 100%, this metric allows to specify the reason in comments.

Development assessment rule	Development
96% - 100%	**3**
81% - 95%	**2**
51% - 80%	**1**
50%	**0**

O66 - Wastewater collection (%)

Percentage of households served by wastewater collection

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	Availability and access to basic services
Source	ISO37120 20.1 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

If the percentage is not 100%, this metric allows to specify the reason in comments.

Development assessment rule	Development
91% - 100%	**3**
81% - 90%	**2**
51% - 80%	**1**
50% or less	**0**

O67 - Wastewater treatment (-)

Provision of adequate treatment to wastewater through wastewater treatment plant

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	Availability and access to basic services
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Provision can be ensured either by the city or by a legally established entity.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

O68 - Urban waste collection (%)

Percentage of population served by regular solid waste collection (having waste picked up within 200m from households, by a legally established entity, on at least a weekly basis)

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	Availability and access to basic services
Source	ISO37120 16.1 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

If the percentage is not 100%, this metric allows to specify the reason in comments.

Development assessment rule	Development
96% - 100% of the population served	**3**
81% - 95% served or 96%-100% of the population served at least every two weeks	**2**
51% - 80% of the population served or 95% or less of the population served at least every two weeks	**1**
50% or less of the population served	**0**

O69 - Urban waste treatment (-)

Provision of adequate treatment to solid waste through recovery methods or disposal in landfill?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	Availability and access to basic services
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Provision can be ensured either by the city or by a legally established entity.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

O70 - Urban electrical energy network (%)

Percentage of households with regular connection to the electricity network

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	Availability and access to basic services
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

If the percentage is not 100%, this metric allows to specify the reason in comments.

Development assessment rule	Development
98% - 100%	**3**
91% - 97%	**2**
81% - 90%	**1**
80% or less	**0**

O71 - Urban electrical energy alternative sources (%)

Estimated percentage of households connected to alternative sources of electricity

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	Availability and access to basic services
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric allows to answer with an estimated figure [%] in comments.

Development assessment rule	Development
More or equal to 50%	**3**
Between 10 and 50%	**1.5**
Less than 10%	**0**

O72 - Urban gas energy network (%)

Percentage of households with regular access to the gas distribution network

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	Availability and access to basic services
Source	ISO37120 7.2 (adapted)
Importance	Complementary
Level	Tactical
Metric type	Single choice

If the percentage is not 100%, this metric allows to specify the reason in comments.

Development assessment rule	Development
98% - 100%	**3**
91% - 97%	**2**
81% - 90%	**1**
80% or less	**0**

O73 - Urban mobility accessing collective transportation (%)

Percentage of population living less than 500 m. from any type of public stop, including trains, subway, tram, bus transportation

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	Availability and access to basic services
Source	ISO37120 18.1 and 18.2 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

If the percentage is not 100%, this metric allows to specify the reason in comments.

Development assessment rule	Development
98% - 100%	**3**
91% - 97%	**2**
81% - 90%	**1**
80% or less	**0**

O74 - Urban cycling mobility (-)

Is there a public plan/strategy to develop cycling paths in the city or expend the existing network?

Dimension	Organisational
Subdimension	-
Resilience objective	City preparedness
Criteria	Availability and access to basic services
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes, to expend the existing network	**3**
Yes, to develop a network	**2**
No new development	**1**
No network	**0**

SPATIAL

PI code PI name Unit*

S01 - Presentation process for risk information (-)

Do clear hazard maps and data on risk exist?

Dimension	Spatial
Subdimension	-
Resilience objective	Spatial risk management
Criteria	General hazard and exposure mapping
Source	UNISDR Scorecard Scorecard P2.5 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metric S02.

Development assessment rule	Development
Yes	**3**
No	**0**

S02 - Update process for risk information (-)

If yes, are these maps regularly updated?

Dimension	Spatial
Subdimension	-
Resilience objective	Spatial risk management
Criteria	General hazard and exposure mapping
Source	UNISDR Scorecard P2.5 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

This metric depends on metric S01.

Development assessment rule	Development
Yes	**3**
No	**0**

S03 - Knowledge of exposure and vulnerability (-)

Existence of scenarios setting out city-wide exposure and vulnerability from each hazard level

Dimension	Spatial
Subdimension	-
Resilience objective	Spatial risk management
Criteria	General hazard and exposure mapping
Source	UNISDR Scorecard D2.2.1
Importance	Essential
Level	Strategic
Metric type	Single choice

A scale to 3 is made.

Development assessment rule	Development
Comprehensive scenarios exist city-wide, for the “most probable” and “most severe” incidence of each hazard, updated in last 18 months and reviewed by a 3rd party	**5**
Scenarios have minor shortcomings in terms of coverage, when updated, level or thoroughness of review	**4**
Scenarios have more significant shortcomings in terms of coverage, when updated, level of review, thoroughness	**3**
Partial scenarios exist but are not comprehensive or complete; and/or are more than 18 months old; and/or are not reviewed by a 3rd party	**2**
Only a generalized notion of exposure and vulnerability, with no attempt systematically to identify impacts	**1**
No risk assessment	**0**

* (-) without unit or dimensionless

S04 - Scenarios and update process for risk information (-)

Risk scenarios are updated at least every three years for the following

Dimension	Spatial
Subdimension	-
Resilience objective	Spatial risk management
Criteria	General hazard and exposure mapping
Source	UNISDR Scorecard D2.5.1 (adapted)
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and a scale to 3 is made.

Development assessment rule	Development
a) Hazard patterns	**1**
b) Climate change projections	**1**
c) Demographic transformations	**1**
d) Land-use patterns	**1**
e) none of the above	**0**

S05 - Damage and loss estimation (-)

Damage and loss aspects taken into account by risk assessments for key identified scenarios

Dimension	Spatial
Subdimension	-
Resilience objective	Spatial risk management
Criteria	General hazard and exposure mapping
Source	UNISDR Scorecard D2.2.2
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and a scale to 3 is made.

Development assessment rule	Development
a) Changes in economic activities	**1**
b) Population at risk	**1**
c) Urban footprint at risk	**1**
d) Economic activities at risk	**1**
e) none of the above	**0**

S06 - Potential population at risk of displacement for climate change scenarios (-)

Percentage of population at risk of displacement for three months or longer according to climate change scenarios

Dimension	Spatial
Subdimension	-
Resilience objective	Spatial risk management
Criteria	Hazard and exposure for climate change
Source	UNISDR Scorecard D4.1.1 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

This metric depends on metric O54.

Development assessment rule	Development
No population displacement for “most severe” scenario	**3**
No population displacement for “most probable” scenario	**2**
Less than 2.5% population displacement for “most probable” scenario	**1**
2.5% -100% population displacement for “most probable” scenario	**0**

S07- Urban footprint at risk for climate change scenarios (-)

Percentage of urban footprint at risk, according to climate change scenarios

Dimension	Spatial
Subdimension	-
Resilience objective	Spatial risk management
Criteria	Hazard and exposure for climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Consider urban footprint as a spatial extent of urbanized areas on a regional scale. This metric depends on metric O54.

Development assessment rule	Development
No urban footprint at risk for “most severe” scenario	**3**
No urban footprint at risk for “most probable” scenario	**2**
Less than or equal to 2.5% urban footprint at risk for “most probable” scenario	**1**
Between 2.5% and 100% urban footprint at risk for “most probable” scenario	**0**

S08 - Economic activity at risk for climate change scenarios (-)

Percentage of economic activity at risk from climate change scenarios

Dimension	Spatial
Subdimension	-
Resilience objective	Spatial risk management
Criteria	Hazard and exposure for climate change
Source	UNISDR Scorecard D4.1.2.1 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

This metric depends on metric O54.

Development assessment rule	Development
No economic activities at risk for “most severe” scenario	**3**
No economic activities at risk for “most probable” scenario	**2**
Less than 2.5% of economic activities at risk for “most probable” scenario	**1**
2.5% -100% of economic activities at risk for “most probable” scenario	**0**

S09 - Land use zoning and planning (-)

Is the land use plan - including zoning - informed by risk scenarios?

Dimension	Spatial
Subdimension	-
Resilience objective	Spatial risk management
Criteria	Resilient urban development
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on metric O54 and conditions the metrics S10.

Development assessment rule	Development
Yes	**3**
No	**0**

S10 - Land use plan monitoring and review (-)

Is this plan regularly monitored and reviewed?

Dimension	Spatial
Subdimension	-
Resilience objective	Spatial risk management
Criteria	Resilient urban development
Source	UNISDR Scorecard P4.1 (adapted)
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on metric S09.

Development assessment rule	Development
Yes, being reviewed at least once every 10 years	**3**
The plan is reviewed at least once every 20 years or was not informed by the impact from risk scenarios	**2**
The existing plan does not include zone tipology as mentioned	**1**
No land use and zoning plan exists	**0**

S11 - Land use zoning implementation (-)

Extent to which land use zoning is implemented in the city and complied with?

Dimension	Spatial
Subdimension	-
Resilience objective	Spatial risk management
Criteria	Resilient urban development
Source	UNISDR Scorecard D4.4.1 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Zoning is 100% implemented and all settlement and economic activity is compliant	**3**
Zoning is ≥ 90% and < 100% implemented and enforced	**3**
Zoning is ≥ 80% and < 90% implemented and enforced	**2**
Zoning is ≥ 70% and < 80% implemented and enforced	**2**
Zoning is ≥ 50% and < 70% implemented and enforced	**1.5**
Zoning is < 50% implemented and enforced	**0**

S12 - New urban development (-)

Is there a policy promoting physical measures in new development that enhance resilience to one or multiple hazards?

Dimension	Spatial
Subdimension	-
Resilience objective	Spatial risk management
Criteria	Resilient urban development
Source	UNISDR Scorecard P4.2 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Clear policy exists at city level. Guidance has been prepared for a range of practitioners (e.g. Architects, landscape architects, engineers etc)	**3**
Policy exist but supporting guidance is inadequate	**2**
Resilience approaches are promoted, but not in a consistent manner, and not underpinned by city policy	**1**

Little / no promotion of resilience in new urban development	**0**

S13 - Urban design solutions that increase resilience (-)

Does the city implement urban design solutions tasked to improve resilience?

Dimension	Spatial
Subdimension	-
Resilience objective	Spatial risk management
Criteria	Resilient urban development
Source	UNISDR Scorecard D4.2.1 (adapted)
Importance	Complementary
Level	Tactical
Metric type	Single choice

If the answer is yes, this metric allows to specify solutions in comments.

Development assessment rule	Development
Yes	**3**
Some use, in specific areas of the city or enforced by codes	**2**
Little use and little interest or no codes in place	**1**
No use and no interest	**0**

S14 - Building codes and standards (-)

Do building codes or standards exist, and do they address specific known hazards and risks for the city? Are these standards regularly updated?

Dimension	Spatial
Subdimension	-
Resilience objective	Spatial risk management
Criteria	Resilient urban development
Source	UNISDR Scorecard P4.3
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metric S15.

Development assessment rule	Development
Local codes and standards exist; these address all known city hazards and are regularly updated	**3**
Local codes and standards exist; these address main city hazards and are regularly updated	**2**
Some codes exist covering some hazards. No clear plan for updating the codes	**1**
No real use / existence of relevant building codes and standards	**0**

S15 - Application of building codes (-)

Implementation of building codes on relevant structures, certified as such by a 3rd party

Dimension	Spatial
Subdimension	-
Resilience objective	Spatial risk management
Criteria	Resilient urban development
Source	UNISDR Scorecard D4.4.2
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

A scale to 3 is made. This metric depends on metric S14.

Development assessment rule	Development
Codes are 100% implemented on applicable structures and certified as such by a 3rd party	**5**
Codes are ≥ 90% and < 100% implemented on applicable structures and 3rd-party certified	**4**
Codes are ≥ 80 and < 90% implemented on applicable structures. They may or may not be 3rd party certified	**3**
Codes are ≥ 70% and < 80% implemented on applicable structures. They may or may not be 3rd party certified	**2**
Codes are ≥ 50 and < 70% implemented on applicable structures. No 3rd party certification	**1**
Codes are < 50% implemented on applicable structures. No 3rd party certification	**0**

S16 - Human loss in the last events (-)

Human impact of the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Spatial
Subdimension	-
Resilience objective	Spatial risk management
Criteria	Impacts of climate-related events
Source	-
Importance	Essential
Level	Strategic
Metric type	Open value

Please answer with an estimated figure [inhab.], disaggregating according to a) number of casualties, b) missing persons and c) people affected - including severe injuries and displaced. This metric allows to answer with a value. This metric depends on metric O54.

Development assessment rule	Development
a) number of casualties	**3 if a, b and c=0**
b) missing persons	**2 if a and b=0 and c<=50**
c) people affected - including severe injuries and displaced	**1 if a=0, b<=5 and c<=50**
	0 if any other answer

S17 - Damages in urban footprint in the last events (%)

Impact on urban footprint of the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Spatial
Subdimension	-
Resilience objective	Spatial risk management
Criteria	Impacts of climate-related events
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Consider urban footprint as a spatial extent of urbanized areas on a regional scale. This metric depends on metric O54.

Development assessment rule	Development
0%	**3**
Less or equal to 0.5%	**2**
Between 0.5 and 2.5%	**1**
More or equal to 2.5%	**0**

S18 - Existing protective infrastructure (-)

Is existing protective infrastructure designed and built according to risk information?

Dimension	Spatial
Subdimension	-
Resilience objective	Provision of protective infrastructures and ecosystems
Criteria	Protective infrastructures and ecosystems services
Source	UNISDR Scorecard P8.2 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

Protective infrastructures such as: sea walls, levees and flood barriers, shelters such as tornado/hurricane shelters.

Development assessment rule	Development
Yes	**3**
In some cases not consistent with best practices or not based on risk information	**2**
Some strategic protective infrastructure is missing	**1**
Significant parts of the city are unprotected from known risks/hazards	**0**

S19 - New protective infrastructure (-)

Is new protective infrastructure (in design or construction process) under development and consistent with best practice (for asset design, buiding and management, based on relevant risk information)?

Dimension	Spatial
Subdimension	-
Resilience objective	Provision of protective infrastructures and ecosystems
Criteria	Protective infrastructures and ecosystems services
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
In some cases not integrating all best practices or risk information	**2**
Some required strategic protective infrastructure are not under development	**1**
Significant parts of the city will remain unprotected from known risks/hazards	**0**

S20 - Maintenance of protective infrastructure (-)

Is protective infrastructure regularly maintained?

Dimension	Spatial
Subdimension	-
Resilience objective	Provision of protective infrastructures and ecosystems
Criteria	Protective infrastructures and ecosystems services
Source	UN-Habitat CRPT 4-3.2.3.4.1 (adapted)
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Just in some cases or registration is not fully assured	**2**
Preventive maintenance is not in place or corrective maintenance is not effective and efficient	**1**
Maintenance is not in place	**0**

S21 - Awareness and understanding of ecosystem services/functions (-)

Beyond just an awareness of the natural assets, does the city understand the functions that this natural capital provides for the city?

Dimension	Spatial
Subdimension	-
Resilience objective	Provision of protective infrastructures and ecosystems
Criteria	Protective infrastructures and ecosystems services
Source	UNISDR Scorecard P5.1
Importance	Essential
Level	Strategic
Metric type	Single choice

Examples of functions or ecosystem services: mitigation of flooding, heat waves and land slides, provision of food, water, raw material or medicinal resources, habitat services, carbon sequestration, air regulation, pollination, aesthetic value, mental and physical health benefits and cultural services.

Development assessment rule	Development
The city and key stakeholders are familiar with the term ecosystem services and understand and economic value all of the functions provided by key local natural assets	**3**
The city and key stakeholders understand the majority of the functions provided by key local natural assets. These are not economically valued	**2**
There is an incomplete, awareness and understanding of the functions delivered by the cities natural capital	**1**
Very little/no awareness of this topic area in the city	**0**

S22 - Awareness of the role that ecosystem services may play in the city's resilience (-)

Assets that provide ecosystem services are specifically identified and managed as critical assets?

Dimension	Spatial
Subdimension	-
Resilience objective	Provision of protective infrastructures and ecosystems
Criteria	Protective infrastructures and ecosystems services
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

This metric conditions the metric S23 and S24.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**1**

S23 - Trends in ecosystem services health (-)

Change in health, extent or benefit of each ecosystem service in last 5 years

Dimension	Spatial
Subdimension	-
Resilience objective	Provision of protective infrastructures and ecosystems
Criteria	Protective infrastructures and ecosystems services
Source	UNISDR Scorecard D5.1.2
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

A scale to 3 is made. This metric depends on metric S22.

Development assessment rule	Development
Improved health and performance across the board for critical eco-system services	**5**
At least neutral status across the board, with some improvements in some cases	**4**
Neutral status on average – some improvements offset by some declines	**3**
Generalized decline in ecosystem service status	**2**
Generalized severe degradation in status known or suspected	**1**
Potentially fatal damage to some or many key ecosystem services	**0**

S24 - Maintenance of ecosystem services (-)

Are ecosystem services specifically maintained and annually monitored on a defined set of key health/performance indicators?

Dimension	Spatial
Subdimension	-
Resilience objective	Provision of protective infrastructures and ecosystems
Criteria	Protective infrastructures and ecosystems services
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

A scale to 3 is made. This metric depends on metric S22.

Development assessment rule	Development
Critical ecosystem services identified and monitored annually on a defined set of key health/performance indicators	**5**
Critical ecosystem services identified and monitored annually, but less systematic use of metrics	**4**
Critical ecosystem services identified but have ad hoc monitoring – no real attempt to track health over time	**3**
Some key ecosystem services omitted from monitoring altogether	**2**
Identification and monitoring of ecosystem services is formative at best, or is seriously deficient	**1**
No monitoring	**0**

S25 - Availability of green and blue infrastructures (m^2/inhabitant)

Estimated green and blue area per inhabitant

Dimension	Spatial
Subdimension	-
Resilience objective	Provision of protective infrastructures and ecosystems
Criteria	Protective infrastructures and ecosystems services
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

It includes greening streets, squares, roadsides and parks, greening roofs and facades, urban agriculture, green corridors, natural water filtration, open urban rivers, wetlands, lakes and other waterways.

Development assessment rule	Development
More or equal to 40	**3**
Between 40 and 15	**2**
Between 15 and 5	**1**
Less than 5	**0**

S26 - Integration of green and blue infrastructure into city policy and projects (-)

Is green and blue infrastructure being promoted on major urban development and infrastructure projects through policy?

Dimension	Spatial
Subdimension	-
Resilience objective	Provision of protective infrastructures and ecosystems
Criteria	Protective infrastructures and ecosystems services
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
In some cases not consistent with best practices or not based on risk information	**2**
Some strategic protective infrastructure is missing	**1**
Significant parts of the city are unprotected from known risks/hazards	**0**

S27 - Critical services dependence of protective infrastructures and ecosystems under climate change scenarios (-)

Critical services (CS -RESCCUE services) dependence of protective infrastructures and ecosystems under climate change scenarios

Dimension	Spatial
Subdimension	-
Resilience objective	Provision of protective infrastructures and ecosystems
Criteria	Dependence and autonomy regarding other services considering climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

This metric depends on metric O54.

Development assessment rule	Development
No dependence (CS are not affected or failure is not likely to occur due to problems in protective infrastructure and in ecosystem services)	**3**
Minor dependence (CS are affected and failure is likely to occur in one of the CS)	**2**
Major dependence (CS are affected and failure is likely to occur in more than one CS)	**1**
Total dependence (failure is likely to occur in all CS)	**0**

S28 - Autonomy from other services under climate change scenarios (-)

Protective infrastruture and ecosystems autonomy regarding critical services (CS -RESCCUE services) loss under climate change scenarios

Dimension	Spatial
Subdimension	-
Resilience objective	Provision of protective infrastructures and ecosystems
Criteria	Dependence and autonomy regarding other services considering climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

This metric depends on metric O54.

Development assessment rule	Development
Total autonomy (do not depend on CS services continuity - e.g. water for irrigation, energy, communication, fuel)	**3**
Major autonomy (are affected but do not fail in case of CS continuity loss)	**2**
Minor autonomy (failure is likely to occur in at least one infrastructure or ecosystem in case of CS continuity loss)	**1**
No autonomy (failure is likely to occur in the majority of infrastructures or ecosystems in case of CS continuity loss)	**0**

S29 - Transboundary environmental issues (-)

Is the city aware of ecosystem services being provided to the city from natural capital beyond its administrative borders? Are agreements in place with neighbouring administrations to support the protection and management of these assets?

Dimension	Spatial
Subdimension	-
Resilience objective	Provision of protective infrastructures and ecosystems
Criteria	Dependence and autonomy regarding other services considering climate change
Source	UNISDR Scorecard P5.3
Importance	Comprehensive
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
The city is aware of the importance of natural capital beyond its administrative borders and has plans in place with neighbouring administrations to support the protection and management of these assets	**3**
There city is aware of the functions provided by natural capital beyond the city administrative borders; there have been some early discussions with neighbouring administrations	**2**
The city has some awareness of the functions provided by natural capital beyond the city administrative borders, but has taken no action	**1**
Little to no awareness	**0**

FUNCTIONAL

WATER

PI code	PI name	Unit*

FWts01 - Water service strategic plan making and implementation (-)

Does the service have a strategic plan and is it implemented

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Strategic planning
Source	UNISDR Scorecard P1.1 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metric FWts02 and FWts03.

Development assessment rule	Development
Yes	**3**
Partially. The plan exists, but it is still not implemented OR Not all the responsible utilities have an implemented plan	**1.5**
No	**0**

FWts02 - Plan alignment with the City Master Plan (-)

If yes, is the plan aligned with the city main planning document?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on metric FWts01.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FWts03 - Service plan monitoring and review (-)

If existing, is the plan periodically monitored and reviewed, ensuring it remains relevant and operational?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on metric FWts01.

Development assessment rule	Development
Yes, at least once every 5 years	**3**
Yes, at least once every 10 years	**2**
The frequency exceeds once every 10 years, or the plan is not considered relevant or operational	**1**
No periodical monitoring and review	**0**

* (-) without unit or dimensionless

FWts04 - Exchange of information to the city (-)

Is there regular exchange of data and information between service and the city concerning the review of planning documents?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please indicate the last review's date.

Development assessment rule	Development
Yes, at least once every 5 years	**3**
Yes, at least once every 10 years	**2**
The frequency exceeds once every 10 years, or the plan is not considered relevant or operational or analysis of relevant data is not undertaken to inform city planning and strategies	**1**
No periodical exchange	**0**

FWts05 - Land use zoning compliance (-)

Do the service-specific plans comply with up-to-date land use and zoning regulations?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FWts06 - Resilience in water service strategy and alignment with the City Master Plan (-)

Does the service have a resilience plan (either as an autonomous action plan or as a strategy included in the service's strategic plan) and what is its timeframe?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please specify the last update/review. This metric conditions the metric FWts07.

Development assessment rule	Development
Yes approved. It considers short-, medium- and long-term	**3**
Yes approved. Its timeframe is not defined or considers only short-, medium- or long-term	**2**
It is under approval or under preparation. Timeframe is not yet finalised	**1**
No plan	**0**

FWts07 - Service strategic plan for resilience and Climate Change (-)

Does the resilience plan consider climate change (projection, scenarios, impacts, etc.)?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on metric FWts06.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FWts08 - Service financial plan and budget for resilience (-)

Do the service financial plans have dedicated allocations for resilience-building actions (incl. DRR)?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
The service financial plan is comprehensive in relation to resilience-building, budgets are ring fenced and necessary resources and arrangements for local DRR in place	**3**
The service financial plan allows for resilience-building, budgets are ring fenced	**2**
The service financial plan allows for some resilience-building activities not aligned, budgets are not ring fenced	**1.5**
No clear plan	**0**

FWts09 - Water service business continuity (-)

Do business continuity plans exist?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

A business continuity plan allows that appropriate management and delivery of services may be provided by e.g., technological tools, such as GPS or communication devices, to support daily management exist and intercommunicate, collecting circuits can be easily changed, type of vehicles adequate to the locations and circuits. Adequate competences may be competent human resources, who are dynamic and easily assume different functions. A command chain ensures responsibilities are clearly allocated and several decision levels are attributed.

Development assessment rule	Development
Yes	**3**
No	**0**

FWts10 - Co-ordination with other water services in the city (-)

Is there any coordination mechanism in place with other water services/entities either at municipal or metropolitan level?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Formal mechanism: e.g., Office, Committee, MoU, Protocols, National/Regional Platform. If yes please specify.

Development assessment rule	Development
Yes	**3**
No	**0**

FWts11 - Learning from other water services (-)

Is there any knowledge exchange with other services?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

Services facing similar challenges: e.g other water services, other urban services. Please select all applicable answers. Sum of the selected options and a scale to 3 is made.

Development assessment rule	Development
a) International exchanges are in place	**1**
b) National exchanges are in place	**1**
c) With similar services	**1**
d) With different services	**1**
e) None of the above	**0**

FWts12- Risk information related to the water service (-)

Do specific service plans include risk information (such as exposure and vulnerability, damage and loss quantification, etc.) related to the service and are regurlarly updated?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please indicate the last review's date.

Development assessment rule	Development
Yes	**3**
Partially, not covering the all the hazards or all the city or not regurlarly updated	**1.5**
No	**0**

FWts13 - Damage and loss estimation (-)

Does risk assessment include estimations of damage and loss for agreed climate change scenarios, based on current development and future urban and population growth?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Risk management
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Risk assessments focus mostly on spatial, physical assets at risk. Data is limited	**2**
There are plans to develop risk assessments	**1**
Risk assessments do not identify all risk areas or there are no plans to update them	**0**

FWts14 - Expected water supply interruptions, not caused by water quality problems, in the city area according to climate change scenarios (% of city area)

Percentage of the city area expected to be affected by water supply interruptions exceeding 6h, not caused by water quality problems, according to climate change scenarios

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Risk management
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

This metric depends on metric FWts48.

Development assessment rule	Development
No area at risk for “most severe” scenario	**3**
No area at risk for “most probable” scenario	**2**
Less than or equal to 2.5% area at risk for “most probable” scenario	**1.5**
Between 2.5% and 100% area at risk for “most probable” scenario	**0**

FWts15- Expected water supply interruptions caused by water quality problems, in the city area according to climate change scenarios (% of city area)

Percentage of the city area expected to be affected by interruptions exceeding 6h, caused by water quality problems, according to climate change scenarios

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Risk management
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

This metric depends on metric FWts48.

Development assessment rule	Development
No area at risk for “most severe” scenario	**3**
No area at risk for “most probable” scenario	**2**
Less than or equal to 2.5% area at risk for “most probable” scenario	**1.5**
Between 2.5% and 100% area at risk for “most probable” scenario	**0**

FWts16 - Expected water supply interruptions, not caused by water quality problems, for sensitive customers according to climate change scenarios (% of sensitive customers)

Percentage of sensitive customers expected to be affected by water supply interruptions exceeding 6h, not caused by water quality problems, according to climate change scenarios

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. This metric depends on metric FWts48.

Development assessment rule	Development
No sensitive customers expected to be affected for “most severe” scenario	**3**
No sensitive customers expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% sensitive customers expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% sensitive customers expected to be affected for “most probable” scenario	**0**

FWts17 - Expected water supply interruptions caused by water quality problems, for sensitive customers according to climate change scenarios (% of sensitive customers)

Percentage of sensitive customers expected to be affected by by interruptions exceeding 6h, caused by water quality problems, according to climate change scenarios

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. This metric depends on metric FWts48.

Development assessment rule	Development
No sensitive customers expected to be affected for “most severe” scenario	**3**
No sensitive customers expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% sensitive customers expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% sensitive customers expected to be affected for “most probable” scenario	**0**

FWts18 - Expected water supply interruptions, not caused by water quality problems, for other services according to climate change scenarios (% customers of other services)

Percentage of customers of other services expected to be affected by water supply interruptions exceeding 6h, not caused by water quality problems, according to climate change scenarios

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Risk management
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Specify the percentage for each service. Other city services: RESCCUE services. If other, explain in comments. This metric depends on metric FWts48.

Development assessment rule	Development
No customers of other services expected to be affected for “most severe” scenario	**3**
No customers of other services expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% customers of other services expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% customers of other services expected to be affected for “most probable” scenario	**0**

FWts19 - Expected water supply interruptions caused by water quality problems, for other services according to climate change scenarios (% customers of other services)

Percentage of customers of other services expected to be affected by interruptions exceeding 6h, caused by water quality problems, according to climate change scenarios

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Risk management
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Specify the percentage for each service in comments. Other city services: RESCCUE services. If other, explain in comments. This metric depends on metric FWts48.

Development assessment rule	Development
No customers of other services expected to be affected for “most severe” scenario	**3**
No customers of other services expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% customers of other services expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% customers of other services expected to be affected for “most probable” scenario	**0**

FWts20 - Expected water supply interruptions, not caused by water quality problems, for households according to climate change scenarios (% of households)

Percentage of households expected to be affected by water supply interruptions exceeding 6h, not caused by water quality problems, according to climate change scenarios

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please specify the percentage in comments. This metric depends on metric FWts48.

Development assessment rule	Development
No households expected to be affected for “most severe” scenario	**3**
No households expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% households expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% households expected to be affected for “most probable” scenario	**0**

FWts21 - Expected water supply interruptions caused by water quality problems, for households according to climate change scenarios (% of households)

Percentage of households expected to be affected by interruptions exceeding 6h, caused by water quality problems, according to climate change scenarios

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please specify the percentage in comments. This metric depends on metric FWts48.

Development assessment rule	Development
No households expected to be affected for “most severe” scenario	**3**
No households expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% households expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% households expected to be affected for “most probable” scenario	**0**

FWts22 - Expected total duration of water supply interruption, not caused by water quality problems, according to climate change scenarios (days)

Total duration of expected water supply interruption, not caused by water quality problems, according to climate change scenarios

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please specify how many days in comments. This metric depends on metric FWts48.

Development assessment rule	Development
Less or equal to 1 day for “most severe” scenario	**3**
Less or equal to 1 day for “most probable” scenario	**2**
Between 1 and 3 days for “most probable” scenario	**1.5**
More than 3 days for “most probable” scenario	**0**

FWts23 - Expected total duration of water supply interruption, caused by water quality problems, according to climate change scenarios (days)

Total duration of expected water supply interruption, caused by water quality problems, according to climate change scenarios

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please specify how many days in comments. This metric depends on metric FWts48.

Development assessment rule	Development
Less or equal to 1 day for “most severe” scenario	**3**
Less or equal to 1 day for “most probable” scenario	**2**
Between 1 and 3 days for “most probable” scenario	**1.5**
More than 3 days for “most probable” scenario	**0**

FWts24 - Water supply interruptions, not caused by water quality problems, in the city area last year (% of the city area)

Percentage of the city area affected by water supply interruptions exceeding 6h, not caused by water quality problems, last year

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Reliable service
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
No area affected	**3**
Less than or equal to 2.5% area affected	**2**
Between 2.5% and 10% area affected	**1.5**
More than or equal to 10% area affected	**0**

FWts25 - Water supply interruptions caused by water quality problems, in the city area last year (% of the city area)

Percentage of the city area affected by water supply interruptions exceeding 6h, caused by water quality problems, last year

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Reliable service
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
No area affected	**3**
Less than or equal to 2.5% area affected	**2**
Between 2.5% and 10% area affected	**1.5**
More than or equal to 10% area affected	**0**

FWts26 - Water supply interruptions, not caused by water quality problems, for sensitive customers last year (% of sensitive customers)

Percentage of sensitive customers affected by water supply interruptions exceeding 6h, not caused by water quality problems, last year

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. Please list which sensitive customers were affected.

Development assessment rule	Development
No sensitive customers affected	**3**
Less or equal to 0.1% sensitive customers affected	**2**
Between 0.1% and 0.25% of sensitive customers affected	**1.5**
More than or equal to 0.25% area affected	**0**

FWts27 - Water supply interruptions caused by water quality problems, for sensitive customers last year (% of sensitive customers)

Percentage of sensitive customers affected by water supply interruptions exceeding 6h, caused by water quality problems, last year

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. Please list which sensitive customers were affected.

Development assessment rule	Development
No sensitive customers affected	**3**
Less or equal to 0.1% sensitive customers affected	**2**
Between 0.1% and 0.25% of sensitive customers affected	**1.5**
More than or equal to 10% area affected	**0**

FWts28 - Water supply interruptions, not caused by water quality problems, for other services last year (% customers of other services)

Percentage of customers of other services affected by water supply interruptions exceeding 6h, not caused by water quality problems, last year

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Reliable service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Other city services: RESCCUE services. If other, explain in comments. Please list which other services were affected. Please answer with an estimated figure [%] in comments. Refers to the % of the affected customers that provide other services and not the % of affected customers of such services.

Development assessment rule	Development
Less or equal to 0.1% customers affected	**3**
More than 0.1% and less than 0.25% of customers affected	**2**
More or equal to 0.25% and less than 0.5% of customers affected	**1**
More than or equal to 0.5% of customers affected	**0**

FWts29 - Water supply interruptions caused by water quality problems, for other services last year (% customers of other services)

Percentage of customers of other services affected by water supply interruptions exceeding 6h, caused by water quality problems, last year

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Reliable service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Other city services: RESCCUE services. If other, explain in comments. Please list which other services were affected. Please answer with an estimated figure [%] in comments. Refers to the % of the affected customers that provide other services and not the % of affected customers of such services.

Development assessment rule	Development
Less or equal to 0.1% customers affected	**3**
More than 0.1% and less than 0.25% of customers affected	**2**
More or equal to 0.25% and less than 0.5% of customers affected	**1**
More than or equal to 0.5% of customers affected	**0**

FWts30 - Water supply interruptions, not caused by water quality problems, for households last year (% of households)

Percentage of households affected by water supply interruptions exceeding 6h, not caused by water quality problems, last year

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Reliable service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less or equal to 0.1% of households affected	**3**
More than 0.1% and less than 0.25% of households affected	**2**
More or equal to 0.25% and less than 0.5% of households affected	**1**
More than or equal to 0.5% of households affected	**0**

FWts31 - Water supply interruptions caused by water quality problems, for households last year (% of households)

Percentage of households affected by water supply interruptions exceeding 6h, caused by water quality problems, last year

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less or equal to 0.1% of households affected	**3**
More than 0.1% and less than 0.25% of households affected	**2**
More or equal to 0.25% and less than 0.5% of households affected	**1**
More than or equal to 0.5% of households affected	**0**

FWts32 - Total duration of water supply interruption, not caused by water quality problems, last year (days)

Total duration (days) of water supply interruption, not caused by water quality problems, last year

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Reliable service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
Less or equal to 1 day of water supply interruption	**3**
More than 1 and less than 3 days of water supply interruption	**2**
More or equal to 3 and less than 6 days of water supply interruption	**1**
More than or equal to 6 days of water supply interruption	**0**

FWts33 - Total duration of water supply interruption, caused by water quality problems, last year (days)

Total duration (days) of water supply interruption, caused by water quality problems, last year

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
Less or equal to 1 day of water supply interruption	**3**
More than 1 and less than 3 days of water supply interruption	**2**
More or equal to 3 and less than 6 days of water supply interruption	**1**
More than or equal to 6 days of water supply interruption	**0**

FWts34 - Water losses last year (m3/(km.day))

Water losses last year (water loss volume in the supply system/(total pipe length.365))

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Reliable service
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [m3/(km.day)] in comments.

Development assessment rule	Development
Less or equal to 15 m^3 of loss water	**3**
More than 15 and less than 22.5 m^3 of loss water	**2**
More or equal to 22.5 and less than 50 m^3 of loss water	**1**
More than or equal to 50 m^3 of loss water	**0**

FWts35 - Water uses (% of drinking water)

Percentage of drinking water being used for irrigation, street cleaning, fire fighting or other public uses

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Flexible service
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less or equal to 10%	**3**
More than 10% and less than 25%	**2**
More or equal to 25% and less than 50%	**1**
More than or equal to 50%	**0**

FWts36 - Water sources (-)

Which types of water supply sources are being used in the city?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Flexible service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 = 0).

Development assessment rule	Development
a) Surface water	**1**
b) Groundwater (pumped)	**1**
c) Groundwater (wells)	**1**
d) Ocean water dessalinization	**1**
e) Other (explain in Comments)	**1**
f) None	**0**

FWts37 - Water sources location (-)

Where are the city's water supply sources located?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Flexible service
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1.5; Sum<1 = 0).

Development assessment rule	Development
a) within the urban area	**1**
b) outside city boundaries but within the metropolitan area	**1**
c) far from the outskirsts of the metropolitan area	**1**
d) none	**0**

FWts38 - Service management (-)

Services are appropriately managed, i.e. technological tools are used, existing competences are adequate and a command chain is in place?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service planning and risk management
Criteria	Flexible service
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
No significant technological tools exist but competences are adequate and a command chain is in place	**2**
Only a command chain is in place	**1**
No	**0**

FWts39 - Stakeholders perception (-)

Is there a mechanism to provide service score, based on stakeholders' perception and is it applied? If yes quantify the service score from stakehoder perception

Dimension	Functional
Subdimension	Water
Resilience objective	Autonomous water service
Criteria	Service importance to the city
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
More than or equal to 3	**3**
More than or equal to 2 and less than 3	**2**
More than 1 and less than 2	**1**
Less than or equal to 1 or there is no mechanism in place	**0**

FWts40 - Cascading impacts (-)

Is there an understanding of potentially cascading failures between different services, under different scenarios?

Dimension	Functional
Subdimension	Water
Resilience objective	Autonomous water service
Criteria	Service importance to the city
Source	UNISDR Scorecard P2.4 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Cascading effects have been studied, but CC scenarios were not considered	**2**
Cascading effects have been studied, but only for some services and CC scenarios were not considered	**1.5**
No	**0**

FWts41 - Critical services dependence on water service according to climate change scenarios (-)

To what extent are critical services (CS -RESCCUE services) dependent on the water service, based on climate change scenarios?

Dimension	Functional
Subdimension	Water
Resilience objective	Autonomous water service
Criteria	Service inter-dependency with other services considering climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Refer in Comments which services have high dependence of this service. This metric depends on metric FWts48.

Development assessment rule	Development
No dependence (CS are not affected or failure is not likely to occur due to problems in water service)	**3**
Minor dependence (CS are affected and failure is likely to occur in one of the CS)	**2**
Major dependence (CS are affected and failure is likely to occur in more than one CS)	**1**
Total dependence (failure is likely to occur in all CS)	**0**

FWts42 - Water services autonomy from other critical services according to climate change scenarios (-)

To what extent is the water service dependent on other critical services (CS -RESCCUE services), based on climate change scenarios?

Dimension	Functional
Subdimension	Water
Resilience objective	Autonomous water service
Criteria	Service inter-dependency with other services considering climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Refer in Comments which services does this service have low autonomy from. This metric depends on metric FWts48.

Development assessment rule	Development
Total autonomy (does not depend on CS services continuity - e.g. energy, fuel)	**3**
Major autonomy (are affected but do not fail in case of CS continuity loss)	**2**
Minor autonomy (failure is likely to occur in at least one infrastructure in case of CS continuity loss)	**1**
No autonomy (failure is likely to occur in the majority of infrastructures in case of CS continuity loss)	**0**

FWts43 - Water service event management plans (-)

Is there a disaster management / preparedness / emergency response plan outlining service mitigation, preparedness and response to local emergencies?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for disaster response
Source	UNISDR Scorecard P9.2 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
No, but the service is included in the city-wide disaster management plan	**2**
The plan only addresses some of the indicated requirements	**1**
No	**0**

FWts44 - Water services interdepartmental collaboration for emergency (-)

Is there an emergency operations centre, automating standard operating procedures specifically designed to deal with “most probable” and “most severe” scenarios?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for disaster response
Source	UNISDR Scorecard P9.6 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially, there is an emergency operations centre, automating standard operating procedures but not specifically designed to deal with “most probable” and “most severe” scenarios	**1.5**
No	**0**

FWts45 - Water services early warning (-)

Does the service have a plan or standard operating procedure to act on early warnings and forecasts? Is the city warned by this system?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for disaster response
Source	UNISDR Scorecard P9.1 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Yes, a plan or a SOP exists, but the city is not informed	**1.5**
No	**0**

FWts46 - Water service drills (-)

Are practices and drills carried out internally and periodically?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for disaster response
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes, every year	**3**
Yes, occasionally	**1.5**
No	**0**

FWts47 - Service commitment with mitigation of climate change effects (% of reduction of GHG)

Is the service commited with an established mitigation target regarding reduction of GHG within its strategic planning?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes, a 50% reduction or higher is the target	**3**
Yes, a 20% - 49% reduction is the target	**2**
Yes, but the target is lower than 20% or there is no target defined	**1**
No compromise	**0**

FWts48 - Existence of agreed climate change scenarios and alignment with the city climate change scenarios ( )

Are there agreed climate change scenarios, setting out service exposure and vulnerability, from each hazard level? Are they aligned with the city-wide climate change scenarios?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metrics FWts14, FWts15, FWts16, FWts17, FWts18, FWts19,FWts20, FWts21, FWts22, FWts23, FWts41, FWts42, FWts49, FWts58, FWts59, FWts60, FWts61, FWts62, FWts63, FWts64, FWts65, FWts66, FWts67, PWts20, PWts36, PWts37, PWts38, PWts41, PWts42, PWts43, PWts44, PWts45, PWts46, PWts47, PWts48 and PWts49.

Development assessment rule	Development
Comprehensive scenarios exist (at least “most probable” and “most severe”) updated in last 5 years and are aligned with the city	**3**
Partial scenarios exist but are not comprehensive or complete and/or are more than 5 years old and only partially aligned with the city	**2**
Only a generalized notion of exposure and vulnerability, with no attempt systematically to identify impacts	**1**
No	**0**

FWts49 - Knowledge of exposure and service vulnerability for climate change scenarios (-)

The analysis of exposure and service vulnerability for climate change scenarios addresses:

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and a scale to 3 is made. This metric depends on metric FWts48.

Development assessment rule	Development
a) People	**2**
b) Housing	**2**
c) Service's infrastructures	**1**
d) Critical service's infrastructures	**2**
e) Other service's infrastructures	**1**
f) Protective infrastructures	**1**
g) Green / blue infrastructures	**1**
h) None of the above	**0**

FWts50 - Service planning for adaptation to climate change (-)

Is adaptation to climate change being considered in the service plans and enforced in new projects?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Yes, but only for some climate change hazards	**1.5**
No	**0**

FWts51 - Implemented measures to address climate change mitigation and adaptation (-)

What type of measures has the service implemented to address climate change mitigation and adaptation?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥3 and f)=1 =3; Sum>0 and <3 or Sum≥3 and f)=0 =2; Sum=0 =0).

Development assessment rule	Development
a) Drills and training	**1**
b) Stakeholder or public engagement and awareness	**1**
c) Improvement of information collection and analysis	**1**
d) Improvement of the administrative buildings' and processes' environmental efficiency	**1**
e) Reduction of GHG in the fleet	**1**
f) Development of emergency or contigency plans	**1**
g) Use of social media for warnings and information	**1**
h) Other (explain in the Comments column)	**1**
i) None of the above	**0**

FWts52 - Planned measures to address climate change mitigation and adaptation (-)

What type of measures is the service planning to implement to address climate change mitigation and adaptation?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and Sum<2 =2; Sum=0 =0).

Development assessment rule	Development
a) Drills and training	**1**
b) Stakeholder or public engagement and awareness	**1**
c) Improvement of information collection and analysis	**1**
d) Improvement of the administrative buildings' and processes' environmental efficiency	**1**
e) Reduction of GHG in the fleet	**1**
f) Development of emergency or contigency plans	**1**
g) Use of social media for warnings and information	**1**
h) Other (explain in the Comments column)	**1**
i) None of the above	**0**

FWts53 - Equipment capacity of the service (-)

Has the service adequate equipment capacity, in normal and emergency circumstances?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

Insert some examples in Comments.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FWts54 - Staffing capacity of the service (-)

Has the service adequate staffing capacity, in normal and emergency circumstances?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

Insert some examples in Comments.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FWts55 - Water service climate change recovery planning (-)

Is there a strategy or process in place for post-event service recovery and reconstruction?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for recovery and build back
Source	UNISDR Scorecard P10.1
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
There is a strategy/process in place. It is robust and well-understood by relevant stakeholders	**3**
There is a strategy/process in place. It is well- understood by relevant stakeholders but has known weaknesses	**2**
Some plans/strategies exist but they are not comprehensive or joined up or understood by relevant stakeholders	**1**
No known plans	**0**

FWts56 - Water service damage and loss post-event assessment (-)

Does the service has a system in place to provide Post-Disaster Needs Assessment?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metric FWts57.

Development assessment rule	Development
Yes	**3**
No	**0**

FWts57 - Current post-event assessment system (-)

If yes, has such system been defined, implemented, tested and historic data is registered?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on metric FWts56.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FWts58 - Water supply interruption, not caused by water quality problems, in the city area in the last relevant climate-related event (% of the city area)

Percentage of the city area affected by water supply interruptions exceeding 6h, not caused by water quality, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

This metric depends on metric FWts48.

Development assessment rule	Development
No area affected	**3**
Less than or equal to 2.5% area affected	**2**
Between 2.5% and 10% area affected	**1**
More than or equal to 10% area affected	**0**

FWts59 - Water supply interruptions caused by water quality problems, in the city area, in the last relevant climate-related event (% of the city area)

Percentage of the city area affected by water supply interruptions exceeding 6h, caused by water quality problems, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

This metric depends on metric FWts48.

Development assessment rule	Development
No area affected	**3**
Less than or equal to 2.5% area affected	**2**
Between 2.5% and 10% area affected	**1**
More than or equal to 10% area affected	**0**

FWts60 - Water supply interruptions, not caused by water quality problems, for sensitive customers in the last relevant climate-related event (% of sensitive customers)

Percentage of sensitive customers affected by water supply interruptions exceeding 6h, not caused by water quality problems, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please list which sensitive customers were affected and answer with an estimated figure [%] in comments. Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. This metric depends on metric FWts48.

Development assessment rule	Development
No sensitive customers affected	**3**
Less than or equal to 2.5% sensitive customers affected	**2**
More than 2.5% and less than 5% sensitive customers affected	**1.5**
More than or equal to 5% and less than 100% sensitive customers affected	**0**

FWts61 - Water supply interruptions caused by water quality problems, for sensitive customers in the last relevant climate-related event (% of sensitive customers)

Percentage of sensitive customers affected by water supply interruptions exceeding 6h, caused by water quality problems, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please list which sensitive customers were affected and answer with an estimated figure [%] in comments. Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. This metric depends on metric FWts48.

Development assessment rule	Development
No sensitive customers affected	**3**
Less than or equal to 2.5% sensitive customers affected	**2**
More than 2.5% and less than 5% sensitive customers affected	**1.5**
More than or equal to 5% and less than 100% sensitive customers affected	**0**

FWts62 - Water supply interruptions, not caused by water quality problems, for other services in the last relevant climate-related event (% customers of other services)

Percentage of customers of other services affected by water supply interruptions exceeding 6h, not caused by water quality problems, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please list which other services were affected and answer with an estimated figure [%] in comments. This metric depends on metric FWts48.

Development assessment rule	Development
No customers of other services affected	**3**
Less than or equal to 2.5% customers of other services affected	**2**
More than 2.5% and less than 5% customers of other services affected	**1.5**
More than or equal to 5% and less than 100% customers of other services affected	**0**

FWts63 - Water supply interruptions caused by water quality problems, for other services in the last relevant climate-related event (% customers of other services)

Percentage of customers of other services affected by water supply interruptions exceeding 6h, caused by water quality problems, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please list which other services were affected and answer with an estimated figure [%] in comments. This metric depends on metric FWts48.

Development assessment rule	Development
No customers of other services affected	**3**
Less than or equal to 2.5% customers of other services affected	**2**
More than 2.5% and less than 5% customers of other services affected	**1.5**
More than or equal to 5% and less than 100% customers of other services affected	**0**

FWts64 - Water supply interruptions, not caused by water quality problems, for households in the last relevant climate-related event (% of households)

Percentage of households affected by water supply interruptions exceeding 6h, not caused by water quality problems, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments. This metric depends on metric FWts48.

Development assessment rule	Development
No households affected	**3**
Less than or equal to 2.5% households affected	**2**
More than 2.5% and less than 5% households affected	**1.5**
More than or equal to 5% and less than 100% households affected	**0**

FWts65 - Water supply interruptions caused by water quality problems, for households in the last relevant climate-related event (% of households)

Percentage of households affected by water supply interruptions exceeding 6h, caused by water quality problems, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments. This metric depends on metric FWts48.

Development assessment rule	Development
No households affected	**3**
Less than or equal to 2.5% households affected	**2**
More than 2.5% and less than 5% households affected	**1.5**
More than or equal to 5% and less than 100% households affected	**0**

FWts66 - Total duration of water supply interruption, not caused by water quality problems, in the last relevant climate-related event (days)

Days of water supply interruption, not caused by water quality problems, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments. This metric depends on metric FWts48.

Development assessment rule	Development
Less or equal to 1 day	**3**
> 1 and ≤ 3 days	**2**
> 3 and ≤ 6 days	**1.5**
> 6 days	**0**

FWts67 - Total duration of water supply interruption, caused by water quality problems in the last relevant climate-related event (days)

Days of water supply interruption, caused by water quality problems, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments. This metric depends on metric FWts48.

Development assessment rule	Development
Less or equal to 1 day	**3**
> 1 and ≤ 3 days	**2**
> 3 and ≤ 6 days	**1.5**
> 6 days	**0**

FWts68 - Water service lessons learnt and learning loops (-)

Are service-specific processes in place for lessons learnt, including failure analysis? If yes, are service-specific plans informed by them?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Processes in place but plans are not informed by them	**2**
Partially	**1**
No	**0**

FWts69 - Insurance (-)

What level of insurance cover exists in the service?

Dimension	Functional
Subdimension	Water
Resilience objective	Water service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Sectors within the service: e.g. infrastructure, equipment, fleet, human resources, administrative buildings.

Development assessment rule	Development
The uptake for insurance products across all sectors within the service is high	**3**
The level of insurance varies significantly by sector or by area	**2**
Little insurance cover	**1**
No insurance cover	**0**

FUNCTIONAL

WASTEWATER

PI code	PI name	Unit

FWwt01 - Wastewater service strategic plan making and implementation (-)

Does the service have a strategic plan and is it implemented

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Strategic planning
Source	UNISDR Scorecard P1.1 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metric FWwt02 and FWwt03.

Development assessment rule	Development
Yes	**3**
Partially. The plan exists, but it is still not implemented OR Not all the responsible utilities have an implemented plan	**1.5**
No	**0**

FWwt02 - Plan alignment with the City Master Plan (-)

If yes, is the plan aligned with the city main planning document?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on metric FWwt01.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FWwt03 - Service plan monitoring and review (-)

If existing, is the plan periodically monitored and reviewed, ensuring it remains relevant and operational?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on metric FWwt01.

Development assessment rule	Development
Yes, at least once every 5 years	**3**
Yes, at least once every 10 years	**2**
The frequency exceeds once every 10 years, or the plan is not considered relevant or operational	**1**
No periodical monitoring and review	**0**

* (-) without unit or dimensionless

FWwt04 - Exchange of information to the city (-)

Is there regular exchange of data and information between service and the city concerning the review of planning documents?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please indicate the last review's date.

Development assessment rule	Development
Yes, at least once every 5 years	**3**
Yes, at least once every 10 years	**2**
The frequency exceeds once every 10 years, or the plan is not considered relevant or operational or analysis of relevant data is not undertaken to inform city planning and strategies	**1**
No periodical exchange	**0**

FWwt05 - Land use zoning compliance (-)

Do the service-specific plans comply with up-to-date land use and zoning regulations?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FWwt06 - Resilience in wastewater service strategy and alignment with the City Master Plan (-)

Does the service have a resilience plan (either as an autonomous action plan or as a strategy included in the service's strategic plan) and what is its timeframe?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please specify the last update/review. This metric conditions the metric FWwt07.

Development assessment rule	Development
Yes approved. It considers short-, medium- and long-term	**3**
Yes approved. Its timeframe is not defined or considers only short-, medium- or long-term	**2**
It is under approval or under preparation. Timeframe is not yet finalised	**1**
No plan	**0**

FWwt07 - Service strategic plan for resilience and Climate Change (-)

Does the resilience plan consider climate change (projection, scenarios, impacts, etc.)?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FWwt06.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FWwt08 - Service financial plan and budget for resilience (-)

Do the service financial plans have dedicated allocations for resilience-building actions (including disaster risk reduction (DRR))?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
The service financial plan is comprehensive in relation to resilience-building, budgets are ring fenced and necessary resources and arrangements for local DRR in place	**3**
The service financial plan allows for resilience-building, budgets are ring fenced	**2**
The service financial plan allows for some resilience-building activities not aligned, budgets are not ring fenced	**1.5**
No clear plan	**0**

FWwt09 - Wastewater service business continuity (-)

Do business continuity plans exist?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

A business continuity plan allows that appropriate management and delivery of services may be provided by e.g., technological tools, such as GPS or communication devices, to support daily management exist and intercommunicate, collecting circuits can be easily changed, type of vehicles adequate to the locations and circuits. Adequate competences may be competent human resources, who are dynamic and easily assume different functions. A command chain ensures responsibilities are clearly allocated and several decision levels are attributed.

Development assessment rule	Development
Yes	**3**
No	**0**

FWwt10 - Co-ordination with other wastewater services in the city (-)

Is there any coordination mechanism in place with other wastewater services/entities either at municipal or metropolitan level?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Formal mechanism: e.g., Office, Committee, MoU, Protocols, National/Regional Platform. If yes please specify.

Development assessment rule	**Development**
Yes	**3**
No	**0**

FWwt11 - Learning from other wastewater services (-)

Is there any knowledge exchange with other services?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

Services facing similar challenges: e.g other wastewater services, other urban services. Please select all applicable answers. Sum of the selected options and a scale to 3 is made.

Development assessment rule	**Development**
a) International exchanges are in place	**1**
b) National exchanges are in place	**1**
c) With similar services	**1**
d) With different services	**1**
e) None of the above	**0**

FWwt12- Risk information related to the wastewater service (-)

Do specific service plans include risk information (such as exposure and vulnerability, damage and loss quantification, etc.) related to the service and are regurlarly updated?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please indicate the last review's date.

Development assessment rule	**Development**
Yes	**3**
Partially, not covering the all the hazards or all the city or not regurlarly updated	**1.5**
No	**0**

FWwt13 - Damage and loss estimation (-)

Does risk assessment include estimations of damage and loss for agreed climate change scenarios, based on current development and future urban and population growth?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Risk management
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Risk assessments focus mostly on spatial, physical assets at risk. Data is limited	**2**
There are plans to develop risk assessments	**1**
Risk assessments do not identify all risk areas or there are no plans to update them	**0**

FWwt14 - Expected wastewater flooding in the city area according to climate change scenarios (% of the city area)

Percentage of the city area expected to be affected by flooding due to wastewater collection interruption, according to climate change scenarios

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Risk management
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

This metric depends on metric FWwt45.

Development assessment rule	Development
No area at risk for “most severe” scenario	**3**
No area at risk for “most probable” scenario	**2**
Less than or equal to 2.5% area at risk for “most probable” scenario	**1.5**
Between 2.5% and 100% area at risk for “most probable” scenario	**0**

FWwt15 - Expected wastewater treatment failures in the city area according to climate change scenarios (% of the city area)

Percentage of the city area expected to be affected by wastewater treatment failures, according to climate change scenarios

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Risk management
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on metric FWwt45.

Development assessment rule	Development
No area at risk for “most severe” scenario	**3**
No area at risk for “most probable” scenario	**2**
Less than or equal to 2.5% area at risk for “most probable” scenario	**1.5**
Between 2.5% and 100% area at risk for “most probable” scenario	**0**

FWwt16 - Expected wastewater flooding in sensitive customers according to climate change scenarios (% of sensitive customers)

Percentage of sensitive customers expected to be affected by flooding due to wastewater collection interruption, according to climate change scenarios

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments. Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. This metric depends on metric FWwt45.

Development assessment rule	Development
No sensitive customers expected to be affected for “most severe” scenario	**3**
No sensitive customers expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% sensitive customers expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% sensitive customers expected to be affected for “most probable” scenario	**0**

FWwt17 - Expected wastewater discharges, due to failure in wastewater service to ecosystem services according to climate change scenarios (-)

Number of expected wastewater discharges into ecosystems services due to wastewater service interruption, according to climate change scenarios

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Risk management
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Wastewater service failure in the system or treatment plant. Please answer with an estimated figure [-] in comments. This metric depends on metric FWwt45.

Development assessment rule	Development
≤3 for “most severe” scenario	**3**
≤3 for “most probable” scenario	**2**
>3 and ≤6 for “most probable” scenario	**1.5**
>6 for “most probable” scenario	**0**

FWwt18- Expected wastewater flooding in other services according to climate change scenarios (% customers of other services)

Percentage of customers of other services expected to be affected by flooding due to wastewater collection interruption, according to climate change scenarios

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Other city services: RESCCUE services. If other, explain in comments. Please answer with an estimated figure [%] in comments. This metric depends on metric FWwt45.

Development assessment rule	Development
No customers of other services expected to be affected for “most severe” scenario	**3**
No customers of other services expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% customers of other services expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% customers of other services expected to be affected for “most probable” scenario	**0**

FWwt19 - Expected wastewater flooding in households according to climate change scenarios (% of households)

Percentage of households expected to be affected by flooding due to wastewater collection interruption, according to climate change scenarios

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments. This metric depends on metric FWwt45.

Development assessment rule	Development
No households expected to be affected for “most severe” scenario	**3**
No households expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% households expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% households expected to be affected for “most probable” scenario	**0**

FWwt20 - Expected total duration of wastewater flooding period according to climate change scenarios (days)

Total duration of expected wastewater flooding due to wastewater collection interruption, according to climate change scenarios

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments. This metric depends on metric FWwt45.

Development assessment rule	Development
Less or equal to 1 day for “most severe” scenario	**3**
Less or equal to 1 day for “most probable” scenario	**2**
Between 1 and 3 days for “most probable” scenario	**1.5**
More than 3 days for “most probable” scenario	**0**

FWwt21 - Expected total duration of wastewater treatment failure period according to climate change scenarios (days)

Total duration of expected wastewater treatment failures, according to climate change scenarios

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Risk management
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments. This metric depends on metric FWwt45.

Development assessment rule	Development
Less or equal to 1 day for “most severe” scenario	**3**
Less or equal to 1 day for “most probable” scenario	**2**
Between 1 and 3 days for “most probable” scenario	**1.5**
More than 3 days for “most probable” scenario	**0**

FWwt22 - Wastewater flooding in the city area last year (% of the city area)

Percentage of the city area affected by flooding due to wastewater collection interruption, last year

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Reliable service
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
No area affected	**3**
Less than or equal to 2.5% area affected	**2**
Between 2.5% and 10% area affected	**1.5**
More than or equal to 10% area affected	**0**

FWwt23 - Wastewater treatment failures in the city area last year (% of the city area)

Percentage of the city area affected by wastewater treatment failures, last year

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Reliable service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
No area affected	**3**
Less than or equal to 2.5% area affected	**2**
Between 2.5% and 10% area affected	**1.5**
More than or equal to 10% area affected	**0**

FWwt24 - Wastewater flooding in sensitive customers last year (% of sensitive customers)

Percentage of sensitive customers affected by flooding due to wastewater collection interruption, last year

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. Please list which sensitive customers were affected.

Development assessment rule	Development
No sensitive customers affected	**3**
Less or equal to 0.1% sensitive customers affected	**2**
Between 0.1% and 0.25% of sensitive customers affected	**1.5**
More than or equal to 0.25% area affected	**0**

FWwt25 - Wastewater discharges, due to failure in wastewater service, to ecosystem services last year (-)

Number of wastewater discharges into ecosystems services due to wastewater service interruption, last year

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Reliable service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Wastewater service failure in the system or treatment plant. Please answer with an estimated figure [-] in comments.

Development assessment rule	Development
Less or equal to 3 wastewater discharges	**3**
More than 3 and less than 6 wastewater discharges	**2**
More or equal to 6 and less than 10 wastewater discharges	**1**
More than or equal to 10 wastewater discharges	**0**

FWwt26 - Wastewater flooding in other services last year (% customers of other services)

Percentage of customers of other services affected by flooding due to wastewater collection interruption, last year

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Other city services: RESCCUE services. If other, explain in comments. Please list which other services were affected. Please answer with an estimated figure [%] in comments. Refers to the % of the affected customers that provide other services and not the % of affected customers of such services.

Development assessment rule	Development
Less or equal to 0.1% customers affected	**3**
More than 0.1% and less than 0.25% of customers affected	**2**
More or equal to 0.25% and less than 0.5% of customers affected	**1**
More than or equal to 0.5% of customers affected	**0**

FWwt27 - Wastewater effective treatment in the city area last year (%)

Percentage of wastewater that was collected and safely treated, last year

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Reliable service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
100% of wastewater collected and safely treated	**3**
More than or equal to 95% and less than 100% of wastewater collected and safely treated	**2**
More than 85% and less than 95% of wastewater collected and safely treated	**1**
Less than or equal to 85% of wastewater collected and safely treated	**0**

FWwt28 - Wastewater flooding in households last year (% of households)

Percentage of households affected by flooding due to wastewater collection interruption, last year

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less or equal to 0.1% of households affected	**3**
More than 0.1% and less than 0.25% of households affected	**2**
More or equal to 0.25% and less than 0.5% of households affected	**1**
More than or equal to 0.5% of households affected	**0**

FWwt29 - Total duration of wastewater flooding period last year (days)

Total duration of wastewater flooding, last year

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
Less or equal to 1 day of wastewater flooding	**3**
More than 1 and less than 3 days of wastewater flooding	**2**
More or equal to 3 and less than 6 days of wastewater flooding	**1**
More than or equal to 6 days of wastewater flooding	**0**

FWwt30 - Total duration of wastewater treatment failure period last year (days)

Total duration of wastewater treatment failure, last year

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Reliable service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
Less or equal to 1 day of wastewater treatment failure	**3**
More than 1 and less than 3 days of wastewater treatment failure	**2**
More or equal to 3 and less than 6 days of wastewater treatment failure	**1**
More than or equal to 6 days of wastewater treatment failure	**0**

FWwt31 - Estimated undue inflows into wastewater system last year (m3/(km.day))

Undue inflows (e.g. stormwater, industrial, saline, water supply inflows) into the system last year (undue wastewater inflow volume in the collection system / (total pipe length.365))

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Reliable service
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [m3/(km.day)] in comments.

Development assessment rule	Development
Less or equal to 10 m^3 of undue inflows	**3**
More than 10 and less than 80 m^3 of undue inflows	**2**
More or equal to 80 and less than 150 m^3 of undue inflows	**1**
More than or equal to 150 m^3 of undue inflows	**0**

FWwt32 - Treated wastewater uses (% of treated wastewater)

Percentage of treated wastewater being recycled or reused (for e.g. irrigation, urban cleaning, firefighting)

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Flexible servie
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More than or equal to 10%	**3**
More than 5% and less than 10%	**2**
More than 1% and less or equal to 5%	**1**
Less or equal to 1%	**0**

FWwt33 - Wastewater disposal (-)

Which solutions for wastewater disposal are used in the city?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Flexible service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 = 0).

Development assessment rule	Development
a) Superficial streams	**1**
b) Culverted streams	**1**
c) Tidal coast	**1**
d) Bathing waters	**1**
e) Submarine outfall	**1**
f) Other (specify in Comments)	**1**

g) None	**0**

FWwt34 - Wastewater disposal location (-)

Where are the city's wastewater disposal points located?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Flexible service
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1.5; Sum<1 = 0).

Development assessment rule	Development
a) within the urban area	**1**
b) outside city boundaries but within the metropolitan area	**1**
c) far from the outskirsts of the metropolitan area	**1**
d) none	**0**

FWwt35 - Service management (-)

Services are appropriately managed, i.e. technological tools are used, existing competences are adequate and a command chain is in place?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service planning and risk management
Criteria	Flexible service
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
No significant technological tools exist but competences are adequate and a command chain is in place	**2**
Only a command chain is in place	**1**
No	**0**

FWwt36 - Stakeholders perception (-)

Is there a mechanism to provide service score, based on stakeholders' perception and is it applied? If yes quantify the service score from stakehoder perception

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Autonomous wastewater service
Criteria	Service importance to the city
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
More than or equal to 3	**3**
More than or equal to 2 and less than 3	**2**
More than 1 and less than 2	**1**
Less than or equal to 1 or there is no mechanism in place	**0**

FWwt37- Cascading impacts (-)

Is there an understanding of potentially cascading failures between different services, under different scenarios?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Autonomous wastewater service
Criteria	Service importance to the city
Source	UNISDR Scorecard P2.4 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Cascading effects have been studied, but CC scenarios were not considered	**2**
Cascading effects have been studied, but only for some services and CC scenarios were not considered	**1.5**
No	**0**

FWwt38 - Critical services dependence on wastewater service according to climate change scenarios (-)

To what extent are critical services (CS -RESCCUE services) dependent on the wastewater service, based on climate change scenarios?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Autonomous wastewater service
Criteria	Service inter-dependency with other services considering climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Refer in Comments which services have high dependence of this service. This metric depends on metric FWwt45.

Development assessment rule	Development
No dependence (CS are not affected or failure is not likely to occur due to problems in wastewater service)	**3**
Minor dependence (CS are affected and failure is likely to occur in one of the CS)	**2**
Major dependence (CS are affected and failure is likely to occur in more than one CS)	**1**
Total dependence (failure is likely to occur in all CS)	**0**

FWwt39 - Wastewater services autonomy from other services according to climate change scenarios (-)

To what extent is the wastewater service dependent on other critical services (CS -RESCCUE services), based on climate change scenarios?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Autonomous wastewater service
Criteria	Service inter-dependency with other services considering climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Refer in Comments which services does this service have low autonomy from. This metric depends on metric FWwt45.

Development assessment rule	Development
Total autonomy (does not depend on CS services continuity - e.g. energy, fuel)	**3**
Major autonomy (are affected but do not fail in case of CS continuity loss)	**2**
Minor autonomy (failure is likely to occur in at least one infrastructure in case of CS continuity loss)	**1**
No autonomy (failure is likely to occur in the majority of infrastructures in case of CS continuity loss)	**0**

FWwt40 - Wastewater service event management plans (-)

Is there a disaster management / preparedness / emergency response plan outlining service mitigation, preparedness and response to local emergencies?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for disaster response
Source	UNISDR Scorecard P9.2 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
No, but the service is included in the city-wide disaster management plan	**2**
The plan only addresses some of the indicated requirements	**1**
No	**0**

FWwt41 - Wastewater services interdepartmental collaboration for emergency (-)

Is there an emergency operations centre, automating standard operating procedures specifically designed to deal with “most probable” and “most severe” scenarios?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for disaster response
Source	UNISDR Scorecard P9.6 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially, there is an emergency operations centre, automating standard operating procedures but not specifically designed to deal with “most probable” and “most severe” scenarios	**1.5**
No	**0**

FWwt42 - Wastewater services early warning (-)

Does the service have a plan or standard operating procedure to act on early warnings and forecasts? Is the city warned by this system?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for disaster response
Source	UNISDR Scorecard P9.1 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Yes, a plan or a SOP exists, but the city is not informed	**1.5**
No	**0**

FWwt43 - Wastewater service drills (-)

Are practices and drills carried out internally and periodically?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for disaster response
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes, every year	**3**
Yes, occasionally	**1.5**
No	**0**

FWwt44 - Service commitment with mitigation of climate change effects (% of reduction of GHG)

Is the service commited with an established mitigation target regarding reduction of GHG within its strategic planning?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes, a 50% reduction or higher is the target	**3**
Yes, a 20% - 49% reduction is the target	**2**
Yes, but the target is lower than 20% or there is no target defined	**1**
No compromise	**0**

FWwt45 - Existence of agreed climate change scenarios and alignment with the city climate change scenarios (-)

Are there agreed climate change scenarios, setting out service exposure and vulnerability, from each hazard level? Are they aligned with the city wide climate change scenarios?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metrics FWwt14, FWwt15, FWwt16, FWwt17, FWwt18, FWwt19, FWwt20, FWwt21, FWwt38, FWwt39, FWwt46, FWwt55, FWwt56, FWwt57, FWwt58, FWwt59, FWwt60, FWwt61, FWwt62, FWwt63, PWwt20, PWwt35, PWwt36, PWwt37, PWwt40, PWwt41, PWwt42, PWwt43, PWwt44, PWwt45, PWwt46, PWwt47 and PWwt48.

Development assessment rule	Development
Comprehensive scenarios exist (at least “most probable” and “most severe”) updated in last 5 years and are aligned with the city	**3**
Partial scenarios exist but are not comprehensive or complete and/or are more than 5 years old and only partially aligned with the city	**2**
Only a generalized notion of exposure and vulnerability, with no attempt systematically to identify impacts	**1**
No	**0**

FWwt46 - Knowledge of exposure and service vulnerability for climate change scenarios (-)

The analysis of exposure and service vulnerability for climate change scenarios addresses:

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and a scale to 3 is made. This metric depends on metric FWwt45.

Development assessment rule	Development
a) People	**2**
b) Housing	**2**
c) Service's infrastructures	**1**
d) Critical service's infrastructures	**2**
e) Other service's infrastructures	**1**
f) Protective infrastructures	**1**
g) Green / blue infrastructures	**1**
h) None of the above	**0**

FWwt47 - Service planning for adaptation to climate change (-)

Is adaptation to climate change being considered in the service plans and enforced in new projects?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Yes, but only for some climate change hazards	**1.5**
No	**0**

FWwt48 - Implemented measures to address climate change mitigation and adaptation (-)

What type of measures has the service implemented to to address climate change mitigation and adaptation?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥3 and f)=1 =3; Sum>0 and <3 or Sum≥3 and f)=0 =2; Sum=0 =0).

Development assessment rule	Development
a) Drills and training	**1**
b) Stakeholder or public engagement and awareness	**1**
c) Improvement of information collection and analysis	**1**
d) Improvement of the administrative buildings' and processes' environmental efficiency	**1**
e) Reduction of GHG in the fleet	**1**
f) Development of emergency or contigency plans	**1**
g) Use of social media for warnings and information	**1**
h) Other (explain in the Comments column)	**1**
i) None of the above	**0**

FWwt49 - Planned measures to address climate change mitigation and adaptation (-)

What type of measures is the service planning to implement to address climate change mitigation and adaptation?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and Sum<2 =2; Sum=0 =0).

Development assessment rule	Development
a) Drills and training	**1**
b) Stakeholder or public engagement and awareness	**1**
c) Improvement of information collection and analysis	**1**
d) Improvement of the administrative buildings' and processes' environmental efficiency	**1**
e) Reduction of GHG in the fleet	**1**
f) Development of emergency or contigency plans	**1**
g) Use of social media for warnings and information	**1**
h) Other (explain in the Comments column)	**1**
i) None of the above	**0**

FWwt50 - Equipment capacity of the service (-)

Has the service adequate equipment capacity, in normal and emergency circumstances?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

Insert some examples in Comments.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FWwt51 - Staffing capacity of the service (-)

Has the service adequate staffing capacity, in normal and emergency circumstances?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

Insert some examples in Comments.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FWwt52 - Wastewater service climate change recovery planning (-)

Is there a strategy or process in place for post-event service recovery and reconstruction?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for recovery and build back
Source	UNISDR Scorecard P10.1
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
There is a strategy/process in place. It is robust and well-understood by relevant stakeholders	**3**
There is a strategy/process in place. It is well- understood by relevant stakeholders but has known weaknesses	**2**
Some plans/strategies exist but they are not comprehensive or joined up or understood by relevant stakeholders	**1**
No known plans	**0**

FWwt53- Wastewater service damage and loss post-event assessment (-)

Does the service has a system in place to provide Post-Disaster Needs Assessment?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metric FWwt54.

Development assessment rule	Development
Yes	**3**
No	**0**

FWwt54 - Current post-event assessment system (-)

If yes, has such system been defined, implemented, tested and historic data is registered?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FWwt53.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FWwt55 - Wastewater flooding in the city area in the last relevant climate-related event (% of the city area)

Percentage of the city area affected by flooding due to wastewater collection interruption, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

This metric depends on metric FWwt45.

Development assessment rule	Development
No area affected	**3**
Less than or equal to 2.5% area affected	**2**
Between 2.5% and 10% area affected	**1**
More than or equal to 10% area affected	**0**

FWwt56 - Wastewater treatment failures in the city area in the last relevant climate-related event (% of the city area)

Percentage of the city area affected by wastewater treatment failures, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

This metric depends on metric FWwt45.

Development assessment rule	Development
No area affected	**3**
Less than or equal to 2.5% area affected	**2**
Between 2.5% and 10% area affected	**1**
More than or equal to 10% area affected	**0**

FWwt57 - Wastewater flooding in sensitive customers in the last relevant climate-related event (% of sensitive customers)

Percentage of sensitive customers affected by flooding due to wastewater collection interruption, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments. Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. This metric depends on metric FWwt45.

Development assessment rule	Development
No sensitive customers affected	**3**
Less than or equal to 2.5% sensitive customers affected	**2**
More than 2.5% and less than 5% sensitive customers affected	**1.5**
More than or equal to 5% and less than 100% sensitive customers affected	**0**

FWwt58 - Wastewater discharges, due to failure in wastewater service, to ecosystem services in the last relevant climate-related event (-)

Number of wastewater discharges into ecosystems services due to wastewater collection interruption, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

Wastewater service failure in the system or treatment plant. Please answer with an estimated figure [-] in comments. This metric depends on metric FWwt45.

Development assessment rule	Development
≤3	**3**
>3 and ≤6	**2**
>6 and ≤10	**1.5**
>10	**0**

FWwt59 - Wastewater flooding for other services in the last relevant event (% customers of other services)

Percentage of customers of other services affected by flooding due to wastewater collection interruption, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments. Other city services: RESCCUE services. If other, explain in comments. Please list which other services were affected. This metric depends on metric FWwt45.

Development assessment rule	Development
No customers of other services affected	**3**
Less than or equal to 2.5% customers of other services affected	**2**
More than 2.5% and less than 5% customers of other services affected	**1.5**
More than or equal to 5% and less than 100% customers of other services affected	**0**

FWwt60 - Wastewater effective treatment in the city area in the last relevant climate-related event (%)

Percentage of wastewater that was collected and safely treated, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments. This metric depends on metric FWwt45.

Development assessment rule	Development
100% of wastewater collected and safely treated	**3**
More than or equal to 95% and less than 100% of wastewater collected and safely treated	**2**
More than 85% and less than 95% of wastewater collected and safely treated	**1.5**
Less than or equal to 85% of wastewater collected and safely treated	**0**

FWwt61 - Wastewater flooding in households in the last relevant climate-related event (% of households)

Percentage of households affected by flooding due to wastewater collection interruption, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments. This metric depends on metric FWwt45.

Development assessment rule	Development
No households affected	**3**
Less than or equal to 2.5% households affected	**2**
More than 2.5% and less than 5% households affected	**1.5**
More than or equal to 5% and less than 100% households affected	**0**

FWwt62 - Total duration of wastewater flooding period in the last relevant climate-related event (days)

Days of wastewater flooding, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments. This metric depends on metric FWwt45.

Development assessment rule	Development
Less or equal to 0.25 day	**3**
> 0.25 and ≤ 0.5 days	**2**
> 0.5 and ≤ 1 days	**1.5**
> 1 days	**0**

FWwt63 - Total duration of wastewater treatment failure period in the last relevant climate-related event (days)

Days of wastewater treatment failure, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments. This metric depends on metric FWwt45.

Development assessment rule	Development
Less or equal to 1 day	**3**
> 1 and ≤ 3 days	**2**
> 3 and ≤ 6 days	**1.5**
> 6 days	**0**

FWwt64 - Wastewater service lessons learnt and learning loops (-)

Are service-specific processes in place for lessons learnt, including failure analysis? If yes, are service-specific plans informed by them?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Processes in place but plans are not informed by them	**2**
Partially	**1**
No	**0**

FWwt65 - Insurance (-)

What level of insurance cover exists in the service?

Dimension	Functional
Subdimension	Wastewater
Resilience objective	Wastewater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Sectors within the service: e.g. infrastructure, equipment, fleet, human resources, administrative buildings.

Development assessment rule	Development
The uptake for insurance products across all sectors within the service is high	**3**
The level of insurance varies significantly by sector or by area	**2**
Little insurance cover	**1**
No insurance cover	**0**

FUNCTIONAL

STORMWATER

PI code	PI name	Unit*

FSwt01 - Stormwater service strategic plan making and implementation (-)

Does the service have a strategic plan and is it implemented

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Strategic planning
Source	UNISDR Scorecard P1.1 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metric FSwt02 and FSwt03.

Development assessment rule	Development
Yes	**3**
Partially. The plan exists, but it is still not implemented OR Not all the responsible utilities have an implemented plan	**1.5**
No	**0**

FSwt02 - Plan alignment with the City Master Plan (-)

If yes, is the plan aligned with the city main planning document?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSwt01.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FSwt03 - Service plan monitoring and review (-)

If existing, is the plan periodically monitored and reviewed, ensuring it remains relevant and operational?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSwt01.

Development assessment rule	Development
Yes, at least once every 5 years	**3**
Yes, at least once every 10 years	**2**
The frequency exceeds once every 10 years, or the plan is not considered relevant or operational	**1**
No periodical monitoring and review	**0**

* (-) without unit or dimensionless

FSwt04 - Exchange of information to the city (-)

Is there regular exchange of data and information between service and the city concerning the review of planning documents?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please indicate the last review's date.

Development assessment rule	Development
Yes, at least once every 5 years	**3**
Yes, at least once every 10 years	**2**
The frequency exceeds once every 10 years, or the plan is not considered relevant or operational or analysis of relevant data is not undertaken to inform city planning and strategies	**1**
No periodical exchange	**0**

FSwt05 - Land use zoning compliance (-)

Do the service-specific plans comply with up-to-date land use and zoning regulations?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FSwt06 - Resilience in stormwater service strategy and alignment with the City Master Plan (-)

Does the service have a resilience plan (either as an autonomous action plan or as a strategy included in the service's strategic plan) and what is its timeframe?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please specify the last update/review. This metric conditions the metric FSwt07.

Development assessment rule	Development
Yes approved. It considers short-, medium- and long-term	**3**
Yes approved. Its timeframe is not defined or considers only short-, medium- or long-term	**2**
It is under approval or under preparation. Timeframe is not yet finalised	**1**
No plan	**0**

FSwt07 - Service strategic plan for resilience and Climate Change (-)

Does the resilience plan consider climate change (projection, scenarios, impacts, etc.)?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSwt06.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FSwt08 - Service financial plan and budget for resilience (-)

Do the service financial plans have dedicated allocations for resilience-building actions (including disaster risk reduction (DRR))?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
The service financial plan is comprehensive in relation to resilience-building, budgets are ring fenced and necessary resources and arrangements for local DRR in place	**3**
The service financial plan allows for resilience-building, budgets are ring fenced	**2**
The service financial plan allows for some resilience-building activities not aligned, budgets are not ring fenced	**1.5**
No clear plan	**0**

FSwt09 - Stormwater service business continuity (-)

Do business continuity plans exist?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

A business continuity plan allows that appropriate management and delivery of services may be provided by e.g., technological tools, such as GPS or communication devices, to support daily management exist and intercommunicate, collecting circuits can be easily changed, type of vehicles adequate to the locations and circuits. Adequate competences may be competent human resources, who are dynamic and easily assume different functions. A command chain ensures responsibilities are clearly allocated and several decision levels are attributed.

Development assessment rule	Development
Yes	**3**
No	**0**

FSwt10 - Co-ordination with other drainage services in the city (-)

Is there any coordination mechanism in place with other stormwater services/entities either at municipal or metropolitan level?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Formal mechanism: e.g., Office, Committee, MoU, Protocols, National/Regional Platform. If yes please specify.

Development assessment rule	Development
Yes	**3**
No	**0**

FSwt11 - Learning from other stormwater services (-)

Is there any knowledge exchange with other services?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

Services facing similar challenges: e.g other water services, other urban services. Please select all applicable answers. Sum of the selected options and a scale to 3 is made.

Development assessment rule	Development
a) International exchanges are in place	**1**
b) National exchanges are in place	**1**
c) With similar services	**1**
d) With different services	**1**
e) None of the above	**0**

FSwt12- Risk information related to the stormwater service (-)

Do specific service plans include risk information (such as exposure and vulnerability, damage and loss quantification, etc.) related to the service and are regurlarly updated?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please indicate the last review's date.

Development assessment rule	Development
Yes	**3**
Partially, not covering the all the hazards or all the city or not regurlarly updated	**1.5**
No	**0**

FSwt13 - Damage and loss estimation (-)

Does risk assessment include estimations of damage and loss for agreed climate change scenarios, based on current development and future urban and population growth?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Risk management
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Risk assessments focus mostly on spatial, physical assets at risk. Data is limited	**2**
There are plans to develop risk assessments	**1**
Risk assessments do not identify all risk areas or there are no plans to update them	**0**

FSwt14 - Expected stormwater flooding in the city area according to climate change scenarios (% of the city area)

Percentage of the city area expected to be affected by flooding due to stormwater drainage problems, according to climate change scenarios

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSwt38.

Development assessment rule	Development
No area at risk for “most severe” scenario	**3**
No area at risk for “most probable” scenario	**2**
Less than or equal to 2.5% area at risk for “most probable” scenario	**1.5**
Between 2.5% and 100% area at risk for “most probable” scenario	**0**

FSwt15 - Expected stormwater flooding in sensitive customers according to climate change scenarios (% of sensitive customers)

Percentage of sensitive customers expected to be affected by flooding due to stormwater drainage problems, according to climate change scenarios

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. This metric depends on the metric FSwt38.

Development assessment rule	Development
No sensitive customers expected to be affected for “most severe” scenario	**3**
No sensitive customers expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% sensitive customers expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% sensitive customers expected to be affected for “most probable” scenario	**0**

FSwt16 - Expected stormwater flooding in other services according to climate change scenarios (% customers of other services)

Percentage of customers of other services expected to be affected by flooding due to stormwater drainage problems, according to climate change scenarios

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Specify the % for each service. Other city services: RESCCUE services. If other, explain in comments. This metric depends on the metric FSwt38.

Development assessment rule	Development
No customers of other services expected to be affected for “most severe” scenario	**3**
No customers of other services expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% customers of other services expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% customers of other services expected to be affected for “most probable” scenario	**0**

FSwt17 - Expected stormwater flooding in households according to climate change scenarios (% of households)

Percentage of households expected to be affected by flooding due to stormwater drainage problems, according to climate change scenarios

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments. This metric depends on the metric FSwt38.

Development assessment rule	Development
No households expected to be affected for “most severe” scenario	**3**
No households expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% households expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% households expected to be affected for “most probable” scenario	**0**

FSwt18 - Expected total duration of stormwater flooding period according to climate change scenarios (days)

Total duration of expected stormwater flooding due to stormwater drainage problems, according to climate change scenarios

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments. This metric depends on the metric FSwt38.

Development assessment rule	Development
Less or equal to 1 day for “most severe” scenario	**3**
Less or equal to 1 day for “most probable” scenario	**2**
Between 1 and 3 days for “most probable” scenario	**1.5**
More than 3 days for “most probable” scenario	**0**

FSwt19 - Stormwater flooding in the city area last year (% of the city area)

Percentage of the city area affected by flooding due to stormwater drainage problems, last year

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
No area affected	**3**
Less than or equal to 2.5% area affected	**2**
Between 2.5% and 10% area affected	**1.5**
More than or equal to 10% area affected	**0**

FSwt20 - Stormwater flooding in sensitive customers last year (% of sensitive customers)

Percentage of sensitive customers affected by flooding due to stormwater drainage problems, last year

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. Please list which sensitive customers were affected.

Development assessment rule	Development
No sensitive customers affected	**3**
Less or equal to 0.1% sensitive customers affected	**2**
Between 0.1% and 0.25% of sensitive customers affected	**1.5**
More than or equal to 0.25% area affected	**0**

FSwt21 - Stormwater flooding in other services last year (% customers of other services)

Percentage of customers of other services affected by flooding due to stormwater drainage problems, last year

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Other city services: RESCCUE services. If other, explain in comments. Please list which other services were affected. Please answer with an estimated figure [%] in comments. Refers to the % of the affected customers that provide other services and not the % of affected customers of such services.

Development assessment rule	Development
Less or equal to 0.1% customers affected	**3**
More than 0.1% and less than 0.25% of customers affected	**2**
More or equal to 0.25% and less than 0.5% of customers affected	**1**
More than or equal to 0.5% of customers affected	**0**

FSwt22 - Stormwater flooding in households last year (% of households)

Percentage of households affected by flooding due to stormwater drainage problems, last year

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less or equal to 0.1% of households affected	**3**
More than 0.1% and less than 0.25% of households affected	**2**
More or equal to 0.25% and less than 0.5% of households affected	**1**
More than or equal to 0.5% of households affected	**0**

FSwt23 - Total duration of stormwater flooding period last year (days)

Total duration of stormwater flooding, due to stormwater drainage problems, last year

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
Less or equal to 1 day of stormwater flooding	**3**
More than 1 and less than 3 days of stormwater flooding	**2**
More or equal to 3 and less than 6 days of stormwater flooding	**1**
More than or equal to 6 days of stormwater flooding	**0**

FSwt24 - Estimated undue inflows into stormwater system last year (m^3/(km.day))

Undue inflows (e.g. wastewater, industrial, saline, water supply inflows) into the system last year (undue wastewater inflow volume in the collection system / (total pipe length.365))

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Reliable service
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [m^3/(km.day)] in comments.

Development assessment rule	Development
Less or equal to 0.5 m^3 of undue inflows	**3**
More than 0.5 and less than 5 m^3 of undue inflows	**2**
More or equal to 5 and less than 10 m^3 of undue inflows	**1**
More than or equal to 10 m^3 of undue inflows	**0**

FSwt25 - Treated stormwater uses (% of treated stormwater)

Percentage of collected stormwater being recycled or reused (for e.g. irrigation, urban cleaning, firefighting)

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Flexible servie
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More than or equal to 50%	**3**
More than 25% and less than 50%	**2**
More than 10% and less than or equal to 25%	**1**
Less than or equal to 10%	**0**

FSwt26 - Stormwater disposal (-)

Which solutions for stormwater disposal are used in the city?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Flexible service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 = 0).

Development assessment rule	Development
a) Superficial streams	**1**
b) Culverted streams	**1**
c) Tidal coast	**1**
d) Bathing waters	**1**
e) Other (explain in Comments)	**1**
f) None	**0**

FSwt27 - Stormwater disposal location (-)

Where are the city's stormwater disposal points located?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Flexible service
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1.5; Sum<1 = 0).

Development assessment rule	Development
a) Within the urban area	**1**
b) Outside city boundaries but within the metropolitan area	**1**
c) Far from the outskirsts of the metropolitan area	**1**
d) None	**0**

FSwt28 - Service management (-)

Services are appropriately managed, i.e. technological tools are used, existing competences are adequate and a command chain is in place?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service planning and risk management
Criteria	Flexible service
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
No significant technological tools exist but competences are adequate and a command chain is in place	**2**
Only a command chain is in place	**1**
No	**0**

FSwt29 - Stakeholders perception (-)

Is there a mechanism to provide service score, based on stakeholders' perception and is it applied? If yes quantify the service score from stakehoder perception

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Autonomous stormwater service
Criteria	Service importance to the city
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
More than or equal to 3	**3**
More than or equal to 2 and less than 3	**2**
More than 1 and less than 2	**1**
Less than or equal to 1 or there is no mechanism in place	**0**

FSwt30 - Cascading impacts (-)

Is there an understanding of potentially cascading failures between different services, under different scenarios?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Autonomous stormwater service
Criteria	Service importance to the city
Source	UNISDR Scorecard P2.4 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Cascading effects have been studied, but CC scenarios were not considered	**2**
Cascading effects have been studied, but only for some services and CC scenarios were not considered	**1.5**
No	**0**

FSwt31 - Critical services dependence on stormwater service according to climate change scenarios (-)

To what extent are critical services (CS -RESCCUE services) dependent on the stormwater service, based on climate change scenarios?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Autonomous stormwater service
Criteria	Service inter-dependency with other services considering climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Refer in Comments which services have high dependence of this service. This metric depends on the metric FSwt38.

Development assessment rule	Development
No dependence (CS are not affected or failure is not likely to occur due to problems in water service)	**3**
Minor dependence (CS are affected and failure is likely to occur in one of the CS)	**2**
Major dependence (CS are affected and failure is likely to occur in more than one CS)	**1**
Total dependence (failure is likely to occur in all CS)	**0**

FSwt32 - Stormwater services autonomy from other services according to climate change scenarios (-)

To what extent is the stormwater service dependent on other critical services (CS -RESCCUE services), based on climate change scenarios?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Autonomous stormwater service
Criteria	Service inter-dependency with other services considering climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Refer in Comments which services does this service have low autonomy from. This metric depends on the metric FSwt38.

Development assessment rule	Development
Total autonomy (does not depend on CS services continuity - e.g. energy, fuel)	**3**
Major autonomy (are affected but do not fail in case of CS continuity loss)	**2**
Minor autonomy (failure is likely to occur in at least one infrastructure in case of CS continuity loss)	**1**
No autonomy (failure is likely to occur in the majority of infrastructures in case of CS continuity loss)	**0**

FSwt33 - Stormwater service event management plans (-)

Is there a disaster management / preparedness / emergency response plan outlining service mitigation, preparedness and response to local emergencies?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for disaster response
Source	UNISDR Scorecard P9.2 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
No, but the service is included in the city-wide disaster management plan	**2**
The plan only addresses some of the indicated requirements	**1**
No	**0**

FSwt34 - Stormwater services interdepartmental collaboration for emergency (-)

Is there an emergency operations centre, automating standard operating procedures specifically designed to deal with “most probable” and “most severe” scenarios?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for disaster response
Source	UNISDR Scorecard P9.6 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially, there is an emergency operations centre, automating standard operating procedures but not specifically designed to deal with “most probable” and “most severe” scenarios	**1.5**
No	**0**

FSwt35 - Stormwater services early warning (-)

Does the service have a plan or standard operating procedure to act on early warnings and forecasts? Is the city warned by this system?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for disaster response
Source	UNISDR Scorecard P9.1 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Yes, a plan or a SOP exists, but the city is not informed.	**1.5**
No	**0**

FSwt36 - Stormwater service drills (-)

Are practices and drills carried out internally and periodically?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for disaster response
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes, every year	**3**
Yes, occasionally	**1.5**
No	**0**

FSwt37 - Service commitment with mitigation of climate change effects (% reduction of GHG)

Is the service commited with an established mitigation target regarding reduction of GHG within its strategic planning?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes, a 50% reduction or higher is the target	**3**
Yes, a 20% - 49% reduction is the target	**2**
Yes, but the target is lower than 20% or there is no target defined	**1**
No compromise	**0**

FSwt38 - Existence of agreed climate change scenarios and alignment with the city climate change scenarios (-)

Are there agreed climate change scenarios, setting out service exposure and vulnerability, from each hazard level? Are they aligned with the city-wide climate change scenarios?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metrics FSwt14, FSwt15, FSwt16, FSwt17, FSwt18, FSwt31, FSwt32, FSwt39, FSwt48, FSwt49, FSwt50, FSwt51, FSwt52, PSwt20, PSwt35, PSwt36, PSwt37, PSwt40, PSwt41, PSwt42, PSwt43, PSwt44, PSwt45, PSwt46, PSwt47 and PSwt48.

Development assessment rule	Development
Comprehensive scenarios exist (at least “most probable” and “most severe”) updated in last 5 years and are aligned with the city	**3**
Partial scenarios exist but are not comprehensive or complete and/or are more than 5 years old and only partially aligned with the city	**2**
Only a generalized notion of exposure and vulnerability, with no attempt systematically to identify impacts	**1**
No	**0**

FSwt39 - Knowledge of exposure and service vulnerability for climate change scenarios (-)

The analysis of exposure and service vulnerability for climate change scenarios addresses:

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and a scale to 3 is made. This metric depends on the metric FSwt38.

Development assessment rule	Development
a) People	**2**
b) Housing	**2**
c) Service's infrastructures	**1**
d) Critical service's infrastructures	**2**
e) Other service's infrastructures	**1**
f) Protective infrastructures	**1**
g) Green / blue infrastructures	**1**
h) None of the above	**0**

FSwt40 - Service planning for adaptation to climate change (-)

Is adaptation to climate change being considered in the service plans and enforced in new projects?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Yes, but only for some climate change hazards	**1.5**
No	**0**

FSwt41 - Implemented measures to address climate change mitigation and adaptation (-)

What type of measures has the service implemented to to address climate change mitigation and adaptation?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥3 and f)=1 =3; Sum>0 and <3 or Sum≥3 and f)=0 =2; Sum=0 =0).

Development assessment rule	Development
a) Drills and training	**1**
b) Stakeholder or public engagement and awareness	**1**
c) Improvement of information collection and analysis	**1**
d) Improvement of the administrative buildings' and processes' environmental efficiency	**1**
e) Reduction of GHG in the fleet	**1**
f) Development of emergency or contigency plans	**1**
g) Use of social media for warnings and information	**1**
h) Other (explain in the Comments column)	**1**
i) None of the above	**0**

FSwt42 - Planned measures to address climate change mitigation and adaptation (-)

What type of measures is the service planning to implement to address climate change mitigation and adaptation?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and Sum<2 =2; Sum=0 =0).

Development assessment rule	Development
a) Drills and training	**1**
b) Stakeholder or public engagement and awareness	**1**
c) Improvement of information collection and analysis	**1**
d) Improvement of the administrative buildings' and processes' environmental efficiency	**1**
e) Reduction of GHG in the fleet	**1**
f) Development of emergency or contigency plans	**1**
g) Use of social media for warnings and information	**1**
h) Other (explain in the Comments column)	**1**
i) None of the above	**0**

FSwt43 - Equipment capacity of the service (-)

Has the service adequate equipment capacity, in normal and emergency circumstances?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary

Level	Strategic
Metric type	Single choice

Insert some examples in Comments.

Development assessment rule	**Development**
Yes	**3**
Partially	**1.5**
No	**0**

FSwt44 - Staffing capacity of the service (-)

Has the service adequate staffing capacity, in normal and emergency circumstances?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

Insert some examples in Comments.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FSwt45 - Stormwater service climate change recovery planning (-)

Is there a strategy or process in place for post-event service recovery and reconstruction?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for recovery and build back
Source	UNISDR Scorecard P10.1
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
There is a strategy/process in place. It is robust and well-understood by relevant stakeholders	**3**
There is a strategy/process in place. It is well- understood by relevant stakeholders but has known weaknesses	**2**
Some plans/strategies exist but they are not comprehensive or joined up or understood by relevant stakeholders	**1**
No known plans	**0**

FSwt46 - Stormwater service damage and loss post-event assessment (-)

Does the service has a system in place to provide Post-Disaster Needs Assessment?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metric FSwt47.

Development assessment rule	Development
Yes	**3**
No	**0**

FSwt47 - Current post-event assessment system (-)

If yes, has such system been defined, implemented, tested and historic data is registered?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FSwt46.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FSwt48 - Stormwater flooding in the city area in the last relevant climate-related event (% of the city area)

Percentage of the city area affected by flooding due to stormwater drainage problems in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSwt38.

Development assessment rule	Development
No area affected	**3**
Less than or equal to 2.5% area affected	**2**
Between 2.5% and 10% area affected	**1**
More than or equal to 10% area affected	**0**

FSwt49 - Stormwater flooding in sensitive customers in the last relevant climate-related event (% of sensitive customers)

Percentage of sensitive customers affected by flooding due to stormwater drainage problems in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments. Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. This metric depends on the metric FSwt38.

Development assessment rule	Development
No sensitive customers affected	**3**
Less than or equal to 2.5% sensitive customers affected	**2**
More than 2.5% and less than 5% sensitive customers affected	**1.5**
More than or equal to 5% and less than 100% sensitive customers affected	**0**

FSwt50 - Stormwater flooding in other services in the last relevant climate-related event (% customers of other services)

Percentage of customers of other services affected by flooding due to stormwater drainage problems in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Other city services: RESCCUE services. If other, explain in comments. Please list which other services were affected. Please answer with an estimated figure [%] in comments. This metric depends on the metric FSwt38.

Development assessment rule	Development
No customers of other services affected	**3**
Less than or equal to 2.5% customers of other services affected	**2**
More than 2.5% and less than 5% customers of other services affected	**1.5**
More than or equal to 5% and less than 100% customers of other services affected	**0**

FSwt51 - Stormwater flooding in households in the last relevant climate-related event (% of households)

Percentage of households affected by flooding due to stormwater drainage problems in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments. This metric depends on the metric FSwt38.

Development assessment rule	Development
No households affected	**3**
Less than or equal to 2.5% households affected	**2**
More than 2.5% and less than 5% households affected	**1.5**
More than or equal to 5% and less than 100% households affected	**0**

FSwt52 - Total duration of stormwater flooding in the last relevant climate-related event (days)

Days of stormwater flooding due to stormwater drainage problems in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments. This metric depends on the metric FSwt38.

Development assessment rule	Development
≤ 0.5 day	**3**
> 0.5 and ≤ 1 days	**2**
> 1 and ≤ 2 days	**1.5**
> 2 days	**0**

FSwt53 - Stormwater service lessons learnt and learning loops (-)

Are service-specific processes in place for lessons learnt, including failure analysis? If yes, are service-specific plans informed by them?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Processes in place but plans are not informed by them	**2**
Partially	**1**
No	**0**

FSwt54 - Insurance (-)

What level of insurance cover exists in the service?

Dimension	Functional
Subdimension	Stormwater
Resilience objective	Stormwater service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Sectors within the service: e.g. infrastructure, equipment, fleet, human resources, administrative buildings.

Development assessment rule	Development
The uptake for insurance products across all sectors within the service is high	**3**
The level of insurance varies significantly by sector or by area	**2**
Little insurance cover	**1**
No insurance cover	**0**

FUNCTIONAL

WASTE

PI code	PI name	Unit

FSlw01 - Solid waste service strategic plan making and implementation (-)

Does the service have a strategic plan and is it implemented

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Strategic planning
Source	UNISDR Scorecard P1.1 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metric FSlw02 and FSlw03.

Development assessment rule	Development
Yes	**3**
Partially. The plan exists, but it is still not implemented OR Not all the responsible utilities have an implemented plan	**1.5**
No	**0**

FSlw02 - Plan alignment with the City Master Plan (-)

If yes, is the plan aligned with the city main planning document?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSlw01.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FSlw03 - Service plan monitoring and review (-)

If existing, is the plan periodically monitored and reviewed, ensuring it remains relevant and operational?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSlw01.

Development assessment rule	Development
Yes, at least once every 5 years	**3**
Yes, at least once every 10 years	**2**
The frequency exceeds once every 10 years, or the plan is not considered relevant or operational	**1**
No periodical monitoring and review	**0**

* (-) without unit or dimensionless

FSlw04 - Exchange of information to the city (-)

Is there regular exchange of data and information between service and the city concerning the review of planning documents?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please indicate the last review's date.

Development assessment rule	Development
Yes, at least once every 5 years	**3**
Yes, at least once every 10 years	**2**
The frequency exceeds once every 10 years, or the plan is not considered relevant or operational or analysis of relevant data is not undertaken to inform city planning and strategies	**1**
No periodical exchange	**0**

FSlw05 - Land use zoning compliance (-)

Do the service-specific plans comply with up-to-date land use and zoning regulations?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FSlw06 - Resilience in solid waste service strategy and alignment with the City Master Plan (-)

Does the service have a resilience plan (either as an autonomous action plan or as a strategy included in the service's strategic plan) and what is its timeframe?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please specify the last update/review. This metric conditions the metric FSlw07.

Development assessment rule	Development
Yes approved. It considers short-, medium- and long-term	**3**
Yes approved. Its timeframe is not defined or considers only short-, medium- or long-term	**2**
It is under approval or under preparation. Timeframe is not yet finalised	**1**
No plan	**0**

FSlw07 - Service strategic plan for resilience and Climate Change (-)

Does the resilience plan consider climate change (projection, scenarios, impacts, etc.)?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSlw06.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FSlw08 - Service financial plan and budget for resilience (-)

Do the service financial plans have dedicated allocations for resilience-building actions (including disaster risk reduction (DRR))?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
The service financial plan is comprehensive in relation to resilience-building, budgets are ring fenced and necessary resources and arrangements for local DRR in place	**3**
The service financial plan allows for resilience-building, budgets are ring fenced	**2**
The service financial plan allows for some resilience-building activities not aligned, budgets are not ring fenced	**1.5**
No clear plan	**0**

FSlw09 - Solid waste service business continuity (-)

Do business continuity plans exist?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

A business continuity plan allows that appropriate management and delivery of services may be provided by e.g., technological tools, such as GPS or communication devices, to support daily management exist and intercommunicate, collecting circuits can be easily changed, type of vehicles adequate to the locations and circuits. Adequate competences may be competent human resources, who are dynamic and easily assume different functions. A command chain ensures responsibilities are clearly allocated and several decision levels are attributed.

Development assessment rule	Development
Yes	**3**
No	**0**

FSlw10 - Co-ordination with other solid waste services in the city (-)

Is there any coordination mechanism in place with other solid waste services/entities either at municipal or metropolitan level?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Formal mechanism: e.g., Office, Committee, MoU, Protocols, National/Regional Platform. If yes please specify.

Development assessment rule	Development
Yes	**3**
No	**0**

FSlw11 - Learning from other solid waste services (-)

Is there any knowledge exchange with other services?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

Services facing similar challenges: e.g other water services, other urban services. Please select all applicable answers. Sum of the selected options and a scale to 3 is made.

Development assessment rule	Development
a) International exchanges are in place	**1**
b) National exchanges are in place	**1**
c) With similar services	**1**
d) With different services	**1**
e) None of the above	**0**

FSlw12 - Risk information related to the solid waste service (-)

Do specific service plans include risk information (such as exposure and vulnerability, damage and loss quantification, etc.) related to the service and are regurlarly updated?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please indicate the last review's date.

Development assessment rule	Development
Yes	**3**
Partially, not covering the all the hazards or all the city or not regurlarly updated	**1.5**
No	**0**

FSlw13 - Damage and loss estimation (-)

Does risk assessment include estimations of damage and loss for agreed climate change scenarios, based on current development and future urban and population growth?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Risk management
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Risk assessments focus mostly on spatial, physical assets at risk. Data is limited	**2**
There are plans to develop risk assessments	**1**
Risk assessments do not identify all risk areas or there are no plans to update them	**0**

FSlw14 - Expected solid waste collection interruption in the city area according to climate change scenarios (% of the city area)

Percentage of the city area expected to be affected by solid waste collection interruptions exceeding 4 days, according to climate change scenarios

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Risk management
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSlw43.

Development assessment rule	Development
No area at risk for “most severe” scenario	**3**
No area at risk for “most probable” scenario	**2**
Less than or equal to 2.5% area at risk for “most probable” scenario	**1.5**
Between 2.5% and 100% area at risk for “most probable” scenario	**0**

FSlw15 - Expected solid waste treatment failure in the city area according to climate change scenarios (% of the city area)

Percentage of the city area expected to be affected by solid waste treatment problems exceeding 4 days, according to climate change scenarios

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Risk management
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSlw43.

Development assessment rule	Development
No area at risk for “most severe” scenario	**3**
No area at risk for “most probable” scenario	**2**
Less than or equal to 2.5% area at risk for “most probable” scenario	**1.5**
Between 2.5% and 100% area at risk for “most probable” scenario	**0**

FSlw16 - Expected solid waste collection interruption for sensitive customers according to climate change scenarios (% of sensitive customers)

Percentage of sensitive customers expected to be affected by solid waste collection interruption exceeding 4 days, according to climate change scenarios

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. This metric depends on the metric FSlw43.

Development assessment rule	Development
No sensitive customers expected to be affected for “most severe” scenario	**3**
No sensitive customers expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% sensitive customers expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% sensitive customers expected to be affected for “most probable” scenario	**0**

FSlw17 - Expected solid waste collection interruption for other services according to climate change scenarios (% customers of other services)

Percentage of customers of other services expected to be affected by solid waste collection interruption exceeding 4 days, according to climate change scenarios

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Risk management
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Specify the % for each service. Other city services: RESCCUE services. If other, explain in comments. This metric depends on the metric FSlw43.

Development assessment rule	Development
No customers of other services expected to be affected for “most severe” scenario	**3**
No customers of other services expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% customers of other services expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% customers of other services expected to be affected for “most probable” scenario	**0**

FSlw18 - Expected solid waste collection interruption in households according to climate change scenarios (% of households)

Percentage of households expected to be affected by solid waste collection interruption exceeding 4 days, according to climate change scenarios

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments. This metric depends on the metric FSlw43.

Development assessment rule	Development
No households expected to be affected for “most severe” scenario	**3**
No households expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% households expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% households expected to be affected for “most probable” scenario	**0**

FSlw19 - Expected total duration of solid waste collection interruption period according to climate change scenarios (days)

Total duration of expected solid waste collection interruption, according to climate change scenario

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments. This metric depends on the metric FSlw43.

Development assessment rule	Development
Less or equal to 4 days for “most severe” scenario	**3**
Less or equal to 4 days for “most probable” scenario	**2**
Between 4 and 7 days for “most probable” scenario	**1.5**
More than 7 days for “most probable” scenario	**0**

FSlw20 - Expected total duration of solid waste treatment failure period according to climate change scenarios (days)

Total duration of expected solid waste treatment failure, according to climate change scenarios

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments. This metric depends on the metric FSlw43.

Development assessment rule	Development
Less or equal to 4 days for “most severe” scenario	**3**
Less or equal to 4 days for “most probable” scenario	**2**
Between 4 and 7 days for “most probable” scenario	**1.5**
More than 7 days for “most probable” scenario	**0**

FSlw21 - Solid waste collection interruption in the city area last year (% of the city area)

Percentage of the city area affected by solid waste collection interruptions exceeding 4 days, last year

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Reliable service
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
No area affected	**3**
Less than or equal to 2.5% area affected	**2**
Between 2.5% and 10% area affected	**1.5**
More than or equal to 10% area affected	**0**

FSlw22 - Solid waste effective treatment failure in the city area last year (% of the city area)

Percentage of the city area affected by solid waste treatment problems exceeding 4 days, last year

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Reliable service
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
No area affected	**3**
Less than or equal to 2.5% area affected	**2**
Between 2.5% and 10% area affected	**1.5**
More than or equal to 10% area affected	**0**

FSlw23 - Solid waste collection interruption for sensitive customers last year (% of sensitive customers)

Percentage of sensitive customers affected by solid waste collection interruption exceeding 4 days, last year

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. Please list which sensitive customers were affected.

Development assessment rule	Development
No sensitive customers affected	**3**
Less or equal to 0.1% sensitive customers affected	**2**
Between 0.1% and 0.25% of sensitive customers affected	**1.5**
More than or equal to 0.25% of sensitive customers affected	**0**

FSlw24 - Solid waste collection interruption for other services, last year (% customers of other services)

Percentage of customers of other services affected by solid waste collection interruption exceeding 4 days, last year

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Reliable service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Other city services: RESCCUE services. If other, explain in comments. Please list which other services were affected. Please answer with an estimated figure for each service [%]. Refers to the % of the affected customers that provide other services and not the % of affected customers of such services.

Development assessment rule	Development
Less or equal to 0.1% customers affected	**3**
More than 0.1% and less than 0.25% of customers affected	**2**
More or equal to 0.25% and less than 0.5% of customers affected	**1**
More than or equal to 0.5% of customers affected	**0**

FSlw25 - Solid waste effective treatment in the city area last year (% safely treated solid waste)

Percentage of solid waste that was collected and safely treated, last year

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Reliable service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
100% of solid waste collected and safely treated	**3**
More than or equal to 95% and less than 100% of solid waster collected and safely treated	**2**
More than 85% and less than 95% of solid waste collected and safely treated	**1.5**
Less than or equal to 85% of solid waste collected and safely treated	**0**

FSlw26 - Solid waste collection interruption in households, last year (% of households)

Percentage of households affected by solid waste collection interruption exceeding 4 day, last year

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Reliable service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less or equal to 0.1% of households affected	**3**
More than 0.1% and less than 0.25% of households affected	**2**
More or equal to 0.25% and less than 0.5% of households affected	**1**
More than or equal to 0.5% of households affected	**0**

FSlw27 - Total duration of solid waste collection interruption period last year (days)

Total duration of solid waste collection interruption, last year

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
Less or equal to 4 days of solid waste collection interruption	**3**
More than 4 and less than 7 days of solid waste collection interruption	**2**
More than or equal to 7 and less than 14 days of solid waste collection interruption	**1**
More than 14 days of solid waste collection interruption	**0**

FSlw28 - Total duration of solid waste treatment failure period last year (days)

Total duration of solid waste treatment failure, last year

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Reliable service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
Less or equal to 4 days of solid waste treatment failure	**3**
Between 4 and 7 days of solid waste treatment failure	**2**
Between 7 and 14 days of of solid waste treatment failure	**1**
More than or equal to 14 days of solid waste treatment failure	**0**

FSlw29 - Estimated undue wastes into solid waste system last year (-)

Types of undue wastes into the solid waste system

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Reliable service
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum=0 =3; Sum=1 =1; Sum>1 =0).

Development assessment rule	Development
a) Industrial	**1**
b) Dangerous/Toxic	**1**
c) Medical	**1**
d) Other, specify	**1**
e) None	**0**

FSlw30 -Treated solid waste recovered (% treated solid waste being recovered)

Percentage of treated solid waste being recovered (from recycling and reuse, energy recovery, composting…)

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Flexible service
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Multiple choice

If the values are disaggregated please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More than or equal to 95% and less or equal to 100%	**3**
More than or equal to 80% and less than 95%	**2**
More than or equal to 50% and less than 80%	**1**
Less than 50%	**0**

FSlw31 - Solid waste disposal (-)

Which solutions for solid waste disposal are used in the city?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Flexible service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 = 0).

Development assessment rule	Development
a) Landfill	**1**
b) Incineration	**1**
c) Composting	**1**
d) Recycling	**1**
e) Other, specify in comments	**1**
f) None	**0**

FSlw32 - Solid waste disposal location (-)

Where are the city's solid waste disposal points located?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Flexible service
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1.5; Sum<1 = 0).

Development assessment rule	Development
a) Within the urban area	**1**
b) Outside city boundaries but within the metropolitan area	**1**
c) Far from the outskirsts of the metropolitan area	**1**
d) None	**0**

FSlw33 - Service management (-)

Services are appropriately managed, i.e. technological tools are used, existing competences are adequate and a command chain is in place?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service planning and risk management
Criteria	Flexible service
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
No significant technological tools exist but competences are adequate and a command chain is in place	**2**
Only a command chain is in place	**1**
No	**0**

FSlw34 - Stakeholders perception (-)

Is there a mechanism to provide service score, based on stakeholders' perception and is it applied? If yes quantify the service score from stakeholder perception

Dimension	Functional
Subdimension	Waste
Resilience objective	Autonomous waste service
Criteria	Service importance to the city
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
More than or equal to 3	**3**
More than or equal to 2 and less than 3	**2**
More than 1 and less than 2	**1**
Less than or equal to 1 or there is no mechanism in place	**0**

FSlw35 - Cascading impacts (-)

Is there an understanding of potentially cascading failures between different services, under different scenarios?

Dimension	Functional
Subdimension	Waste
Resilience objective	Autonomous waste service
Criteria	Service importance to the city
Source	UNISDR Scorecard P2.4 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Cascading effects have been studied, but CC scenarios were not considered	**2**
Cascading effects have been studied, but only for some services and CC scenarios were not considered	**1.5**
No	**0**

FSlw36 - Critical services dependence on solid waste service according to climate change scenarios (-)

To what extent are critical services (CS -RESCCUE services) dependent on the waste service, based on climate change scenarios?

Dimension	Functional
Subdimension	Waste
Resilience objective	Autonomous waste service
Criteria	Service inter-dependency with other services considering climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Refer in Comments which services have high dependence of this service. This metric depends on the metric FSlw43.

Development assessment rule	Development
No dependence (CS are not affected or failure is not likely to occur due to problems in water service)	**3**
Minor dependence (CS are affected and failure is likely to occur in one of the CS)	**2**
Major dependence (CS are affected and failure is likely to occur in more than one CS)	**1**
Total dependence (failure is likely to occur in all CS)	**0**

FSlw37 - Solid waste services autonomy from other services according to climate change scenarios (-)

To what extent is the waste service dependent on other critical services (CS -RESCCUE services), based on climate change scenarios?

Dimension	Functional
Subdimension	Waste
Resilience objective	Autonomous waste service
Criteria	Service inter-dependency with other services considering climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Refer in Comments which services does this service have low autonomy from. This metric depends on the metric FSlw43.

Development assessment rule	Development
Total autonomy (does not depend on CS services continuity - e.g. water, energy, fuel)	**3**
Major autonomy (are affected but do not fail in case of CS continuity loss)	**2**
Minor autonomy (failure is likely to occur in at least one infrastructure in case of CS continuity loss)	**1**
No autonomy (failure is likely to occur in the majority of infrastructures in case of CS continuity loss)	**0**

FSlw38 - Solid waste service event management plans (-)

Is there a disaster management / preparedness / emergency response plan outlining service mitigation, preparedness and response to local emergencies?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for disaster response
Source	UNISDR Scorecard 9.2 (adapted)
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
No, but the service is included in the city-wide disaster management plan	**2**
The plan only addresses some of the indicated requirements	**1**
No	**0**

FSlw39 - Solid waste services interdepartmental collaboration for emergency (-)

Is there an emergency operations centre, automating standard operating procedures specifically designed to deal with “most probable” and “most severe” scenarios?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for disaster response
Source	UNISDR Scorecard P9.6 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially, there is an emergency operations centre, automating standard operating procedures but not specifically designed to deal with “most probable” and “most severe” scenarios	**1.5**
No	**0**

FSlw40 - Solid waste services early warning (-)

Does the service have a plan or standard operating procedure to act on early warnings and forecasts? Is the city warned by this system?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for disaster response
Source	UNISDR Scorecard P9.1 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Yes, a plan or a SOP exists, but the city is not informed	**1.5**
No	**0**

FSlw41 - Solid waste service drills (-)

Are practices and drills carried out internally and periodically?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for disaster response
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes, every year	**3**
Yes, occasionally	**1.5**
No	**0**

FSlw42 - Service commitment with mitigation of climate change effects (% reduction of GHG)

Is the service commited with an established mitigation target regarding reduction of GHG within its strategic planning?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes, a 50% reduction or higher is the target	**3**
Yes, a 20% - 49% reduction is the target	**2**
Yes, but the target is lower than 20% or there is no target defined	**1**
No compromise	**0**

FSlw43 - Existence of agreed climate change scenarios and alignment with the city climate change scenarios (-)

Are there agreed climate change scenarios, setting out service exposure and vulnerability, from each hazard level? Are they aligned with the city-wide climate change scenarios?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metrics FSlw14, FSlw15, FSlw16, FSlw17, FSlw18, FSlw19, FSlw20, FSlw36, FSlw37, FSlw44, FSlw53, FSlw54, FSlw55, FSlw56, FSlw57, FSlw58, FSlw59, FSlw60, PSlw18, PSlw35, PSlw36, PSlw37, PSlw40, PSlw41, PSlw42, PSlw43, PSlw44, PSlw45, PSlw46, PSlw47 and PSlw48.

Development assessment rule	Development
Comprehensive scenarios exist (at least “most probable” and “most severe”) updated in last 5 years and are aligned with the city	**3**
Partial scenarios exist but are not comprehensive or complete and/or are more than 5 years old and only partially aligned with the city	**2**
Only a generalized notion of exposure and vulnerability, with no attempt systematically to identify impacts	**1**
No	**0**

FSlw44 - Knowledge of exposure and service vulnerability for climate change scenarios (-)

The analysis of exposure and service vulnerability for climate change scenarios addresses:

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and a scale to 3 is made. This metric depends on the metric FSlw43.

Development assessment rule	Development
a) People	**2**
b) Housing	**2**
c) Service's infrastructures	**1**
d) Critical service's infrastructures	**2**
e) Other service's infrastructures	**1**
f) Protective infrastructures	**1**
g) Green / blue infrastructures	**1**
h) None of the above	**0**

FSlw45 - Service planning for adaptation to climate change (-)

Is adaptation to climate change being considered in the service plans and enforced in new projects?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Yes, but only for some climate change hazards	**1.5**
No	**0**

FSlw46 - Implemented measures to address climate change mitigation and adaptation (-)

What type of measures has the service implemented to to address climate change mitigation and adaptation?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥3 and f)=1 =3; Sum>0 and <3 or Sum≥3 and f)=0 =2; Sum=0 =0).

Development assessment rule	Development
a) Drills and training	**1**
b) Stakeholder or public engagement and awareness	**1**
c) Improvement of information collection and analysis	**1**
d) Improvement of the administrative buildings' and processes' environmental efficiency	**1**
e) Reduction of GHG in the fleet	**1**
f) Development of emergency or contigency plans	**1**
g) Use of social media for warnings and information	**1**
h) Other (explain in the Comments column)	**1**
i) None of the above	**0**

FSlw47 - Planned measures to address climate change mitigation and adaptation (-)

What type of measures is the service planning to implement to address climate change mitigation and adaptation?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and Sum<2 =2; Sum=0 =0).

Development assessment rule	Development
a) Drills and training	**1**
b) Stakeholder or public engagement and awareness	**1**
c) Improvement of information collection and analysis	**1**
d) Improvement of the administrative buildings' and processes' environmental efficiency	**1**
e) Reduction of GHG in the fleet	**1**
f) Development of emergency or contigency plans	**1**
g) Use of social media for warnings and information	**1**
h) Other (explain in the Comments column)	**1**
i) None of the above	**0**

FSlw48 - Equipment capacity of the service (-)

Has the service adequate equipment capacity, in normal and emergency circumstances?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

Insert some examples in Comments.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FSlw49 - Staffing capacity of the service (-)

Has the service adequate staffing capacity, in normal and emergency circumstances?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

Insert some examples in Comments.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FSlw50 - Solid waste service climate change recovery planning (-)

Is there a strategy or process in place for post-event service recovery and reconstruction?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for recovery and build back
Source	UNISDR Scorecard 10.1
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
There is a strategy/process in place. It is robust and well-understood by relevant stakeholders	**3**
There is a strategy/process in place. It is well- understood by relevant stakeholders but has known weaknesses	**2**
Some plans/strategies exist but they are not comprehensive or joined up or understood by relevant stakeholders	**1**
No known plans	**0**

FSlw51 - Solid waste service damage and loss post-event assessment (-)

Does the service has a system in place to provide Post-Disaster Needs Assessment?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metric FSlw52.

Development assessment rule	Development
Yes	**3**
No	**0**

FSlw52 - Current post-event assessment system (-)

If yes, has such system been defined, implemented, tested and historic data is registered?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FSlw51.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FSlw53 - Solid waste collection interruption in the city area in the last relevant climate-related event (% of the city area)

Percentage of the city area with solid waste collection interruption in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSlw43.

Development assessment rule	Development
No area affected	**3**
Less than or equal to 2.5% area affected	**2**
Between 2.5% and 10% area affected	**1**
More than or equal to 10% area affected	**0**

FSlw54 - Solid waste effective treatment failure in the city area in the last relevant climate-related event (% of the city area)

Percentage of the city area affected by solid waste treatment problems, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSlw43.

Development assessment rule	Development
No area affected	**3**
Less than or equal to 2.5% area affected	**2**
Between 2.5% and 10% area affected	**1**
More than or equal to 10% area affected	**0**

FSlw55 - Solid waste collection interruption for sensitive customers in the last relevant climate-related event (% of sensitive customers)

Percentage of sensitive customers affected by solid waste collection interruption, in the last climate-related event, with similar or harsher climate variables than the most probable scenario.

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments. Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. Please list which sensitive customers were affected. This metric depends on the metric FSlw43.

Development assessment rule	Development
No sensitive customers affected	**3**
Less than or equal to 2.5% sensitive customers affected	**2**
More than 2.5% and less than 5% sensitive customers affected	**1.5**
More than or equal to 5% and less than 100% sensitive customers affected	**0**

FSlw56 - Solid waste collection interruption for other services in the last relevant climate-related event (% customers of other services)

Percentage of customers of other services affected by solid waste collection interruption in the last climate-related event, with similar or harsher climate variables than the most probable scenario. Please list which other services were affected

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments. Please list which other services were affected. Other city services: RESCCUE services. If other, explain in comments. This metric depends on the metric FSlw43.

Development assessment rule	Development
No customers of other services affected	**3**
Less than or equal to 2.5% customers of other services affected	**2**
More than 2.5% and less than 5% customers of other services affected	**1.5**
More than or equal to 5% and less than 100% customers of other services affected	**0**

FSlw57 - Solid waste effective treatment in the city area in the last relevant climate-related event (% solid waste safely treated)

Percentage of solid waste that was collected and safely treated in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments. This metric depends on the metric FSlw43.

Development assessment rule	Development
100%	**3**
More than or equal to 95% and less than 100% of waste collected and safely treated	**2**
More than 85% and less than 95% of waste collected and safely treated	**1.5**
Less than or equal to 85% of waste collected and safely treated	**0**

FSlw58 - Solid waste collection interruption in households in the last relevant climate-related event (% of households)

Percentage of households affected by solid waste collection interruption in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments. This metric depends on the metric FSlw43.

Development assessment rule	Development
No households affected	**3**
Less than or equal to 2.5% households affected	**2**
More than 2.5% and less than 5% households affected	**1.5**
More than or equal to 5% and less than 100% households affected	**0**

FSlw59 - Total duration of solid waste collection interruption in the last relevant climate-related event (days)

Days of solid waste collection interruption, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments. This metric depends on the metric FSlw43.

Development assessment rule	Development
≤ 4 days	**3**
> 4 and ≤ 7 days	**2**
> 7 and ≤ 14 days	**1.5**
> 14 days	**0**

FSlw60 - Total duration of solid waste treatment failure in the last relevant climate-related event (days)

Days of solid waste treatment failure, in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments. This metric depends on the metric FSlw43.

Development assessment rule	Development
≤ 4 days	**3**
> 4 and ≤ 7 days	**2**
> 7 and ≤ 14 days	**1.5**
> 14 days	**0**

FSlw61 - Solid waste service lessons learnt and learning loops (-)

Are service-specific processes in place for lessons learnt, including failure analysis? If yes, are service-specific plans informed by them?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Processes in place but plans are not informed by them	**2**
Partially	**1**
No	**0**

FSlw62 - Insurance (-)

What level of insurance cover exists in the service?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Sectors within the service: e.g. infrastructure, equipment, fleet, human resources, administrative buildings.

Development assessment rule	Development
The uptake for insurance products across all sectors within the service is high	**3**
The level of insurance varies significantly by sector or by area	**2**
Little insurance cover	**1**
No insurance cover	**0**

FUNCTIONAL

ENERGY

PI code	PI name	Unit

FEne01 - Energy service strategic plan making and implementation (-)

Does the service have a strategic plan and is it implemented

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Strategic planning
Source	UNISDR Scorecard P1.1 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metrics FEne02 and FEne03.

Development assessment rule	Development
Yes	**3**
Partially. The plan exists, but it is still not implemented OR Not all the responsible utilities have an implemented plan	**1.5**
No	**0**

FEne02 - Plan alignment with the City Master Plan (-)

If yes, is the plan aligned with the city main planning document?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FEne01.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FEne03 - Service plan monitoring and review (-)

If existing, is the plan periodically monitored and reviewed, ensuring it remains relevant and operational?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FEne01.

Development assessment rule	Development
Yes, at least once every 5 years	**3**
Yes, at least once every 10 years	**2**
The frequency exceeds once every 10 years, or the plan is not considered relevant or operational	**1**
No periodical monitoring and review	**0**

* (-) without unit or dimensionless

FEne04 - Exchange of information to the city (-)

Is there regular exchange of data and information between service and the city concerning the review of planning documents?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please indicate the last review's date.

Development assessment rule	Development
Yes, at least once every 5 years	**3**
Yes, at least once every 10 years	**2**
The frequency exceeds once every 10 years, or the plan is not considered relevant or operational or analysis of relevant data is not undertaken to inform city planning and strategies	**1**
No periodical exchange	**0**

FEne05 - Land use zoning compliance (-)

Do the service-specific plans comply with up-to-date land use and zoning regulations?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FEne06 - Resilience in energy service strategy and alignment with the City Master Plan (-)

Does the service have a resilience plan (either as an autonomous action plan or as a strategy included in the service's strategic plan) and what is its timeframe?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please specify the last update/review. This metric conditions the metric FEne07.

Development assessment rule	Development
Yes approved. It considers short-, medium- and long-term	**3**
Yes approved. Its timeframe is not defined or considers only short-, medium- or long-term	**2**
It is under approval or under preparation. Timeframe is not yet finalised	**1**
No plan	**0**

FEne07 - Service strategic plan for resilience and Climate Change (-)

Does the resilience plan consider climate change (projection, scenarios, impacts, etc.)?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FEne06.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FEne08 - Service financial plan and budget for resilience (-)

Do the service financial plans have dedicated allocations for resilience-building actions (including disaster risk reduction (DRR))?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
The service financial plan is comprehensive in relation to resilience-building, budgets are ring fenced and necessary resources and arrangements for local DRR in place	**3**
The service financial plan allows for resilience-building, budgets are ring fenced	**2**
The service financial plan allows for some resilience-building activities not aligned, budgets are not ring fenced	**1.5**
No clear plan	**0**

FEne09 - Energy service business continuity (-)

Do business continuity plans exist?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

A business continuity plan allows that appropriate management and delivery of services may be provided by e.g., technological tools, such as GPS or communication devices, to support daily management exist and intercommunicate, collecting circuits can be easily changed, type of vehicles adequate to the locations and circuits. Adequate competences may be competent human resources, who are dynamic and easily assume different functions. A command chain ensures responsibilities are clearly allocated and several decision levels are attributed.

Development assessment rule	Development
Yes	**3**
No	**0**

FEne10 - Co-ordination with other energy services in the city (-)

Is there any coordination mechanism in place with other energy services/entities either at municipal or metropolitan level?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Formal mechanism: e.g., Office, Committee, MoU, Protocols, National/Regional Platform. If yes please specify.

Development assessment rule	Development
Yes	**3**
No	**0**

FEne11 - Learning from other energy services (-)

Is there any knowledge exchange with other services?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Resilience engaged service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

Services facing similar challenges: e.g other water services, other urban services. Please select all applicable answers. Sum of the selected options and a scale to 3 is made.

Development assessment rule	Development
a) International exchanges are in place	**1**
b) National exchanges are in place	**1**
c) With similar services	**1**
d) With different services	**1**
e) None of the above	**0**

FEne12 - Risk information related to the energy service (-)

Do specific service plans include risk information (such as exposure and vulnerability, damage and loss quantification, etc.) related to the service and are regurlarly updated?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please indicate the last review's date.

Development assessment rule	Development
Yes	**3**
Partially, not covering the all the hazards or all the city or not regurlarly updated	**1.5**
No	**0**

FEne13 - Damage and loss estimation (-)

Does risk assessment include estimations of damage and loss for agreed climate change scenarios, based on current development and future urban and population growth?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Risk management
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Risk assessments focus mostly on spatial, physical assets at risk. Data is limited	**2**
There are plans to develop risk assessments	**1**
Risk assessments do not identify all risk areas or there are no plans to update them	**0**

FEne14 - Expected energy outage in the city area according to climate change scenarios (% of the city area)

Percentage of the city area expected to be affected by energy outage exceeding 6h, according to climate change scenarios

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FEne38.

Development assessment rule	Development
No area at risk for “most severe” scenario	**3**
No area at risk for “most probable” scenario	**2**
Less than or equal to 2.5% area at risk for “most probable” scenario	**1.5**
Between 2.5% and 100% area at risk for “most probable” scenario	**0**

FEne15 - Expected energy outage for sensitive customers according to climate change scenarios (% of sensitive customers)

Percentage of sensitive customers expected to be affected by energy outage exceeding 6h, according to climate change scenarios

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. This metric depends on the metric FEne38.

Development assessment rule	Development
No sensitive customers expected to be affected for “most severe” scenario	**3**
No sensitive customers expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% sensitive customers expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% sensitive customers expected to be affected for “most probable” scenario	**0**

FEne16- Expected energy outage for other services according to climate change scenarios (% customers of other services)

Percentage of customers of other services expected to be affected by energy outage exceeding 6h, according to climate change scenarios

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Specify the % for each service. Other city services: RESCCUE services. If other, explain in comments. This metric depends on the metric FEne38.

Development assessment rule	Development
No customers of other services expected to be affected for “most severe” scenario	**3**
No customers of other services expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% customers of other services expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% customers of other services expected to be affected for “most probable” scenario	**0**

FEne17 - Expected energy outage for households according to climate change scenarios (% of households)

Percentage of households expected to be affected by energy outage exceeding 6h, according to climate change scenarios

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments. This metric depends on the metric FEne38.

Development assessment rule	Development
No households expected to be affected for “most severe” scenario	**3**
No households expected to be affected for “most probable” scenario	**2**
Less than or equal to 2.5% households expected to be affected for “most probable” scenario	**1.5**
Between 2.5% and 100% households expected to be affected for “most probable” scenario	**0**

FEne18 - Expected total duration of energy outage period according to climate change scenarios (days)

Total duration of expected energy outage, according to climate change scenarios

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [days] in comments. This metric depends on the metric FEne38.

Development assessment rule	Development
Less or equal to 0.25 days for “most severe” scenario	**3**
Less or equal to 0.25 days for “most probable” scenario	**2**
Between 0.25 and 0.5 days for “most probable” scenario	**1.5**
More than 0.5 day for “most probable” scenario	**0**

FEne19 - Energy outage in the city area last year (% of the city area)

Percentage of the city area affected by energy outage exceeding 6 hours, last year

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
No area affected	**3**
Less than or equal to 2.5% area affected	**2**
Between 2.5% and 10% area affected	**1.5**
More than or equal to 10% area affected	**0**

FEne20 - Energy outage for sensitive customers last year (% of sensitive customers)

Percentage of sensitive customers affected by energy outage exceeding 6 hours, last year

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. Please list which sensitive customers were affected.

Development assessment rule	Development
No sensitive customers affected	**3**
Less or equal to 0.1% sensitive customers affected	**2**
Between 0.1% and 0.25% of sensitive customers affected	**1.5**
More than or equal to 0.25% of sensitive customers affected	**0**

FEne21 - Energy outage for other services last year (% customers of other services)

Percentage of customers of other services affected by energy outage exceeding 6 hours, last year

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Other city services: RESCCUE services. If other, explain in comments. Please list which other services were affected. Please answer with an estimated figure for each service [%]. Refers to the % of the affected customers that provide other services and not the % of affected customers of such services.

Development assessment rule	Development
Less or equal to 0.1% customers affected	**3**
More than 0.1% and less than 0.25% of customers affected	**2**
More or equal to 0.25% and less than 0.5% of customers affected	**1**
More than or equal to 0.5% of customers affected	**0**

FEne22 - Energy outage in households last year (% of households)

Percentage of households affected by energy outage exceeding 6 hours, last year

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less or equal to 0.1% of households affected	**3**
More than 0.1% and less than 0.25% of households affected	**2**
More or equal to 0.25% and less than 0.5% of households affected	**1**
More than or equal to 0.5% of households affected	**0**

FEne23 - Total duration of energy outage period last year (days)

Total duration of energy outage periods, last year

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Reliable service
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
Less or equal to 0.25 days of energy outage	**3**
More than 0.25 and less than 0.5 days of energy outage	**2**
More than or equal to 0.5 and less than 1 day of energy outage	**1**
More than or equal to 1 day of energy outage	**0**

FEne24 - Energy losses last year (-)

Energy losses last year (rate of electricity losses in distribution networks measured as the ratio between losses and supplies of electricity)

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Reliable service
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [-] in comments.

Development assessment rule	Development
Less or equal to 5	**3**
More than 5 and less than 10	**2**
More or equal to 10 and less than 15	**1**
More than or equal to 15	**0**

FEne25 - Alternative energy sources (% energy from renewable sources)

Percentage of energy coming from renewable sources

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Flexible service
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More or equal to 30%	**3**
More than 20% and less than 30%	**2**
More than 10% and less than or equal to 20%	**1**
Less than or equal to 10%	**0**

FEne26 - Energy sources (-)

Which energy sources are used in the city?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Flexible service
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥3 =3; Sum≥2 and <3 =2; Sum≥1 and <2 =1 Sum<1 = 0).

Development assessment rule	Development
a) Fossil fuels	**1**
b) Nuclear power	**1**
c) Hydroelectric	**1**
d) Solar	**1**
e) Wind	**1**
f) Tidal	**1**
g) Wave	**1**
h) Geo thermal	**1**
i) Biomass	**1**
j) Other (explain in comments)	**0**

FEne27 - Energy sources location (-)

Where are the city's energy source points located?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Flexible service
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1.5; Sum<1 = 0).

Development assessment rule	Development
a) Within the urban area	**1**
b) Outside city boundaries but within the metropolitan area	**1**
c) Far from the outskirsts of the metropolitan area	**1**
d) None	**0**

FEne28 - Service management (-)

Services are appropriately managed, i.e. technological tools are used, existing competences are adequate and a command chain is in place?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service planning and risk management
Criteria	Flexible service
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
No significant technological tools exist but competences are adequate and a command chain is in place	**2**
Only a command chain is in place	**1**
No	**0**

FEne29 - Stakeholders perception (-)

Is there a mechanism to provide service score, based on stakeholders' perception and is it applied? If yes quantify the service score from stakehoder perception

Dimension	Functional
Subdimension	Energy
Resilience objective	Autonomous energy service
Criteria	Service importance to the city
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
More than or equal to 3	**3**
More than or equal to 2 and less than 3	**2**
More than 1 and less than 2	**1**
Less than or equal to 1 or there is no mechanism in place	**0**

FEne30 - Cascading impacts (-)

Is there an understanding of potentially cascading failures between different services, under different scenarios?

Dimension	Functional
Subdimension	Energy
Resilience objective	Autonomous energy service
Criteria	Service importance to the city
Source	UNISDR Scorecard P2.4 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Cascading effects have been studied, but CC scenarios were not considered	**2**
Cascading effects have been studied, but only for some services and CC scenarios were not considered	**1.5**
No	**0**

FEne31 - Critical services dependence on energy service according to climate change scenarios (-)

To what extent are critical services (CS -RESCCUE services) dependent on the energy service, based on climate change scenarios?

Dimension	Functional
Subdimension	Energy
Resilience objective	Autonomous energy service
Criteria	Service inter-dependency with other services considering climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Refer in Comments which services have high dependence of this service. This metric depends on the metric FEne38.

Development assessment rule	Development
No dependence (CS are not affected or failure is not likely to occur due to problems in water service)	**3**
Minor dependence (CS are affected and failure is likely to occur in one of the CS)	**2**
Major dependence (CS are affected and failure is likely to occur in more than one CS)	**1**
Total dependence (failure is likely to occur in all CS)	**0**

FEne32 - Energy services autonomy from other services according to climate change scenarios (-)

To what extent is the energy service dependent on other critical services (CS -RESCCUE services), based on climate change scenarios?

Dimension	Functional
Subdimension	Energy
Resilience objective	Autonomous energy service
Criteria	Service inter-dependency with other services considering climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Refer in Comments which services does this service have low autonomy from. This metric depends on the metric FEne38.

Development assessment rule	Development
Total autonomy (does not depend on CS services continuity - e.g. water, waste, fuel)	**3**
Major autonomy (are affected but do not fail in case of CS continuity loss)	**2**
Minor autonomy (failure is likely to occur in at least one infrastructure in case of CS continuity loss)	**1**
No autonomy (failure is likely to occur in the majority of infrastructures in case of CS continuity loss)	**0**

FEne33 - Energy service event management plans (-)

Is there a disaster management / preparedness / emergency response plan outlining service mitigation, preparedness and response to local emergencies?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for disaster response
Source	UNISDR Scorecard P9.2 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
No, but the service is included in the city-wide disaster management plan	**2**
The plan only addresses some of the indicated requirements	**1**
No	**0**

FEne34 - Energy services interdepartmental collaboration for emergency (-)

Is there an emergency operations centre, automating standard operating procedures specifically designed to deal with “most probable” and “most severe” scenarios?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for disaster response
Source	UNISDR Scorecard P9.6 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially, there is an emergency operations centre, automating standard operating procedures but not specifically designed to deal with “most probable” and “most severe” scenarios	**1.5**
No	**0**

FEne35 - Energy services early warning (-)

Does the service have a plan or standard operating procedure to act on early warnings and forecasts? Is the city warned by this system?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for disaster response
Source	UNISDR Scorecard P9.1 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Yes, a plan or a SOP exists, but the city is not informed	**1.5**
No	**0**

FEne36 - Energy service drills (-)

Are practices and drills carried out internally and periodically?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for disaster response
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes, every year	**3**
Yes, occasionally	**1.5**
No	**0**

FEne37 - Service commitment with mitigation of climate change effects (% reduction of GHG)

Is the service commited with an established mitigation target regarding reduction of GHG within its strategic planning?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes, a 50% reduction or higher is the target	**3**
Yes, a 20% - 49% reduction is the target	**2**
Yes, but the target is lower than 20% or there is no target defined	**1**
No compromise	**0**

FEne38 - Existence of agreed climate change scenarios and alignment with the city climate change scenarios (-)

Are there agreed climate change scenarios, setting out service exposure and vulnerability, from each hazard level? Are they aligned with the city-wide climate change scenarios?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metrics FEne14, FEne15, FEne16, FEne17, FEne18, FEne31, FEne32, FEne39, FEne48, FEne49, FEne50, FEne51, FEne52, PEne16, PEne30, PEne31, PEne32, PEne35, PEne36, PEne37, PEne38, PEne39, PEne40 and PEne41.

Development assessment rule	Development
Comprehensive scenarios exist (at least “most probable” and “most severe”) updated in last 5 years and are aligned with the city	**3**
Partial scenarios exist but are not comprehensive or complete and/or are more than 5 years old and only partially aligned with the city	**2**
Only a generalized notion of exposure and vulnerability, with no attempt systematically to identify impacts	**1**
No	**0**

FEne39 - Knowledge of exposure and service vulnerability for climate change scenarios (-)

The analysis of exposure and service vulnerability for climate change scenarios addresses:

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and a scale to 3 is made. This metric depends on the metric FEne38.

Development assessment rule	Development
a) People	**2**
b) Housing	**2**
c) Service's infrastructures	**1**
d) Critical service's infrastructures	**2**
e) Other service's infrastructures	**1**
f) Protective infrastructures	**1**
g) Green / blue infrastructures	**1**
h) None of the above	**0**

FEne40 - Service planning for adaptation to climate change (-)

Is adaptation to climate change being considered in the service plans and enforced in new projects?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Yes, but only for some climate change hazards	**1.5**
No	**0**

FEne41 - Implemented measures to address climate change mitigation and adaptation (-)

What type of measures has the service implemented to to address climate change mitigation and adaptation?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥3 and f)=1 =3; Sum>0 and <3 or Sum≥3 and f)=0 =2; Sum=0 =0).

Development assessment rule	Development
a) Drills and training	**1**
b) Stakeholder or public engagement and awareness	**1**
c) Improvement of information collection and analysis	**1**
d) Improvement of the administrative buildings' and processes' environmental efficiency	**1**
e) Reduction of GHG in the fleet	**1**
f) Development of emergency or contigency plans	**1**
g) Use of social media for warnings and information	**1**
h) Other (explain in the Comments column)	**1**
i) None of the above	**0**

FEne42 - Planned measures to address climate change mitigation and adaptation (-)

What type of measures is the service planning to implement to address climate change mitigation and adaptation?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and Sum<2 =2; Sum=0 =0).

Development assessment rule	Development
a) Drills and training	**1**
b) Stakeholder or public engagement and awareness	**1**
c) Improvement of information collection and analysis	**1**
d) Improvement of the administrative buildings' and processes' environmental efficiency	**1**
e) Reduction of GHG in the fleet	**1**
f) Development of emergency or contigency plans	**1**
g) Use of social media for warnings and information	**1**
h) Other (explain in the Comments column)	**1**
i) None of the above	**0**

FEne43 - Equipment capacity of the service (-)

Has the service adequate equipment capacity, in normal and emergency circumstances?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

Insert some examples in Comments.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FEne44 - Staffing capacity of the service (-)

Has the service adequate staffing capacity, in normal and emergency circumstances?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for climate change
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

Insert some examples in Comments.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FEne45 - Energy service climate change recovery planning (-)

Is there a strategy or process in place for post-event service recovery and reconstruction?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for recovery and build back
Source	UNISDR Scorecard P10.1
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
There is a strategy/process in place. It is robust and well-understood by relevant stakeholders	**3**
There is a strategy/process in place. It is well- understood by relevant stakeholders but has known weaknesses	**2**
Some plans/strategies exist but they are not comprehensive or joined up or understood by relevant stakeholders	**1**
No known plans	**0**

FEne46 - Energy service damage and loss post-event assessment (-)

Does the service has a system in place to provide Post-Disaster Needs Assessment?

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metric FEne47.

Development assessment rule	Development
Yes	**3**
No	**0**

FEne47 - Current post-event assessment system (-)

If yes, has such system been defined, implemented, tested and historic data is registered?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FEne46.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FEne48 - Energy outage in the city area in the last relevant climate-related event (% of the city area)

Percentage of city area affected by energy outage exceeding 6h in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Waste
Resilience objective	Waste service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FEne38.

Development assessment rule	Development
No area affected	**3**
Less than or equal to 2.5% area affected	**2**
Between 2.5% and 10% area affected	**1**
More than or equal to 10% area affected	**0**

FEne49 - Energy outage for sensitive customers in the last relevant climate-related event (% of sensitive customers)

Percentage of sensitive customers affected by energy outage exceeding 6h in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments and list which sensitive customers were affected. Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. This metric depends on the metric FEne38.

Development assessment rule	Development
No sensitive customers affected	**3**
Less than or equal to 2.5% sensitive customers affected	**2**
More than 2.5% and less than 5% sensitive customers affected	**1.5**
More than or equal to 5% and less than 100% sensitive customers affected	**0**

FEne50 - Energy outage in other services in the last relevant climate-related event (% customers of other services)

Percentage of customers of other services affected by energy outage exceeding 6h in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments and list which other services were affected. Other city services: RESCCUE services. If other, explain in comments. This metric depends on the metric FEne38.

Development assessment rule	Development
No customers of other services affected	**3**
Less than or equal to 2.5% customers of other services affected	**2**
More than 2.5% and less than 5% customers of other services affected	**1.5**
More than or equal to 5% and less than 100% customers of other services affected	**0**

FEne51 - Energy outage in households in the last relevant climate-related event (% of households)

Percentage of households affected by energy outage exceeding 6h in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments. This metric depends on the metric FEne38.

Development assessment rule	Development
No households affected	**3**
Less than or equal to 2.5% households affected	**2**
More than 2.5% and less than 5% households affected	**1.5**
More than or equal to 5% and less than 100% households affected	**0**

FEne52 - Total duration of energy outage in the last relevant climate-related event (days)

Days of energy outage in the last relevant climate-related event

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments. This metric depends on the metric FEne38.

Development assessment rule	Development
≤ 0.25 days	**3**
> 0.25 and ≤ 0.5 days	**2**
> 0.5 and ≤ 1 days	**1.5**
> 1 day	**0**

FEne53 - Energy service lessons learnt and learning loops (-)

Are service-specific processes in place for lessons learnt, including failure analysis? If yes, are service-specific plans informed by them?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Processes in place but plans are not informed by them	**2**
Partially	**1**
No	**0**

FEne54 - Insurance (-)

What level of insurance cover exists in the service?

Dimension	Functional
Subdimension	Energy
Resilience objective	Energy service preparedness
Criteria	Service preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Sectors within the service: e.g. infrastructure, equipment, fleet, human resources, administrative buildings.

Development assessment rule	Development
The uptake for insurance products across all sectors within the service is high	**3**
The level of insurance varies significantly by sector or by area	**2**
Little insurance cover	**1**
No insurance cover	**0**

FUNCTIONAL

MOBILITY

PI code	PI name	Unit

FMob01 - Mobility strategic plan making and implementation (-)

Existence and implementation of a strategic plan for the mobility in the city

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Strategic planning
Source	UNISDR Scorecard P1.1 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metric FMob02, FMob03, FMob06, FMob07 and FMob08.

Development assessment rule	Development
Yes	**3**
Partially. The plan exists, but it is still not implemented OR Not all the responsible utilities have an implemented plan	**1.5**
No	**0**

FMob02 - Characterization of mobility needs (-)

The plan includes the characterization of the following population mobility habits:

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum≥4 =3; Sum≥3 and <4 =2.5; Sum≥2 and <3 =1.5 and Sum<2 = 0). This metric depends on the metric FMob01.

Development assessment rule	Development
a) Type of mobility solutions used	**1**
b) Periods of the day used for travelling	**1**
c) Travel duration	**1**
d) Use of different types of mobility solutions per travel	**1**
e) Use of transport interfaces	**1**
f) None	**0**

* (-) without unit or dimensionless

FMob03 - Mobility plan monitoring and review (-)

If existing, is the plan periodically monitored and reviewed, ensuring it remains relevant and operational?

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Insert periodicity in comments. This metric depends on the metric FMob01.

Development assessment rule	Development
Yes, at least once every 5 years	**3**
Yes, at least once every 10 years	**2**
The frequency exceeds once every 10 years, or the plan is not considered relevant or operational	**1**
No periodical monitoring and review	**0**

FMob04 - Routes hierarchy characterization (-)

The city established a hierarchy of its routes?

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FMob05 - Land use zoning compliance (-)

Do mobility-specific plans comply with up-to-date land use and zoning regulations?

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Strategic planning
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FMob06 - Resilience in mobility strategy (-)

Resilience's aspects are included in the mobility plan?

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Resilience engaged mobility
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FMob01.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FMob07 - Mobility plan for Climate Change (-)

The plan considers climate change (hazards, projections, scenarios, impacts, etc.)?

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Resilience engaged mobility
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FMob01.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FMob08 - Budget for resilience (-)

The mobility plan has dedicated allocations for resilience-building actions (including disaster risk reduction (DRR))?

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Resilience engaged mobility
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FMob01.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FMob09 - Co-ordination within mobility services in the city (-)

Is there any coordination mechanism in place with other mobility services/entities either at municipal or metropolitan level?

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Resilience engaged mobility
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

If yes, specify the involved mobility service in comments.

Development assessment rule	Development
Yes	**3**
No	**0**

FMob10 - Learning from other mobility services (-)

Is there any knowledge exchange with other services?

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Resilience engaged mobility
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Services facing similar challenges: e.g other water services, other urban services. Please select all applicable answers. Sum of the selected options and a scale to 3 is made.

Development assessment rule	Development
a) International exchanges are in place	**1**
b) National exchanges are in place	**1**
c) With similar services	**1**
d) With different services	**1**
e) None of the above	**0**

FMob11 - Risk information related to the mobility service (-)

Does the mobility plan include risk information (such as exposure and vulnerability, identification of higher flow routes, damage and loss quantification, etc.) and is it regurlarly updated?

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please indicate the last reviews date in comments. If partially not covering all mobility services, please specify the covered services in comments.

Development assessment rule	Development
Yes	**3**
Partially, not covering the all the hazards or all the city or not regurlarly updated	**1.5**
No	**0**

FMob12 - Damage and loss estimation (-)

Does risk assessment include estimations of damage and loss for agreed climate change scenarios, based on current development and future urban and population growth?

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Risk management
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please specify the covered services in comments. This metric depends on the metric O54.

Development assessment rule	Development
Yes	**3**
Partially, with limited data or not covering all mobility services	**2**
There are plans to develop risk assessments in some mobility services	**1**
Risk assessments do not identify all risk areas or there are no plans to update them	**0**

FMob13 - Expected mobility interruption in the city area according to climate change scenarios (-)

No city area at risk of mobility interruptions exceeding 2h, due to the most probable scenario, for these services:

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Risk management
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select all applicable answers. Sum of the selected options and a scale to N is made. N is the number of selected mobility options under assessment. This metric depends on the metric O54.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**
c) Air based	**1**
d) Water based	**1**

FMob14 - Expected mobility interruption in the higher flow routes according to climate change scenarios (-)

Expected mobility interruption exceeding 2 hours in the higher flow routes according to climate change scenarios

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Risk management
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Higher flow routes correspond to mobility axes with higher traffic volume in the city. This metric depends on the metric O54.

Development assessment rule	Development
Yes	**3**
No	**0**

FMob15 - Expected mobility interruption for population according to climate change scenarios (-)

No population living in the area expected to be affected by mobility interruption exceeding 2h, due to the most probable scenario, for these services:

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Risk management
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select all applicable answers. Sum of the selected options and a scale to N is made. N is the number of selected mobility options under assessment. This metric depends on the metric O54.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**
c) Air based	**1**
d) Water based	**1**

FMob16 - Expected mobility interruption for long-distance passengers according to climate change scenarios (-)

No long-distance passengers expected to be affected by mobility interruption exceeding 2h, due to the most probable scenario, for these services:

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Risk management
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select all applicable answers. Sum of the selected options and a scale to N is made. N is the number of selected mobility options under assessment. This metric depends on the metric O54.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**
c) Air based	**1**
d) Water based	**1**

FMob17 - Expected mobility interruption period according to climate change scenarios (-)

Less than 2h of expected mobility interruption, due to the most probable scenario, for these services:

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Risk management
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select all applicable answers. Sum of the selected options and a scale to N is made. N is the number of selected mobility options under assessment. This metric depends on the metric O54.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**
c) Air based	**1**
d) Water based	**1**

FMob18 - Public transport spatial coverage (% of the city area)

Public transport is available and covers:

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Reliable mobility
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
More than or equal to 80% of the city area	**3**
More than 50% and less than 80% of the city area	**2**
More than 25% and less than or equal to 50% of the city area	**1**
Less than or equal to 25% of the city area	**0**

FMob19 - Public transport daily coverage (hours/day)

Public transport is available:

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Reliable mobility
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
24 hours per day every day of the week in more than 50% of the city area	**3**
Less than 24 hours per day or only in working days, in more than 50% of the city area	**2**
Less than 6 hours per day or only in working days, in more than 50% of the city area	**1**
Less than 6 hours per day in all the city area	**0**

FMob20 - Mobility interruption in the higher flow routes last year (-)

Mobility interruption exceeding 2 hours in the higher flow routes last year

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Reliable mobility
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Higher flow routes correspond to mobility axes with higher traffic volume in the city.

Development assessment rule	Development
Yes	**0**
No	**3**

FMob21 - Mobility interruption in the city area last year (-)

Less than 2.5% of the city area with mobility interruptions exceeding 2h, last year, for these services:

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Reliable mobility
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select all applicable answers. Sum of the selected options and a scale to N is made. N is the number of selected mobility options under assessment. Please answer with correspondent estimated figures in comments.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**
c) Air based	**1**
d) Water based	**1**

FMob22 - Mobility interruption for population last year (-)

Less than 2.5% of the population living in the area affected by mobility interruption exceeding 2h, last year, for these services:

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Reliable mobility
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select all applicable answers. Sum of the selected options and a scale to N is made. N is the number of selected mobility options under assessment. Please answer with correspondent estimated figures [% population] in comments.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**
c) Air based	**1**
d) Water based	**1**

FMob23 - Mobility interruption for long-distance passengers last year (-)

Less than 2.5% of the long-distance passengers affected by mobility interruption exceeding 2h, last year, for these services:

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Reliable mobility
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select all applicable answers. Sum of the selected options and a scale to N is made. N is the number of selected mobility options under assessment. Please answer with correspondent estimated figures [% passengers] in comments.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**
c) Air based	**1**
d) Water based	**1**

FMob24 - Total duration of mobility interruption period last year (-)

Less than 0.5 days of mobility interruption, last year, for these services:

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Reliable mobility
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select all applicable answers. Sum of the selected options and a scale to N is made. N is the number of selected mobility options under assessment. Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**
c) Air based	**1**
d) Water based	**1**

FMob25 - Routes with restrictions to circulation of heavy vehicles (-)

The city has identified the routes with restriction to the circulation of heavy vehicles

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Reliable mobility
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FMob26 - Routes with restrictions to circulation of medical or emergency vehicles (-)

The city has identified the routes with restriction to the circulation of medical or emergency vehicles

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Reliable mobility
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

FMob27 - Alternative mobility (% everyday cycling mobility)

Percentage of everyday cycling mobility

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Flexible mobility
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More than or equal to 20%	**3**
More than 10% and less than 20%	**2**
More than 5% and less than or equal to 10%	**1**
Less than or equal to 5%	**0**

FMob28 - City mobility solutions (-)

Which solutions for mobility are available in the city?

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Flexible mobility
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum≥4 =3; Sum≥3 and <4 =2.5; Sum≥2 and <3 =1.5; Sum<2 = 0).

Development assessment rule	Development
a) Individual cars	**1**
b) Public bus	**1**
c) Taxi	**1**
d) Subway	**1**
e) Train	**1**
f) Plane/helicopter	**1**
g) Bicycle	**1**
h) Car sharing	**1**
i) Car pooling	**1**
j) Door-to-door public vehicles	**1**
k) Other (e.g. tram, specify in Comments)	**0**

FMob29 - Modal split for city road based solutions (% of share)

Percentage of share of each road based solution

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Flexible mobility
Source	-
Importance	Complementary
Level	Tactical
Metric type	Open value

This metric allows to answer with a value. Please answer with an estimated figure [%], disaggregating according to a) individual cars, b) public bus, c) taxi and d) bicycle. The sum of all modes should be equal to 100%.

Development assessment rule	Development
a) Individual cars	**3 if a) is ≤ 60%**
b) Public bus	**2 if a) is ≥ 60% and < 75%**
c) Taxi	**1 if a) is ≥ 75% and <95%**
d) Bicycle	**0 if a) is ≥ 95%**

FMob30 - Long distance mobility solutions (-)

Which solutions for long distance mobility are available in the city?

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Flexible mobility
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum≥4 =3; Sum≥3 and <4 =2.5; Sum≥2 and <3 =1.5; Sum<2 = 0).

Development assessment rule	Development
a) Individual cars	**1**
b) Public bus	**1**
c) Taxi	**1**
d) Subway	**1**
e) Boat	**1**
f) Train	**1**
g) Plane/helicopter	**1**
h) Other (specify in Comments)	**0**

FMob31 - Mobility passenger transference (-)

Where are the city's mobility central node points located?

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Flexible mobility
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1.5; Sum<1 = 0).

Development assessment rule	Development
a) within the urban area	**1**
b) outside city boundaries but within the metropolitan area	**1**
c) far from the outskirsts of the metropolitan area	**1**
d) none	**0**

FMob32 - Use of mobility management tools (-)

Mobility in the city is recurs to the following management tools:

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility planning and risk management
Criteria	Flexible mobility
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1.5; Sum<1 = 0).

Development assessment rule	Development
a) Traffic lighting is managed in an integrated and automatic way	**1**
b) Public lighting is managed in an integrated way	**1**
c) Traffic flow and anomalies are remotely identified	**1**
d) Other. Explain in comments	**1**
e) none	**0**

FMob33 - Stakeholders perception of city mobility (-)

Is there a mechanism to provide service score, based on stakeholders' perception and is it applied? If yes quantify the service score from stakehoder perception

Dimension	Functional
Subdimension	Mobility
Resilience objective	Autonomous mobility
Criteria	Mobility importance to the city
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure in comments, if applicable [-].

Development assessment rule	Development
More than or equal to 3	**3**
More than or equal to 2 and less than 3	**2**
More than 1 and less than 2	**1**
Less than or equal to 1 or there is no mechanism in place	**0**

FMob34 - Cascading impacts (-)

Is there an understanding of potentially cascading failures between different services, under different scenarios?

Dimension	Functional
Subdimension	Mobility
Resilience objective	Autonomous mobility
Criteria	Mobility importance to the city
Source	UNISDR Scorecard P2.4 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes, for all the mobility services	**3**
Cascading effects have been studied, but CC scenarios were not considered	**2**
Cascading effects have been studied, but only for some services and CC scenarios were not considered	**1.5**
No	**0**

FMob35 - Critical services dependence on mobility according to climate change scenarios (-)

To what extent are critical services (CS -RESCCUE services) dependent on the mobility, based on climate change scenarios?

Dimension	Functional
Subdimension	Mobility
Resilience objective	Autonomous mobility
Criteria	Mobility inter-dependency with other services considering climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

CS fail when the respective service provision is interrupted. Refer in Comments which services have high dependence of this service. This metric depends on the metric O54.

Development assessment rule	Development
No dependence (CS are not affected or failure is not likely to occur due to problems in mobility)	**3**
Minor dependence (CS are affected and failure is likely to occur in one of the CS)	**2**
Major dependence (CS are affected and failure is likely to occur in more than one CS)	**1**
Total dependence (failure is likely to occur in all CS)	**0**

FMob36 - Mobility autonomy from other services according to climate change scenarios (-)

To what extent is the mobility dependent on other critical services (CS -RESCCUE services), based on climate change scenarios?

Dimension	Functional
Subdimension	Mobility
Resilience objective	Autonomous mobility
Criteria	Mobility inter-dependency with other services considering climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Refer in Comments which services does this service have low autonomy from. This metric applies to first and second level routes and for occurrences longer than 30 min. Mobility is constrained when traffic volume or velocity are reduced up to 50%; mobility is interrupted when traffic volume or velocity are null. This metric depends on the metric O54.

Development assessment rule	Development
Total autonomy of mobility (does not depend on CS service continuity - e.g. water for pavement cleaning, energy for traffic lighting, street lighting, water pumping, communication)	**3**
Major autonomy (mobility is constrained but it is not interrupted in case of CS failure)	**2**
Minor autonomy (mobility is constrained and likely to be interrupted in case of CS failure)	**1**
No autonomy (mobility is interrupted in case of any CS failure)	**0**

FMob37 - Mobility commitment with mitigation of climate change effects (% reduction of GHG)

Is city mobility commited with an established mitigation target regarding reduction of GHG within its strategic planning?

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility preparedness
Criteria	Mobility preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes, a 50% reduction or higher is the target	**3**
Yes, a 20% - 49% reduction is the target	**2**
Yes, but the target is lower than 20% or there is no target defined	**1**
No compromise	**0**

FMob38 - Mobility interruption in the city area in the last relevant climate-related event (% of the city area)

Percentage of city area affected by mobility interruption exceeding 2h, in the last climate-related event, with similar or harsher climate variables than the most probable scenario:

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility preparedness
Criteria	Mobility preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric O54.

Development assessment rule	Development
No area affected	**3**
Less than or equal to 2.5% area affected	**2**
Between 2.5% and 10% area affected	**1**
More than or equal to 10% area affected	**0**

FMob39 - Mobility interruption in the higher flow routes in the last relevant climate-related event (-)

Mobility interruption exceeded 2 hours in higher flow routes in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility preparedness
Criteria	Mobility preparedness for climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric O54.

Development assessment rule	Development
Yes	**3**
No	**0**

FMob40 - Mobility interruption for population in the last relevant climate-related event (-)

Less than 2,5% of population living in the area affected by mobility interruption exceeding 2h, in the last climate-related event, with similar or harsher climate variables than the most probable scenario, for these services:

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility preparedness
Criteria	Mobility preparedness for climate change
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select all applicable answers. Sum of the selected options and a scale to N is made. N is the number of selected mobility options under assessment. Please answer with an estimated figure [% population] in comments. This metric depends on the metric O54.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**
c) Air based	**1**
d) Water based	**1**

FMob41 - Mobility interruption for long-distance passengers in the last relevant climate-related event (-)

Less than 2,5% of long-distance passengers affected by mobility interruption exceeding 2h, in the last climate-related event, with similar or harsher climate variables than the most probable scenario, for these services:

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility preparedness
Criteria	Mobility preparedness for climate change
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select all applicable answers. Sum of the selected options and a scale to N is made. N is the number of selected mobility options under assessment. Please answer with an estimated figure [% passengers] in comments. This metric depends on the metric O54.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**
c) Air based	**1**
d) Water based	**1**

FMob42 - Mobility interruption period in the last relevant climate-related event (-)

Less than 2h that mobility services suffered from interruption, in the last climate-related event, with similar or harsher climate variables than the most probable scenario, for these services:

Dimension	Functional
Subdimension	Mobility
Resilience objective	Mobility preparedness
Criteria	Mobility preparedness for climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select all applicable answers. Sum of the selected options and a scale to N is made. N is the number of selected mobility options under assessment. Please answer with correspondent estimated figures [hours] in comments. This metric depends on the metric O54.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**
c) Air based	**1**

d) Water based **1**

PHYSICAL

WATER

PI code	PI name	Unit*

PWts01 - Water infrastructure critical assets (-)

Are the critical infrastructure assets for service provision identified?

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Service provision includes treatment, transport and distribution. This metric conditions the metrics PWts02, PWts03, PWts04, PWts36 and PWts47.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

PWts02 - Component importance (-)

The identification of infrastructure critical assets is based in the following:

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. Please select one or more of the options provided as answers. Sum of the selected answers and a scale to 3 is made. This metric depends on the metric PWts01.

Development assessment rule	Development
a) Population served	**1**
b) Associated sensitive customers	**1**
c) Location	**1**
d) High dependence on other services infrastructures	**1**
e) Other services infrastructure highly depend on water infrastructure	**1**
f) Other (explain in Comments)	**1**
g) None	**0**

* (-) without unit or dimensionless

PWts03 - Water infrastructure critical assets mapping, review and update (-)

Are the infrastructure critical assets identified on hazard maps and included in data on risk?

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please specify how often this maps are reviewed and updated, and the data of the last update, in comments. This metric depends on the metric PWts01.

Development assessment rule	Development
Yes	**3**
Partially, not covering the all the hazards or all the infrastructure	**1.5**
No	**0**

PWts04 - Exchange of information (-)

Is there a regular exchange of information regarding infrastructure critical assets, hazard maps and data on risk with the city?

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric PWts01.

Development assessment rule	Development
Yes, exchange of information from both sides	**3**
The service is informed by the city	**2**
The city is informed by the service	**1**
No exchange	**0**

PWts05 - Protective buffers mapping and information to the city (-)

Have protective buffers to safeguard infrastructure assets been defined, are they clearly identified on hazard maps and data on risk and is the city informed?

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Protective buffers are spatially delimited areas surrounding the infrastructure where activities are restricted to protect the structural integrity of the assets.

Development assessment rule	Development
Yes	**3**
Partially, or with a time horizon longer than 10 years	**1.5**
No	**0**

PWts06 - Codes and standards for infrastructure (-)

Do codes or standards for infrastructure design and construction exist and are these implemented?

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Yes but only applied to infrastructure built at least in the last 10 years	**2**
Only recent use / existence of relevant codes and standards	**1**
No	**0**

PWts07 - Maintenance of infrastructure (-)

Is infrastructure maintained on a regular basis (according to a preventive maintenance plan), resources for corrective maintenance are assured and all maintenance information is continuously registered?

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please specify which infrastructure are being maintained (treatment, transport, distribution or all).

Development assessment rule	Development
Yes	**3**
Just in some cases or registration is not fully assured	**2**
Preventive maintenance is not in place or corrective maintenance is not effective and efficient	**1**
Maintenance is not in place	**0**

PWts08 - Water pump failures last year (days)

Average number of days that system pumps were out of order last year (for all system pumps)

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PWts09 - Water mains bursts last year (No./100 km)

Relative number of water mains bursts last year (No./system length (km) x 100 km)

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [No./100 km] in comments.

Development assessment rule	Development
Less than or equal to 30	**3**
More than 30 and less than or equal to 60	**1.5**
More than 60	**0**

PWts10 - Water connections bursts last year (No./1000 connections)

Number of water connections bursts last year (No./connections in the system x 1000 connections)

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets robustness
Source	ERSAR 3G AA03 (adapted)
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [No./1000 connections] in comments.

Development assessment rule	Development
Less than or equal to 1,0	**3**
More than 1,0 and less than or equal to 2,5	**1.5**
More than 2,5	**0**

PWts11 - Hydrant failures last year (No./1000 hydrants)

Average number of hydrant failures last year (No./hydrants in the system x 1000 hydrants)

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [No./1000 hydrants] in comments.

Development assessment rule	Development
Less than or equal to 1,0	**3**
More than 1,0 and less than or equal to 2,5	**1.5**
More than 2,5	**0**

PWts12 - Power failures last year (days)

Average number of days pumping stations were out of service due to power supply interruptions last year (for all system pumps)

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PWts13 - Water quality last year (%)

Percentage of performed laboratory analysis that were in accordance to legal or regulatory requirements last year

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets robustness
Source	ERSAR 1G AA04 (adapted)
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More than or equal to 99%	**3**
More than or equal to 97,5% and less than 99%	**1.5**
Less than 97,5%	**0**

PWts14 - Level of failure of critical infrastructure assets last year (%)

Percentage of critical infrastructure assets out of order last year

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please specify which critical infrastructure assets are included (treatment, transport, distribution or all). Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PWts15 - Coverage of expenditure in infrastructure last year (-)

Ratio between expenditure with rehabilitation, operation and management of infrastructure and annual operating budget of last year

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

Compares the expenditure (regarding rehabilitation, operation and asset management activities) with the available budget (for the same activities). Please answer with an estimated figure [-] in comments.

Development assessment rule	Development
More than or equal to 1,0 and less than or equal to 1,1	**3**
More than or equal to 0,9 and less than 1,0 or more than 1,1 and less than or equal to 1,2	**1.5**
Less than 0,9 or more than 1,2	**0**

PWts16 - Time for restoration last year (days)

Maximum out-of-service period for all failures in infrastructure, including recovery time, last year

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

For treatment, transport and distribution. Refers to structural failures on the assets, both having service interruption as a consequence or not. Does not refer to assets that have been decomissioned. Please answer with an estimated figures for treatment and distribution [days].

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PWts17 - Real water losses (m^3/(km.day))

Volume of real physical water losses, through any leaks, damaged pipes or overflows (water loss volume in the supply system/(total pipe length.365))

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets robustness
Source	ERSAR 3G AA12
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [m^3/(km.day)] in comments.

Development assessment rule	Development
Less than or equal to 15	**3**
More than 15 and less than or equal to 22,5	**1.5**
More than 22,5	**0**

PWts18 - Energy efficiency in pumping stations (kWh/m3.100m)

Average normalized energy consumption in PS - pumping stations = (Total energy consumption for pumping / sum (Water volume in PS i x Manometric pressure head i / 100)

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets robustness
Source	ERSAR 3G AA13
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [kWh/m^3.100m] in Comments.

Development assessment rule	Development
More than or equal to 0,27 and less than or equal to 0,40	**3**
More than 0,40 and less than or equal to 0,54	**1.5**
More than 0,54	**0**

PWts19 - Pollution prevention (% appropriate sludge disposal)

Percentage of sludge from water treatment with appropriate final disposal

Dimension	Physical
Subdimension	Water
Resilience objective	Safe water infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Equal to 100%	**3**
More than or equal to 95% and less than 100%	**1.5**
Less than 95%	**0**

PWts20 - Cascading impacts (-)

There is knowledge concerning potentially cascading failures between the components of the infrastructure and the following infrastructure, under the agreed scenarios:

Dimension	Physical
Subdimension	Water
Resilience objective	Autonomous and flexible water infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum≥3 =3; Sum≥2 and <3 =2; Sum≥1 and <2 =1 Sum<1 =0). This metric depends on the metric FWts48.

Development assessment rule	Development
a) Other infrastructure of the water service	**1**
b) Infrastructure of the wastewater service	**1**
c) Infrastructure of the stormwater service	**1**
d) Infrastructure of the solid waste service	**1**
e) Infrastructure of the energy service	**1**
f) Infrastructure of the mobility service	**1**
g) Other (explain in Comments)	**1**
h) None	**0**

PWts21 - Infrastructure of other services dependency on water infrastructure (-)

The infrastructure of the following services are dependent on water infrastructure:

Dimension	Physical
Subdimension	Water
Resilience objective	Autonomous and flexible water infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum<2 =3; Sum≥2 and <3 =2; Sum≥3 and <4 =1.5 Sum≥4 =0).

Development assessment rule	Development
a) Infrastructure of the wastewater service	**1**
b) Infrastructure of the stormwater service	**1**
c) Infrastructure of the solid waste service	**1**
d) Infrastructure of the energy service	**1**
e) Infrastructure of the mobility service	**1**
f) Other (explain in Comments)	**1**
g) None	**0**

PWts22 - Dependency on infrastructures of other services (-)

The infrastructure of the water service directly depends on the infrastructure of the following services:

Dimension	Physical
Subdimension	Water
Resilience objective	Autonomous and flexible water infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum<2 =3; Sum≥2 and <3 =2; Sum≥3 and <4 =1.5 Sum≥4 =0).

Development assessment rule	Development
a) Infrastructure of the wastewater service	**1**
b) Infrastructure of the stormwater service	**1**
c) Infrastructure of the solid waste service	**1**
d) Infrastructure of the energy service	**1**
e) Infrastructure of the mobility service	**1**
f) Other (e.g. gas, fuel, telecommunication, explain in Comments)	**1**
g) None	**0**

PWts23 - Level of dependency (% of customers affected)

Percentage of customers affected by infrastructure dependent on other services

Dimension	Physical
Subdimension	Water
Resilience objective	Autonomous and flexible water infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less than or equal to 10%	**3**
More than 10% and less than or equal to 20%	**1.5**
More than 20%	**0**

PWts24 - Autonomy from infrastructures of other services (% infrastructure)

Percentage of infrastructure directly dependent on other services that have an autonomy solution managed by the water service

Dimension	Physical
Subdimension	Water
Resilience objective	Autonomous and flexible water infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

First, analyse what infrastructure depends on other services (e.g pumping stations depend on electricity). After, from this subset identify which percentage has self-autonomy (e.g., the pumping station might have a generator). Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More than or equal to 80%	**3**
More than or equal to 70% and less than 80%	**1.5**
Less than 70%	**0**

PWts25 - Level of autonomy (% of customers covered)

Percentage of customers covered by infrastructure dependent on other services that benefit from autonomy solutions (i.e. customers that benefit/customers affected)

Dimension	Physical
Subdimension	Water
Resilience objective	Autonomous and flexible water infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Disaggregating into households, critical facilities/services and other services, if possible, in comments. Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More than or equal to 80%	**3**
More than or equal to 70% and less than 80%	**1.5**
Less than 70%	**0**

PWts26 - Autonomy activation (-)

How is infrastructure autonomy activated? Specify the time required to activate it, if possible

Dimension	Physical
Subdimension	Water
Resilience objective	Autonomous and flexible water infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. The development is obtained throught 4 conditions: If c) is the only selected answer =3; If c) is not selected but b) is selected =2; If c) and b) are not selected but a) is selected =1.5; if the only selected answer is e) = 0.

Development assessment rule	Development
a) Manual operation	**1**
b) Remote operation	**1**
c) Automatic operation	**1**
d) Other (explain in Comments)	**1**
e) None	**0**

PWts27 - Autonomy period (days)

Weighted average of autonomy period (Ti) of each dependent infrastructure (i) i.e. Sum (Ti x level of autonomy i)

Dimension	Physical
Subdimension	Water
Resilience objective	Autonomous and flexible water infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
More than or equal to 2	**3**
More than or equal to 1.5 and less than 2	**2**
More than or equal to 1 and less than 1.5	**1**
Less than 1	**0**

PWts28 - Water storage autonomy (days)

Days of water supply autonomy provided by supply and distribution storage tanks = water inflow [m^3/year] / (water storage volume [m^3] x 365)

Dimension	Physical
Subdimension	Water
Resilience objective	Autonomous and flexible water infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
More than or equal to 2	**3**
More than or equal to 1.5 and less than 2	**2**
More than or equal to 1 and less than 1.5	**1**
Less than 1	**0**

PWts29 - Energy self production (%)

Percentage of energy consumption coming from self production

Dimension	Physical
Subdimension	Water
Resilience objective	Autonomous and flexible water infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More than or equal to 30%	**3**
More than or equal to 15% and less than 30%	**2**
More than or equal to 5% and less than 15%	**1**
Less than 5%	**0**

PWts30 - Redundancy (-)

Is there an understanding of infrastructure redundancy, clearly identified on hazard maps and data on risk?

Dimension	Physical
Subdimension	Water
Resilience objective	Autonomous and flexible water infrastructure
Criteria	Infrastructure assets redundancy
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

PWts31 - Redundancy activation (-)

How is infrastructure redundancy activated? Specify the time required to activate it, if possible

Dimension	Physical
Subdimension	Water
Resilience objective	Autonomous and flexible water infrastructure
Criteria	Infrastructure assets redundancy
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. The development is obtained throught 4 conditions: If c) or d) are selected =3; If c) is not selected but b) is selected =2; If c) and b) are not selected but a) is selected =1.5; if the only selected answer is e) = 0.

Development assessment rule	Development
a) Manual operation	**1**
b) Remote operation	**1**
c) Automatic operation	**1**
d) No operation required	**1**
e) Other (explain in Comments)	**1**
f) None	**0**

PWts32 - Level of redundancy (% customers covered)

Percentage of customers covered by redundant infrastructure, i.e., with alternative infrastructure able to provide the service

Dimension	Physical
Subdimension	Water
Resilience objective	Autonomous and flexible water infrastructure
Criteria	Infrastructure assets redundancy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Disaggregating into households, critical facilities/services and other services, if possible. Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Equal to 100%	**3**
More than or equal 90% and less than 100%	**2**
More than or equal 80% and less than 90%	**1**
Less than 80%	**0**

PWts33 - Use of design solutions to improve city resilience (-)

The design of the infrastructure incorporate the use of the following solutions to improve city resilience:

Dimension	Physical
Subdimension	Water
Resilience objective	Water infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

Design solutions that contribute to the city's resilience that are not a direct component of the infrastructure that provides the service. E.g., any entity in its office buildings may have green roofs or porous floors in the parking lot. Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum≥3 =3; Sum≥2 and <3 =2; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Soakaways and porous pavement	**1**
b) Underground parking garages used as holding tanks for storm water	**1**
c) Parks that function as flood zones	**1**
d) Green roofs	**1**
e) Renewable energy generation	**1**
f) Water reuse and recycling	**1**
g) Other (explain in Comments)	**1**
h) None	**0**

PWts34 - Greenhouse gas emission target (-)

Contribution to greenhouse gas emission reduction

Dimension	Physical
Subdimension	Water
Resilience objective	Water infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Infrastructure operation	**1**
b) Fleet	**1**
c) Administrative buildings	**1**
d) Other (explain in Comments)	**0**
e) None	**0**

PWts35 - Other contributions to city resilience (-)

The water infrastructure and related services provide other contributions to city resilience in emergency situation, such as:

Dimension	Physical
Subdimension	Water
Resilience objective	Water infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Shelter	**1**
b) Medical services	**1**
c) First aid	**1**
d) Food storage	**1**
e) Food cooking and supply	**1**
f) Energy supply	**1**
g) Fuel supply	**1**
h) Emergency transport vehicles	**1**
i) Escape routes	**1**
j) Other (e.g. standby generators feeding into electricity supply grid, vehicles and personnel to support emergency services, explain in Comments)	**1**
k) None	**0**

PWts36 - Level of exposure of critical infrastructure assets to the most probable scenario (-)

Identify the critical infrastructure assets for which less than 10% is exposed to different hazards for climate change scenarios

Dimension	Physical
Subdimension	Water
Resilience objective	Water infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥3 =3; Sum≥2 and <3 =1; Sum<2 =0). This metric depends on the metric PWts01 and FWts48.

Development assessment rule	Development
a) Pumps	**1**
b) Water mains length	**1**
c) Water connections	**1**
d) Hydrants	**1**
e) Pumping station exposure to power failure	**1**
f) Water treatment plant	**1**
g) Other (explain in Comments)	**0**
h) None	**0**

PWts37 - Coverage of expenditure in infrastructure for most probable scenario (%)

Ratio between predicted expenditure on infrastructure affected by climate change scenarios and annual operating budget of last year

Dimension	Physical
Subdimension	Water
Resilience objective	Water infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments. This metric depends on the metric FWts48.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PWts38 - Time for restoration for most probable scenario (days)

Maximum out-of-service period predicted for all failures in infrastructure, including recovery time, due to different hazards for climate change scenarios

Dimension	Physical
Subdimension	Water
Resilience objective	Water infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments. This metric depends on the metric FWts48.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PWts39 - Implemented infrastructural measures to address climate change mitigation and adaptation (-)

What type of measures were implemented in infrastructure design to address climate change mitigation and adaptation?

Dimension	Physical
Subdimension	Water
Resilience objective	Water infrastructure preparedness
Criteria	Preparedness for climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Alternative water supply solutions to recur to	**1**
b) Alternative water storage solutions to recur to	**1**
c) Covered or buried reservoirs	**1**
d) Networked conduits	**1**
e) Renewable energy production equipment	**1**
f) Other (explain in Comments)	**0**
g) None	**0**

PWts40 - Planned infrastructural measures to address climate change mitigation and adaptation (-)

What type of measures are being planned in infrastructure design to address climate change mitigation and adaptation?

Dimension	Physical
Subdimension	Water
Resilience objective	Water infrastructure preparedness
Criteria	Preparedness for climate change
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Alternative water supply solutions to recur to	**1**
b) Alternative water storage solutions to recur to	**1**
c) Covered or buried reservoirs	**1**
d) Networked conduits	**1**
e) Renewable energy production equipment	**1**
f) Other (explain in Comments)	**0**
g) None	**0**

PWts41 - Water pump failures in the last relevant event (days)

Number of days system pumps were out of order due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Water
Resilience objective	Water infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days]. This metric depends on the metric FWts48.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PWts42 - Water service mains failures in the last relevant event (No./100 km)

Number of mains failures due to the last climate-related event, with similar or harsher climate variables than the most probable scenario (No./system length (km) x 100 km)

Dimension	Physical
Subdimension	Water
Resilience objective	Water infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [No./100 km] in comments. This metric depends on the metric FWts48.

Development assessment rule	Development
Less than or equal to 30	**3**
More than 30 and less than or equal to 60	**1.5**
More than 60	**0**

PWts43 - Water service connection mains bursts in the last relevant event (No./1000 connections)

Number of water service connections mains bursts due to the last climate-related event, with similar or harsher climate variables than the most probable scenario (No./connections in the system x 1000 connections)

Dimension	Physical
Subdimension	Water
Resilience objective	Water infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [No./1000 connections] in comments. This metric depends on the metric FWts48.

Development assessment rule	Development
Less than or equal to 1,0	**3**
More than 1,0 and less than or equal to 2,5	**1.5**
More than 2,5	**0**

PWts44 - Hydrant bursts in the last relevant event (No./1000 hydrants)

Number of hydrant bursts due to the last climate-related event, with similar or harsher climate variables than the most probable scenario (No./hydrants in the system x 1000 hydrants)

Dimension	Physical
Subdimension	Water
Resilience objective	Water infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [No./1000 hydrants] in comments. This metric depends on the metric FWts48.

Development assessment rule	Development
Less than or equal to 1,0	**3**
More than 1,0 and less than or equal to 2,5	**1.5**
More than 2,5	**0**

PWts45 - Power failures in the last relevant event (days)

Number of days pumping stations were out of service by power supply interruptions due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Water
Resilience objective	Water infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments. This metric depends on the metric FWts48.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PWts46- Water quality compliance in the last relevant event (%)

Percentage of laboratory analysis that were in accordance to legal or regulatory requirements due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Water
Resilience objective	Water infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments. This metric depends on the metric FWts48.

Development assessment rule	Development
More than or equal to 99%	**3**
More than or equal to 97,5% and less than 99%	**1.5**
Less than 97,5%	**0**

PWts47 - Level of failure of critical infrastructure assets in the last relevant event (%)

Percentage of critical infrastructure assets out of order due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Water
Resilience objective	Water infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments. This metric depends on the metric PWts01 and FWts48.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PWts48 - Coverage of expenditure in infrastructure in the last relevant event (%)

Ratio between expenditure on infrastructure affected by the last climate-related event, with similar or harsher climate variables than the most probable scenario and annual operating budget of last year

Dimension	Physical
Subdimension	Water
Resilience objective	Water infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments. This metric depends on the metric FWts48.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PWts49 - Time for restoration in the last relevant event (days)

Maximum out-of-service period for all failures in infrastructure, including recovery time, due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Water
Resilience objective	Water infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [days] in comments. This metric depends on the metric FWts48.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PHYSICAL

WASTEWATER

PI code	PI name	Unit*

PWwt01 - Wastewater infrastructure critical assets (-)

Are the critical infrastructure assets for service provision identified?

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Service provision includes collection and treatment. This metric conditions the metrics PWwt02, PWwt03, PWwt04, PWwt35 and PWwt46.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

PWwt02 - Component importance (-)

The identification of infrastructure critical assets is based in the following:

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. Please select one or more of the options provided as answers. Sum of the selected answers and a scale to 3 is made. This metric depends on the metric PWwt01.

Development assessment rule	Development
a) Population served	**1**
b) Associated sensitive customers	**1**
c) Location	**1**
d) High dependence on other services infrastructures	**1**
e) Other services infrastructure highly depend on wastewater infrastructure	**1**
f) Other (e.g. type of receiving bodies, explain in Comments)	**1**
g) None	**0**

* (-) without unit or dimensionless

PWwt03 - Wastewater infrastructure critical assets mapping, review and update (-)

Are the infrastructure critical assets identified on hazard maps and included in data on risk?

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please specify how often this maps are reviewed and updated, and the data of the last update, in comments. This metric depends on the metric PWwt01.

Development assessment rule	Development
Yes	**3**
Partially, not covering the all the hazards or all the infrastructure	**1.5**
No	**0**

PWwt04 - Exchange of information (-)

Is there a regular exchange of information regarding infrastructure critical assets, hazard maps and data on risk with the city?

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric PWwt01.

Development assessment rule	Development
Yes, exchange of information from both sides	**3**
The service is informed by the city	**2**
The city is informed by the service	**1**
No exchange	**0**

PWwt05 - Protective buffers mapping and information to the city (-)

Have protective buffers to safeguard infrastructure assets been defined, are they clearly identified on hazard maps and data on risk and is the city informed?

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Protecticve buffers are spatial delimited areas surrounding the infrastructure where activities are restricted to protect the strcutural integrity of the assets.

Development assessment rule	Development
Yes	**3**
Partially, or with a time horizon longer than 10 years	**1.5**
No	**0**

PWwt06 - Codes and standards for infrastructure (-)

Do codes or standards for infrastructure design and construction exist and are these implemented?

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Yes but only applied to infrastructure built at least in the last 10 years	**2**
Only recent use / existence of relevant codes and standards	**1**
No	**0**

PWwt07 - Maintenance of infrastructure (-)

Is infrastructure maintained on a regular basis (according to a preventive maintenance plan), resources for corrective maintenance are assured and all maintenance information is continuously registered?

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please specify which infrastructure are being maintained (treatment, collection or both).

Development assessment rule	Development
Yes	**3**
Just in some cases or registration is not fully assured	**2**
Preventive maintenance is not in place or corrective maintenance is not effective and efficient	**1**
Maintenance is not in place	**0**

PWwt08 - Wastewater pump failures last year (days)

Average number of days that system pumps were out of order last year (for all system pumps)

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets robustness
Source	ERSAR 1G AR14 (adapted)
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PWwt09 - Wastewater sewer pipe collapses last year (No./100 km)

Relative number of collapses in wastewater sewers last year (No./system length (km) x 100 km)

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets robustness
Source	ERSAR 3G AR08
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [No./100 km] in comments.

Development assessment rule	Development
Equal to 0	**3**
More than 0 and less than or equal to 2	**1.5**
More than 2	**0**

PWwt10 - Wastewater connection collapses last year (No./1000 connections)

Number of collapses in wastewater connections last year (No./connections in the system x 1000 connections)

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [No./1000 connections] in comments.

Development assessment rule	Development
Less than or equal to 1,0	**3**
More than 1,0 and less than or equal to 2,5	**1.5**
More than 2,5	**0**

PWwt11 - Power failures last year (days)

Average number of days pumping stations were out of service due to power supply interruptions last year (for all system pumps)

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PWwt12 - Combined sewer overflows last year (CSO discharges/total CSO devices)

Average number of combined sewer overflows last year (for all CSO devices in the system)

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Number of combined overflow discharges/total CSO devices.

Development assessment rule	Development
Less than or equal to 6	**3**
More than 6 and less than or equal to 10	**2**
More than 10 and less than or equal to 30	**1**
More than 30	**0**

PWwt13 - Wastewater quality last year (%)

Percentage of performed laboratory analysis that were in accordance to legal or regulatory requirements last year

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets robustness
Source	ERSAR 2G 14ab
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Equal to 100%	**3**
More than or equal to 95% and less than 100%	**1.5**
Less than 95%	**0**

PWwt14 - Level of failure of critical infrastructure assets last year (%)

Percentage of critical infrastructure assets out of order last year

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please specify which critical infrastructure assets are included (treatment, collection or both). Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PWwt15 - Coverage of expenditure in infrastructure last year (-)

Ratio between expenditure with rehabilitation, operation and management of infrastructure and annual operating budget of last year

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

Compares the expenditure (regarding rehabilitation, operation and asset management activities) with the available budget (for the same activities). Please answer with an estimated figure [-] in comments.

Development assessment rule	Development
More than or equal to 1,0 and less than or equal to 1,1	**3**
More than or equal to 0,9 and less than 1,0 or more than 1,1 and less than or equal to 1,2	**1.5**
Less than 0,9 or more than 1,2	**0**

PWwt16 - Time for restoration last year (days)

Maximum out-of-service period for all failures in infrastructure, including recovery time, last year

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

For treatment and distribution. Refers to structural failures on the assets, both having service interruption as a consequence or not. Does not refer to assets that have been decomissioned. Please answer with an estimated figures for treatment and distribution [days].

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PWwt17 - Real undue inflows into the wastewater infrastructure (m3/(km.day))

Volume of real physical undue inflows into the wastewater infrastructure, through joints, damaged pipes or wrong connections

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Less or equal to 10	**3**
More than 10 and less than 80	**2**
More or equal to 80 and less than 150	**1**
More than or equal to 150	**0**

PWwt18 - Energy efficiency in pumping stations (kWh/m3.100m)

Average normalized energy consumption in PS - pumping stations = (Total energy consumption for pumping / sum (Wastewater volume in PS i x Manometric pressure head i / 100)

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets robustness
Source	ERSAR 3G AR10
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [kWh/m^3.100m] in comments.

Development assessment rule	Development
More than or equal to 0,27 and less than or equal to 0,45	**3**
More than 0,45 and less than or equal to 0,68	**1.5**
More than 0,68	**0**

PWwt19 - Pollution prevention (% appropriate sludge disposal)

Percentage of sludge from wastewater treatment with appropriate final disposal

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Safe wastewater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Equal to 100%	**3**
More than or equal to 95% and less than 100%	**1.5**
Less than 95%	**0**

Metric PWwt20 - Cascading impacts (-)

There is knowledge concerning potentially cascading failures between the components of the infrastructure and the following infrastructure, under the agreed scenarios:

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Autonomous and flexible wastewater infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum≥3 =3; Sum≥2 and <3 =2; Sum≥1 and <2 =1 Sum<1 =0). This metric depends on the metric FWwt45.

Development assessment rule	Development
a) Other infrastructure of the wastewater service	**1**
b) Infrastructure of the water service	**1**
c) Infrastructure of the stormwater service	**1**
d) Infrastructure of the solid waste service	**1**
e) Infrastructure of the energy service	**1**
f) Infrastructure of the mobility service	**1**
g) Other (explain in Comments)	**1**
h) None	**0**

PWwt21 - Infrastructure of other services dependency on wastewater infrastructure (-)

The infrastructure of the following services are dependent on wastewater infrastructure:

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Autonomous and flexible wastewater infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum<2 =3; Sum≥2 and <3 =2; Sum≥3 and <4 =1.5 Sum≥4 =0).

Development assessment rule	Development
a) Infrastructure of the water service	**1**
b) Infrastructure of the stormwater service	**1**
c) Infrastructure of the solid waste service	**1**
d) Infrastructure of the energy service	**1**
e) Infrastructure of the mobility service	**1**
f) Other (explain in Comments)	**1**
g) None	**0**

PWwt22 - Dependency on infrastructures of other services (-)

The infrastructure of the wastewater service directly depends on the infrastructure of the following services:

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Autonomous and flexible wastewater infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum<2 =3; Sum≥2 and <3 =2; Sum≥3 and <4 =1.5 Sum≥4 =0).

Development assessment rule	Development
a) Infrastructure of the water service	**1**
b) Infrastructure of the stormwater service	**1**
c) Infrastructure of the solid waste service	**1**
d) Infrastructure of the energy service	**1**
e) Infrastructure of the mobility service	**1**
f) Other (e.g. gas, fuel, telecommunication, explain in Comments)	**1**
g) None	**0**

PWwt23 - Level of dependency (% customers affected)

Percentage of customers affected by infrastructure dependent on other services

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Autonomous and flexible wastewater infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less than or equal to 10%	**3**
More than 10% and less than or equal to 20%	**1.5**
More than 20%	**0**

PWwt24 - Autonomy from infrastructures of other services (% infrastructure)

Percentage of infrastructure directly dependent on other services that have an autonomy solution managed by the wastewater service

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Autonomous and flexible wastewater infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

First, analyse what infrastructure depends on other services (e.g pumping stations depend on electricity). After, from this subset identify which percentage has self-autonomy (e.g., the pumping station might have a generator).Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More than or equal to 80%	**3**
More than or equal to 70% and less than 80%	**1.5**
Less than 70%	**0**

PWwt25 - Level of autonomy (% customers covered)

Percentage of customers covered by infrastructure dependent on other services that benefit from autonomy solutions (i.e. customers that benefit/customers affected)

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Autonomous and flexible wastewater infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Disaggregating into households, critical facilities/services and other services, if possible, in comments. Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More than or equal to 80%	**3**
More than or equal to 70% and less than 80%	**1.5**
Less than 70%	**0**

PWwt26 - Autonomy activation (-)

How is infrastructure autonomy activated? Specify the time required to activate it, if possible

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Autonomous and flexible wastewater infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. The development is obtained throught 4 conditions: If c) is the only selected answer =3; If c) is not selected but b) is selected =2; If c) and b) are not selected but a) is selected =1.5; if the only selected answer is e) = 0.

Development assessment rule	Development
a) Manual operation	**1**
b) Remote operation	**1**
c) Automatic operation	**1**
d) Other (explain in Comments)	**1**
e) None	**0**

PWwt27 - Autonomy period (days)

Weighted average of autonomy period (Ti) of each dependent infrastructure (i) i.e. Sum (Ti x level of autonomy i)

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Autonomous and flexible wastewater infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
More than or equal to 2	**3**
More than or equal to 1.5 and less than 2	**2**
More than or equal to 1 and less than 1.5	**1**
Less than 1	**0**

PWwt28 - Energy self production (%)

Percentage of energy consumption coming from self production

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Autonomous and flexible wastewater infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More than or equal to 30%	**3**
More than or equal to 15% and less than 30%	**2**
More than or equal to 5% and less than 15%	**1**
Less than 5%	**0**

PWwt29 - Redundancy (-)

Is there an understanding of infrastructure redundancy, clearly identified on hazard maps and data on risk?

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Autonomous and flexible wastewater infrastructure
Criteria	Infrastructure assets redundancy
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

PWwt30 - Redundancy activation (-)

How is infrastructure redundancy activated? Specify the time required to activate it, if possible

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Autonomous and flexible wastewater infrastructure
Criteria	Infrastructure assets redundancy
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. The development is obtained throught 4 conditions: If c) or d) are selected =3; If c) is not selected but b) is selected =2; If c) and b) are not selected but a) is selected =1.5; if the only selected answer is e) = 0.

Development assessment rule	Development
a) Manual operation	**1**
b) Remote operation	**1**
c) Automatic operation	**1**
d) No operation required	**1**
e) Other (explain in Comments)	**1**
f) None	**0**

PWwt31 - Level of redundancy (% customers covered)

Percentage of customers covered by redundant infrastructure, i.e., with alternative infrastructure able to provide the service

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Autonomous and flexible wastewater infrastructure
Criteria	Infrastructure assets redundancy
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Disaggregating into households, critical facilities/services and other services, if possible. Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Equal to 100%	**3**
More than or equal 90% and less than 100%	**2**
More than or equal 80% and less than 90%	**1**
Less than 80%	**0**

PWwt32 - Use of design solutions to improve city resilience (-)

The design of the infrastructure incorporate the use of the following solutions to improve city resilience:

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Wastewater infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

Design solutions that contribute to the city's resilience that are not a direct component of the infrastructure that provides the service. E.g., any entity in its office buildings may have green roofs or porous floors in the parking lot. Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum≥3 =3; Sum≥2 and <3 =2; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Soakaways and porous pavement	**1**
b) Underground parking garages used as holding tanks for storm water	**1**
c) Parks that function as flood zones	**1**
d) Green roofs	**1**
e) Renewable energy generation	**1**
f) Water reuse and recycling	**1**
g) Other (explain in Comments)	**1**
h) None	**0**

PWwt33 - Greenhouse gas emission target (-)

Contribution to greenhouse gas emission reduction

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Wastewater infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Infrastructure operation	**1**
b) Fleet	**1**
c) Administrative buildings	**1**
d) Other (explain in Comments)	**0**
e) None	**0**

PWwt34 - Other contributions to city resilience (-)

The wastewater infrastructure and related services provide other contributions to city resilience in emergency situation, such as:

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Wastewater infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Shelter	**1**
b) Medical services	**1**
c) First aid	**1**
d) Food storage	**1**
e) Food cooking and supply	**1**
f) Energy supply	**1**
g) Fuel supply	**1**
h) Emergency transport vehicles	**1**
i) Escape routes	**1**
j) Water storage	**1**
k) Other (e.g. standby generators feeding into electricity supply grid, vehicles and personnel to support emergency services, explain in Comments)	**1**
l) None	**0**

PWwt35 - Level of exposure of critical infrastructure assets to the most probable scenario (-)

Identify the critical infrastructure assets for which less than 10% is exposed to different hazards for climate change scenarios

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Wastewater infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥3 =3; Sum≥2 and <3 =1; Sum<2 =0). This metric depends on the metric PWwt01 and FWwt45.

Development assessment rule	Development
a) Wastewater mains	**1**
b) Wastewater connections	**1**
c) Pumping stations	**1**
d) Wastewater treatment plants	**1**
e) Pumping station exposure to power failure	**1**
f) Other (explain in Comments)	**0**
g) None	**0**

PWwt36 - Coverage of expenditure in infrastructure for most probable scenario (%)

Ratio between predicted expenditure on infrastructure affected by climate change scenarios and annual operating budget of last year

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Wastewater infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please answer with an estimated figure [%] in comments. This metric depends on the metric FWwt45.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PWwt37 - Time for restoration for most probable scenario (days)

Maximum out-of-service period predicted for all failures in infrastructure, including recovery time, due to different hazards for climate change scenarios

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Wastewater infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

This metric depends on the metric FWwt45.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PWwt38 - Implemented infrastructural measures to address climate change mitigation and adaptation (-)

What type of measures were implemented in infrastructure design to address climate change mitigation and adaptation?

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Wastewater infrastructure preparedness
Criteria	Preparedness for climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Alternative wastewater treatment solutions to recur to	**1**
b) Separate systems	**1**
c) Enhance storage to reduce combined sewer overflows	**1**
d) Real time control	**1**
e) Reuse greywater	**1**
f) Trap fats, oils and grease at source	**1**
g) Rain harvesting, for combined systems	**1**
h) Actions to reduce undue inflows from buildings and public places	**1**
i) Renewable energy production equipment	**1**
j) Other (explain in Comments)	**0**

PWwt39 - Planned infrastructural measures to address climate change mitigation and adaptation (-)

What type of measures are being planned in infrastructure design to address climate change mitigation and adaptation?

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Wastewater infrastructure preparedness
Criteria	Preparedness for climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1.5; Sum<1 =0).

Development assessment rule	Development
a) Alternative wastewater treatment solutions to recur to	**1**
b) Separate systems	**1**
c) Enhance storage to reduce combined sewer overflows	**1**
d) Real time control	**1**
e) Reuse greywater	**1**
f) Trap fats, oils and grease at source	**1**
g) Rain harvesting, for combined systems	**1**
h) Actions to reduce undue inflows from buildings and public places	**1**
i) Renewable energy production equipment	**1**
j) Other (explain in Comments)	**0**

PWwt40 - Wastewater pump failures in the last relevant event (days)

Number of days system pumps were out of order due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Wastewater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FWwt45.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PWwt41 - Wastewater sewer pipe collapses in the last relevant event (No./100km)

Number of collapses in wastewater sewers due to the last climate-related event, with similar or harsher climate variables than the most probable scenario (No./system length (km) x 100 km)

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Wastewater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [No./100km] in comments. This metric depends on the metric FWwt45.

Development assessment rule	Development
Equal to 0	**3**
More than 0 and less than or equal to 2	**1.5**
More than 2	**0**

PWwt42 - Wastewater connection collapses in the last relevant event (No./100km)

Number of collapses in wastewater connections due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Wastewater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FWwt45.

Development assessment rule	Development
Less than or equal to 1,0	**3**
More than 1,0 and less than or equal to 2,5	**1.5**
More than 2,5	**0**

PWwt43 - Combined sewer overflows in the last relevant event (CSO discharges/total CSO devices)

Number of combined sewer overflows in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Wastewater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Number of combined overflow discharges/total CSO devices. This metric depends on the metric FWwt45.

Development assessment rule	Development
Less than or equal to 6	**3**
More than 6 and less than or equal to 10	**2**
More than 10 and less than or equal to 30	**1**
More than 30	**0**

PWwt44 - Power failures in the last relevant event (days)

Number of days pumping stations were out of service by power supply interruptions due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Wastewater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FWwt45.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PWwt45 - Wastewater quality compliance in the last relevant event (%)

Percentage of laboratory analysis that were in accordance to legal or regulatory requirements due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Wastewater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FWwt45.

Development assessment rule	Development
Equal to 100%	**3**
More than or equal to 95% and less than 100%	**1.5**
Less than 95%	**0**

PWwt46 - Level of failure of critical infrastructure assets in the last relevant event (%)

Percentage of critical infrastructure assets out of order due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Wastewater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric PWwt01 and FWwt45.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PWwt47 - Coverage of expenditure in infrastructure in the last relevant event (%)

Ratio between expenditure on infrastructure affected by the last climate-related event, with similar or harsher climate variables than the most probable scenario and annual operating budget of last year

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Wastewater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FWwt45.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PWwt48 - Time for restoration in the last relevant event (days)

Maximum out-of-service period for all failures in infrastructure, including recovery time, due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Wastewater
Resilience objective	Wastewater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FWwt45.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PHYSICAL

STORMWATER

PI code	PI name	Unit*

PSwt01 - Stormwater infrastructure critical assets (-)

Are the critical infrastructure assets for service provision identified?

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Service provision includes collection and treatment. This metric conditions the metrics PSwt02, PSwt03, PSwt04, PSwt35 and PSwt46.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

PSwt02 - Component importance (-)

The identification of infrastructure critical assets is based in the following:

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. Please select one or more of the options provided as answers. Sum of the selected answers and a scale to 3 is made. This metric depends on the metric PSwt01.

Development assessment rule	Development
a) Population served	**1**
b) Associated sensitive customers	**1**
c) Location	**1**
d) High dependence on other services infrastructures	**1**
e) Other services infrastructure highly depend on stormwater infrastructure	**1**
f) Other (e.g. type of receiving bodies, explain in Comments)	**1**
g) None	**0**

* (-) without unit or dimensionless

PSwt03 - Stormwater infrastructure critical assets mapping, review and update (-)

Are the infrastructure critical assets identified on hazard maps and included in data on risk?

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please specify how often this maps are reviewed and updated, and the data of the last update, in comments. This metric depends on the metric PSwt01.

Development assessment rule	Development
Yes	**3**
Partially, not covering the all the hazards or all the infrastructure	**1.5**
No	**0**

PSwt04- Exchange of information (-)

Is there a regular exchange of information regarding infrastructure critical assets, hazard maps and data on risk with the city?

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric PSwt01.

Development assessment rule	Development
Yes, exchange of information from both sides	**3**
The service is informed by the city	**2**
The city is informed by the service	**1**
No exchange	**0**

PSwt05 - Protective buffers mapping and information to the city (-)

Have protective buffers to safeguard infrastructure assets been defined, are they clearly identified on hazard maps and data on risk and is the city informed?

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Protecticve buffers are spatial delimited areas surrounding the infrastructure where activities are restricted to protect the strcutural integrity of the assets.

Development assessment rule	Development
Yes	**3**
Partially, or with a time horizon longer than 10 years	**1.5**
No	**0**

PSwt06 - Codes and standards for infrastructure (-)

Do codes or standards for infrastructure design and construction exist and are these implemented?

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Yes but only applied to infrastructure built at least in the last 10 years	**2**
Only recent use/existence of relevant codes and standards	**1**
No	**0**

PSwt07 - Maintenance of infrastructure (-)

Is infrastructure maintained on a regular basis (according to a preventive maintenance plan), resources for corrective maintenance are assured and all maintenance information is continuously registered?

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please specify which infrastructure are being maintained (treatment, collection or both).

Development assessment rule	Development
Yes	**3**
Just in some cases or registration is not fully assured	**2**
Preventive maintenance is not in place or corrective maintenance is not effective and efficient	**1**
Maintenance is not in place	**0**

PSwt08 - Stormwater pump failures last year (days)

Average number of days that system pumps were out of order last year (for all system pumps)

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PSwt09 - Stormwater sewer pipe collapses last year (No./100 km)

Relative number of pipe collapses last year (No./system length (km) x 100 km)

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [No./100 km] in comments.

Development assessment rule	Development
Equal to 0	**3**
More than 0 and less than or equal to 2	**1.5**
More than 2	**0**

PSwt10 - Stormwater connection collapses last year (No./1000 connections)

Number of collapses in stormwater connections last year (No./connections in the system x 1000 connections)

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [No./1000 connections] in comments.

Development assessment rule	Development
Less than or equal to 1,0	**3**
More than 1,0 and less than or equal to 2,5	**1.5**
More than 2,5	**0**

PSwt11 - Inlet failures last year (No./1000 inlets)

Average number of Inlet failures last year (No./inlets in the system x 1000 inlets)

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Inlet (or gully) failure relates to any occurrence due to which the inlet was damaged and may not continue to provide service without previous repair. Please answer with an estimated figure [No./1000 inlets] in comments.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1,0 and less than or equal to 2,5	**1.5**
More than 2,5	**0**

PSwt12 - Power failures last year (days)

Average number of days pumping stations were out of service due to power supply interruptions last year (for all system pumps)

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PSwt13 - Stormwater quality last year (%)

Percentage of performed laboratory analysis that were in accordance to legal or regulatory requirements last year (%)

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Equal to 100%	**3**
More than or equal to 95% and less than 100%	**1.5**
Less than 95%	**0**

PSwt14 - Level of failure of critical infrastructure assets last year (%)

Percentage of critical infrastructure assets out of order last year

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please specify which critical infrastructure assets are included (treatment, collection or both). Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PSwt15 - Coverage of expenditure in infrastructure last year (-)

Ratio between expenditure with rehabilitation, operation and management of infrastructure and annual operating budget of last year

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

Compares the expenditure (regarding rehabilitation, operation and asset management activities) with the available budget (for the same activities). Please answer with an estimated figure [-] in comments.

Development assessment rule	Development
More than or equal to 1,0 and less than or equal to 1,1	**3**
More than or equal to 0,9 and less than 1,0 or more than 1,1 and less than or equal to 1,2	**1.5**
Less than 0,9 or more than 1,2	**0**

PSwt16 - Time for restoration last year (days)

Maximum out-of-service period for all failures in infrastructure, including recovery time, last year

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Refers to structural failures on the assets, both having service interruption as a consequence or not. Does not refer to assets that have been decomissioned. Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PSwt17 - Real undue inflows into the stormwater infrastructure (m^3/(km.day))

Volume of real physical undue inflows into the stormwater infrastructure (e.g. soil, wastewater, industrial, saline, water supply inflows), through joints, damaged pipes or wrong connections

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Less or equal to 0.5 m^3 of undue inflows	**3**
More than 0.5 and less than 5 m^3 of undue inflows	**2**
More or equal to 5 and less than 10 m^3 of undue inflows	**1**
More than or equal to 10 m^3 of undue inflows	**0**

PSwt18 - Energy efficiency in pumping stations (kWh/m3.100m)

Average normalized energy consumption in PS - pumping stations = (Total energy consumption for pumping / sum (Wastewater volume in PS i x Manometric pressure head i / 100)

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure in comments.

Development assessment rule	Development
More than or equal to 0,27 and less than or equal to 0,45	**3**
More than 0,45 and less than or equal to 0,68	**1.5**
More than 0,68	**0**

PSwt19 - Pollution prevention (% appropriate sludge disposal)

Percentage of sludge from stormwater treatment with appropriate final disposal

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Safe stormwater infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Equal to 100%	**3**
More than or equal to 95% and less than 100%	**1.5**
Less than 95%	**0**

PSwt20 - Cascading impacts (-)

There is knowledge concerning potentially cascading failures between the components of the infrastructure and the following infrastructure, under the agreed scenarios:

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Autonomous and flexible stormwater infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum≥3 =3; Sum≥2 and <3 =2; Sum≥1 and <2 =1 Sum<1 =0). This metric depends on the metric FSwt38.

Development assessment rule	Development
a) Other infrastructure of the stormwater service	**1**
b) Infrastructure of the wastewater service	**1**
c) Infrastructure of the water service	**1**
d) Infrastructure of the solid waste service	**1**
e) Infrastructure of the energy service	**1**
f) Infrastructure of the mobility service	**1**
g) Other (explain in Comments)	**1**

h) None	**0**

PSwt21 - Infrastructure of other services dependency on stormwater infrastructure (-)

The infrastructure of the following services are dependent on stormwater infrastructure:

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Autonomous and flexible stormwater infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum<2 =3; Sum≥2 and <3 =2; Sum≥3 and <4 =1.5 Sum≥4 =0).

Development assessment rule	Development
a) Infrastructure of the water service	**1**
b) Infrastructure of the wastewater service	**1**
c) Infrastructure of the solid waste service	**1**
d) Infrastructure of the energy service	**1**
e) Infrastructure of the mobility service	**1**
f) Other (explain in Comments)	**1**
g) None	**0**

PSwt22 - Dependency on infrastructures of other services (-)

The infrastructure of the stormwater service directly depends on the infrastructure of the following services:

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Autonomous and flexible stormwater infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum<2 =3; Sum≥2 and <3 =2; Sum≥3 and <4 =1.5 Sum≥4 =0).

Development assessment rule	Development
a) Infrastructure of the water service	**1**
b) Infrastructure of the wastewater service	**1**
c) Infrastructure of the solid waste service	**1**
d) Infrastructure of the energy service	**1**
e) Infrastructure of the mobility service	**1**
f) Other (e.g. gas, fuel, telecommunication, explain in Comments)	**1**
g) None	**0**

PSwt23 - Level of dependency (% of customers affected)

Percentage of customers affected by infrastructure dependent on other services

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Autonomous and flexible stormwater infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less than or equal to 10%	**3**
More than 10% and less than or equal to 20%	**1.5**
More than 20%	**0**

PSwt24 - Autonomy from infrastructures of other services (% infrastructure)

Percentage of infrastructure directly dependent on other services that have an autonomy solution managed by the stormwater service

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Autonomous and flexible stormwater infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

First, analyse what infrastructure depends on other services (e.g pumping stations depend on electricity). After, from this subset identify which percentage has self-autonomy (e.g., the pumping station might have a generator).Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More than or equal to 80%	**3**
More than or equal to 70% and less than 80%	**1.5**
Less than 70%	**0**

PSwt25 - Level of autonomy (% customers covered)

Percentage of customers covered by infrastructure dependent on other services that benefit from autonomy solutions (i.e. customers that benefit/customers affected)

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Autonomous and flexible stormwater infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Disaggregating into households, critical facilities/services and other services, if possible, in comments. Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More than or equal to 80%	**3**
More than or equal to 70% and less than 80%	**1.5**
Less than 70%	**0**

PSwt26 - Autonomy activation (-)

How is infrastructure autonomy activated? Specify the time required to activate it, if possible

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Autonomous and flexible stormwater infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. The development is obtained throught 4 conditions: If c) is the only selected answer =3; If c) is not selected but b) is selected =2; If c) and b) are not selected but a) is selected =1.5; if the only selected answer is e) = 0.

Development assessment rule	Development
a) Manual operation	**1**
b) Remote operation	**1**
c) Automatic operation	**1**
d) Other (explain in Comments)	**1**
e) None	**0**

PSwt27 - Autonomy period (days)

Weighted average of autonomy period (Ti) of each dependent infrastructure (i) i.e. Sum (Ti x level of autonomy i)

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Autonomous and flexible stormwater infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
More than or equal to 2	**3**
More than or equal to 1.5 and less than 2	**2**
More than or equal to 1 and less than 1.5	**1**
Less than 1	**0**

PSwt28 - Capacity for zero floods (years)

Based on the historical data, estimative of the maximum return period without city-wide flood ensured by the existing stormwater infrastructure

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Autonomous and flexible stormwater infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
More than or equal to 20	**3**
More than or equal to 10 and less than 20	**2**
More than or equal to 2 and less than 10	**1**
Less than 2	**0**

PSwt29 - Energy self production (%)

Percentage of energy consumption coming from self production

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Autonomous and flexible stormwater infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
More than or equal to 30%	**3**
More than or equal to 15% and less than 30%	**2**
More than or equal to 5% and less than 15%	**1**
Less than 5%	**0**

PSwt30 - Redundancy (-)

Is there an understanding of infrastructure redundancy, clearly identified on hazard maps and data on risk?

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Autonomous and flexible stormwater infrastructure
Criteria	Infrastructure assets redundancy
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

PSwt31 - Redundancy activation (-)

How is infrastructure redundancy activated? Specify the time required to activate it, if possible

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Autonomous and flexible stormwater infrastructure
Criteria	Infrastructure assets redundancy
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. The development is obtained throught 4 conditions: If c) or d) are selected =3; If c) is not selected but b) is selected =2; If c) and b) are not selected but a) is selected =1.5; if the only selected answer is e) = 0.

Development assessment rule	Development
a) Manual operation	**1**
b) Remote operation	**1**
c) Automatic operation	**1**
d) No operation required	**1**
e) Other (explain in Comments)	**1**
f) None	**0**

PSwt32 - Use of design solutions to improve city resilience (-)

The design of the infrastructure incorporates the use of the following solutions to improve city resilience:

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Stormwater infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum≥3 =3; Sum≥2 and <3 =2; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Soakaways and porous pavement	**1**
b) Underground parking garages used as holding tanks for storm water	**1**
c) Parks that function as flood zones	**1**
d) Green roofs	**1**
e) Renewable energy generation	**1**
f) Other (e.g. green areas, explain in Comments)	**1**
g) None	**0**

PSwt33 - Greenhouse gas emission target (-)

Contribution to greenhouse gas emission reduction

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Stormwater infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Infrastructure operation	**1**
b) Fleet	**1**
c) Administrative buildings	**1**
d) Other (explain in Comments)	**0**
e) None	**0**

PSwt34 - Other contributions to city resilience (-)

The stormwater infrastructure and related services provide other contributions to city resilience in emergency situation, such as:

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Stormwater infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Shelter	**1**
b) Medical services	**1**
c) First aid	**1**
d) Food storage	**1**
e) Food cooking and supply	**1**
f) Energy supply	**1**
g) Fuel supply	**1**
h) Emergency transport vehicles	**1**
i) Escape routes	**1**
j) Water storage	**1**
k) Other (e.g. vehicles and personnel to support emergency services, explain in Comments)	**1**
l) None	**0**

PSwt35 - Level of exposure of critical infrastructure assets to the most probable scenario (-)

Identify the critical infrastructure assets for which less than 10% is exposed to different hazards for climate change scenarios

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Stormwater infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥3 =3; Sum≥2 and <3 =1; Sum<2 =0). This metric depends on the metric PSwt01 and FSwt38.

Development assessment rule	Development
a) Stormwater mains	**1**
b) Stormwater connections	**1**
c) Inlets	**1**
d) Stormwater treatment plants/facilities	**1**
e) Combined sewer overflows (CSO)	**1**
f) Other (explain in Comments)	**0**
g) None	**0**

PSwt36 - Coverage of expenditure in infrastructure for most probable scenario (%)

Ratio between predicted expenditure on infrastructure affected by climate change scenarios and annual operating budget of last year

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Stormwater infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSwt38.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PSwt37 - Time for restoration for most probable scenario (days)

Maximum out-of-service period predicted for all failures in infrastructure, including recovery time, due to different hazards for climate change scenarios

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Stormwater infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

This metric depends on the metric FSwt38.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PSwt38 - Implemented infrastructural measures to address climate change mitigation and adaptation (-)

What type of measures were implemented in infrastructure design to address climate change mitigation and adaptation?

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Stormwater infrastructure preparedness
Criteria	Preparedness for climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Decentralized stormwater outlets	**1**
b) Reuse stormwater	**1**
c) Use of SUDS/LIDS/NBS components (please specify in Comments)	**1**
d) Enhance storage to reduce combined sewer overflows	**1**
e) In-sewer or underground storage management	**1**
f) Real time control	**1**
g) Renewable energy production equipment	**1**
h) Other (explain in Comments)	**0**
j) None	**0**

PSwt39 - Planned infrastructural measures to address climate change mitigation and adaptation (-)

What type of measures are being planned in infrastructure design to address climate change mitigation and adaptation?

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Stormwater infrastructure preparedness
Criteria	Preparedness for climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1.5; Sum<1 =0).

Development assessment rule	Development
a) Decentralized stormwater outlets	**1**
b) Reuse stormwater	**1**
c) Use of SUDS/LIDS/NBS components (please specify in Comments)	**1**
d) Enhance storage to reduce combined sewer overflows	**1**
e) In-sewer or underground storage management	**1**
f) Real time control	**1**
g) Renewable energy production equipment	**1**
h) Other (explain in Comments)	**0**
j) None	**0**

PSwt40 - Stormwater pump failures in the last relevant event (days)

Number of days system pumps were out of order due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Stormwater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FSwt38.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PSwt41 - Stormwater sewer pipe collapses in the last relevant event (No./100 km)

Number of collapses in stormwater sewers due to the last climate-related event, with similar or harsher climate variables than the most probable scenario (No./system length (km) x 100 km)

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Stormwater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FSwt38.

Development assessment rule	Development
Equal to 0	**3**
More than 0 and less than or equal to 2	**1.5**
More than 2	**0**

PSwt42 - Stormwater connection collapses in the last relevant event (No./1000 connections)

Number of collapses in stormwater connections due to the last climate-related event, with similar or harsher climate variables than the most probable scenario (No./connections in the system x 1000 connections)

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Stormwater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FSwt38.

Development assessment rule	Development
Less than or equal to 1.0	**3**
More than 1.0 and less than or equal to 2.5	**1.5**
More than 2.5	**0**

PSwt43 - Inlets failures in the last relevant event (No./1000 inlets)

Number of inlets failures due to the last climate-related event, with similar or harsher climate variables than the most probable scenario (No./inlets in the system x 1000 inlets)

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Stormwater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FSwt38.

Development assessment rule	Development
Less than or equal to 1.0	**3**
More than 1.0 and less than or equal to 2.5	**1.5**
More than 2.5	**0**

PSwt44 - Power failures in the last relevant event (days)

Number of days pumping stations were out of service by power supply interruptions due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Stormwater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FSwt38.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PSwt45 - Stormwater quality compliance in the last relevant event (%)

Percentage of laboratory analysis that were in accordance to legal or regulatory requirements due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Stormwater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FSwt38.

Development assessment rule	Development
Equal to 100%	**3**
More than or equal to 95% and less than 100%	**1.5**
Less than 95%	**0**

PSwt46 - Level of failure of critical infrastructure assets in the last relevant event (%)

Percentage of critical infrastructure assets out of order due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Stormwater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric PSwt01 and FSwt38.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PSwt47 - Coverage of expenditure in infrastructure in the last relevant event (%)

Ratio between expenditure on infrastructure affected by the last climate-related event, with similar or harsher climate variables than the most probable scenario and annual operating budget of last year

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Stormwater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSwt38.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PSwt48 - Time for restoration in the last relevant event (days)

Maximum out-of-service period for all failures in infrastructure, including recovery time, due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Stormwater
Resilience objective	Stormwater infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSwt38.

Development assessment rule	Development
Less than or equal to 1	**3**
More than 1 and less than or equal to 3	**2**
More than 3 and less than or equal to 6	**1**
More than 6	**0**

PHYSICAL

WASTE

PI code	PI name	Unit*

PSlw01 - Waste infrastructure critical assets (-)

Are the critical infrastructure assets for service provision identified?

Dimension	Physical
Subdimension	Waste
Resilience objective	Safe waste infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Service provision includes collection and treatment. This metric conditions the metrics PSlw02, PSlw03, PSlw04, PSlw35 and PSlw46.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

PSlw02 - Component importance (-)

The identification of infrastructure critical assets is based in the following:

Dimension	Physical
Subdimension	Waste
Resilience objective	Safe waste infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. Please select one or more of the options provided as answers. Sum of the selected answers and a scale to 3 is made. This metric depends on the metric PSlw01.

Development assessment rule	Development
a) Population served	**1**
b) Associated sensitive customers	**1**
c) Location	**1**
d) High dependence on other services infrastructures	**1**
e) Other services infrastructure highly depend on waste infrastructure	**1**
f) Other (explain in Comments)	**1**
g) None	**0**

* (-) without unit or dimensionless

PSlw03 - Waste infrastructure critical assets mapping, review and update (-)

Are the infrastructure critical assets identified on hazard maps and included in data on risk?

Dimension	Physical
Subdimension	Waste
Resilience objective	Safe waste infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please specify how often this maps are reviewed and updated, and the data of the last update, in comments. This metric depends on the metric PSlw01.

Development assessment rule	Development
Yes	**3**
Partially, not covering the all the hazards or all the infrastructure	**1.5**
No	**0**

PSlw04 - Exchange of information (-)

Is there a regular exchange of information regarding infrastructure critical assets, hazard maps and data on risk with the city?

Dimension	Physical
Subdimension	Waste
Resilience objective	Safe waste infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric PSlw01.

Development assessment rule	Development
Yes, exchange of information from both sides	**3**
The service is informed by the city	**2**
The city is informed by the service	**1**
No exchange	**0**

PSlw05 - Protective buffers mapping and information to the city (-)

Have protective buffers to safeguard infrastructure assets been defined, are they clearly identified on hazard maps and data on risk and is the city informed?

Dimension	Physical
Subdimension	Waste
Resilience objective	Safe waste infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Protecticve buffers are spatial delimited areas surrounding the infrastructure where activities are restricted to protect the strcutural integrity of the assets.

Development assessment rule	Development
Yes	**3**
Partially, or with a time horizon longer than 10 years	**1.5**
No	**0**

PSlw06 - Codes and standards for infrastructure (-)

Do codes or standards for infrastructure design and construction exist and are these implemented?

Dimension	Physical
Subdimension	Waste
Resilience objective	Safe waste infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Yes but only applied to infrastructure built at least in the last 10 years	**2**
Only recent use / existence of relevant codes and standards	**1**
No	**0**

PSlw07 - Maintenance of infrastructure (-)

Is infrastructure maintained on a regular basis (according to a preventive maintenance plan), resources for corrective maintenance are assured and all maintenance information is continuously registered?

Dimension	Physical
Subdimension	Waste
Resilience objective	Safe waste infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please specify which infrastructure are being maintained (treatment, collection or both).

Development assessment rule	Development
Yes	**3**
Just in some cases or registration is not fully assured	**2**
Preventive maintenance is not in place or corrective maintenance is not effective and efficient	**1**
Maintenance is not in place	**0**

PSlw08 - Waste collection infrastructure components failures last year (days)

Average number of days with collection infrastructure components out of service last year

Dimension	Physical
Subdimension	Waste
Resilience objective	Safe waste infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [days] in comments.

Development assessment rule	Development
Less than or equal to 4	**3**
More than 4 and less than or equal to 7	**2**
More than 7 and less than or equal to 14	**1**
More than 14	**0**

PSlw09 - Waste management service facilities unavailable last year (% of facilities)

Relative number of waste management facilities unavailable for longer than 4 days, last year (facilities unavailable/total number of facilities)

Dimension	Physical
Subdimension	Waste
Resilience objective	Safe waste infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Consider as "waste management facilities" the sites were waste is received from the waste trucks to be sent to treatment plants, the treatment plants or the sites where trucks or containers maintenance takes place. Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less than or equal to 10%	**3**
More than 10% and less than or equal to 20%	**2**
More than 20% and less than or equal to 50%	**1**
More than 50%	**0**

PSlw10 - Waste management fleet failures last year (-)

Average number of days that at least 10% of the waste management fleet was out of service last year

Dimension	Physical
Subdimension	Waste
Resilience objective	Safe waste infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Identify the causes of failures in comments.

Development assessment rule	Development
Less than or equal to 4	**3**
More than 4 and less than or equal to 7	**2**
More than 7 and less than or equal to 14	**1**
More than 14	**0**

PSlw11 - Waste containers dumped or displaced last year (% of waste containers)

Relative number of waste containers dumped or displaced last year (number affected/total number of containers)

Dimension	Physical
Subdimension	Waste
Resilience objective	Safe waste infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Dumped waste container: whenever it was turned around, with or without spilled solid waste. Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less than or equal to 10%	**3**
More than 10% and less than or equal to 20%	**2**
More than 20% and less than or equal to 50%	**1**
More than 50%	**0**

PSlw12 - Power failures interrupting service last year (days)

Average number of days waste management were out of service due to power supply interruptions last year

Dimension	Physical
Subdimension	Waste
Resilience objective	Safe waste infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Less than or equal to 4	**3**
More than 4 and less than or equal to 7	**2**
More than 7 and less than or equal to 14	**1**
More than 14	**0**

PSlw13 - Laboratory analysis compliance (%)

Percentage of performed laboratory analysis that were in accordance to legal or regulatory requirements last year

Dimension	Physical
Subdimension	Waste
Resilience objective	Safe waste infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More or equal to 95%	**3**
More or equal to 75% and less than 95%	**1.5**
Less than 75%	**0**

PSlw14 - Level of failure of critical infrastructure assets last year (%)

Percentage of critical infrastructure assets out of order last year

Dimension	Physical
Subdimension	Waste
Resilience objective	Safe waste infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PSlw15 - Coverage of expenditure in infrastructure last year (-)

Ratio between expenditure with rehabilitation, operation and management of infrastructure and annual operating budget of last year

Dimension	Physical
Subdimension	Waste
Resilience objective	Safe waste infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

Compares the expenditure (regarding rehabilitation, operation and asset management activities) with the available budget (for the same activities). Please answer with an estimated figure [-] in comments.

Development assessment rule	Development
More than or equal to 1,0 and less than or equal to 1,1	**3**
More than or equal to 0,9 and less than 1,0 or more than 1,1 and less than or equal to 1,2	**1.5**
Less than 0,9 or more than 1,2	**0**

PSlw16 - Time for restoration last year (days)

Maximum out-of-service period for all failures in infrastructure, including recovery time, last year

Dimension	Physical
Subdimension	Waste
Resilience objective	Safe waste infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Refers to structural failures on the assets, both having service interruption as a consequence or not. Does not refer to assets that have been decomissioned.

Development assessment rule	Development
Less than or equal to 4	**3**
More than 4 and less than or equal to 7	**2**
More than 7 and less than or equal to 14	**1**
More than 14	**0**

PSlw17 - Pollution prevention (% appropriate leachate disposal)

Percentage of leachate from solid waste treatment with appropriate final disposal

Dimension	Physical
Subdimension	Waste
Resilience objective	Safe waste infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Equal to 100%	**3**
More than or equal to 95% and less than 100%	**2**
More than or equal 75% and less than 95%	**1**
Less than 75%	**0**

PSlw18 - Cascading impacts (-)

There is knowledge concerning potentially cascading failures between the components of the infrastructure and the following infrastructure, under the agreed scenarios:

Dimension	Physical
Subdimension	Waste
Resilience objective	Autonomous and flexible waste infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum≥3 =3; Sum≥2 and <3 =2; Sum≥1 and <2 =1 Sum<1 =0). This metric depends on the metric FSlw43.

Development assessment rule	Development
a) Other infrastructure of the solid waste service	**1**
b) Infrastructure of the wastewater service	**1**
c) Infrastructure of the stormwater service	**1**
d) Infrastructure of the water service	**1**
e) Infrastructure of the energy service	**1**
f) Infrastructure of the mobility service	**1**
g) Other (explain in Comments)	**1**
h) None	**0**

PSlw19 - Infrastructure of other services dependency on solid waste infrastructure (-)

The infrastructure of the following services are dependent on waste infrastructure:

Dimension	Physical
Subdimension	Waste
Resilience objective	Autonomous and flexible waste infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum<2 =3; Sum≥2 and <3 =2; Sum≥3 and <4 =1.5 Sum≥4 =0).

Development assessment rule	Development
a) Infrastructure of the water service	**1**
b) Infrastructure of the wastewater service	**1**
c) Infrastructure of the stormwater service	**1**
d) Infrastructure of the energy service	**1**
e) Infrastructure of the mobility service	**1**
f) Other (explain in Comments)	**1**
g) None	**0**

PSlw20 - Dependency on infrastructures of other services (-)

The infrastructure of the waste service directly depends on the infrastructure of the following services:

Dimension	Physical
Subdimension	Waste
Resilience objective	Autonomous and flexible waste infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum<2 =3; Sum≥2 and <3 =2; Sum≥3 and <4 =1.5 Sum≥4 =0).

Development assessment rule	Development
a) Infrastructure of the water service	**1**
b) Infrastructure of the wastewater service	**1**
c) Infrastructure of the stormwater service	**1**
d) Infrastructure of the energy service	**1**
e) Infrastructure of the mobility service	**1**
f) Other (e.g. gas, fuel, telecommunication, explain in Comments)	**1**
g) None	**0**

PSlw21 - Level of dependency (% customers affected)

Percentage of customers affected by infrastructure dependent on other services

Dimension	Physical
Subdimension	Waste
Resilience objective	Autonomous and flexible waste infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less than or equal to 10%	**3**
More than 10% and less than or equal to 20%	**1.5**
More than 20%	**0**

PSlw22 - Autonomy from infrastructures of other services (% infrastructure)

Percentage of infrastructure directly dependent on other services that have an autonomy solution managed by the solid waste service

Dimension	Physical
Subdimension	Waste
Resilience objective	Autonomous and flexible waste infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

First, analyse what infrastructure depends on other services (e.g pumping stations depend on electricity). After, from this subset identify which percentage has self-autonomy (e.g., the pumping station might have a generator).Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More than or equal to 80%	**3**
More than or equal to 70% and less than 80%	**1.5**
Less than 70%	**0**

PSlw23 - Level of autonomy (% of customers covered)

Percentage of customers covered by infrastructure dependent on other services that benefit from autonomy solutions (i.e. customers that benefit/customers affected)

Dimension	Physical
Subdimension	Waste
Resilience objective	Autonomous and flexible waste infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Disaggregating into households, critical facilities/services and other services, if possible, in comments. Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More than or equal to 80%	**3**
More than or equal to 70% and less than 80%	**1.5**
Less than 70%	**0**

PSlw24 - Autonomy activation (-)

How is infrastructure autonomy activated? Specify the time required to activate it, if possible

Dimension	Physical
Subdimension	Waste
Resilience objective	Autonomous and flexible waste infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. The development is obtained throught 4 conditions: If c) is the only selected answer =3; If c) is not selected but b) is selected =2; If c) and b) are not selected but a) is selected =1.5; if the only selected answer is e) = 0.

Development assessment rule	Development
a) Manual operation	**1**
b) Remote operation	**1**
c) Automatic operation	**1**
d) Other (explain in Comments)	**1**
e) None	**0**

PSlw25 - Autonomy period (days)

Weighted average of autonomy period (Ti) of each dependent infrastructure (i) i.e. Sum (Ti x level of autonomy i)

Dimension	Physical
Subdimension	Waste
Resilience objective	Autonomous and flexible waste infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
More than or equal to 7	**3**
More than or equal to 6 and less than 7	**2**
More than or equal to 4 and less than 6	**1**
Less than 4	**0**

PSlw26 - Waste storage autonomy (days)

Days of waste storage autonomy provided by containers and transfer locations

Dimension	Physical
Subdimension	Waste
Resilience objective	Autonomous and flexible waste infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Waste inflow [m^3/year] / (waste storage volume [m3] x 365 days

Development assessment rule	Development
More than or equal to 7	**3**
More than or equal to 6 and less than 7	**2**
More than or equal to 4 and less than 6	**1**
Less than 4	**0**

PSlw27 - Energy self production (%)

Percentage of energy consumption coming from self production

Dimension	Physical
Subdimension	Waste
Resilience objective	Autonomous and flexible waste infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
More than or equal to 30%	**3**
More than or equal to 15% and less than 30%	**2**
More than or equal to 5% and less than 15%	**1**
Less than 5%	**0**

PSlw28 - Redundancy (-)

Is there an understanding of infrastructure redundancy, clearly identified on hazard maps and data on risk?

Dimension	Physical
Subdimension	Waste
Resilience objective	Autonomous and flexible waste infrastructure
Criteria	Infrastructure assets redundancy
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

PSlw29 - Redundancy activation (-)

How is infrastructure redundancy activated? Specify the time required to activate it, if possible

Dimension	Physical
Subdimension	Waste
Resilience objective	Autonomous and flexible waste infrastructure
Criteria	Infrastructure assets redundancy
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. The development is obtained throught 4 conditions: If c) or d) are selected =3; If c) is not selected but b) is selected =2; If c) and b) are not selected but a) is selected =1.5; if the only selected answer is e) = 0.

Development assessment rule	Development
a) Manual operation	**1**
b) Remote operation	**1**
c) Automatic operation	**1**
d) No operation required	**1**
e) Other (explain in Comments)	**1**
f) None	**0**

PSlw30 - Level of redundancy (% of customers covered)

Percentage of customers covered by redundant infrastructure, i.e., with alternative infrastructure able to provide the service

Dimension	Physical
Subdimension	Waste
Resilience objective	Autonomous and flexible waste infrastructure
Criteria	Infrastructure assets redundancy
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in Comments.

Development assessment rule	Development
Equal to 100%	**3**
More than or equal 90% and less than 100%	**2**
More than or equal 80% and less than 90%	**1**
Less than 80%	**0**

PSlw31 - Use of design solutions to improve city resilience (-)

The design of the infrastructure incorporate the use of the following solutions to improve city resilience:

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

Design solutions that contribute to the city's resilience that are not a direct component of the infrastructure that provides the service. E.g., any entity in its office buildings may have green roofs or porous floors in the parking lot. Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum≥3 =3; Sum≥2 and <3 =2; Sum≥1 and <2 =1 Sum<1 =0).

Development assessment rule	Development
a) Soakaways and porous pavement	**1**
b) Underground parking garages used as holding tanks for storm water	**1**
c) Parks that function as flood zones	**1**
d) Green roofs	**1**
e) Renewable energy generation	**1**
f) Other (explain in Comments)	**1**
g) None	**0**

PSlw32 - Recovered material from waste treatment (% recovered material)

Percentage of recovered material from treatment per year (including composting, recycling and direct recovery)

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
More than or equal to 30%	**3**
More than or equal to 15% and less than 30%	**2**
More than or equal to 5% and less than 15%	**1**
Less than 5%	**0**

PSlw33 - Greenhouse gas emission target (-)

Contribution to green house gas emission reduction

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =2; Sum≥1 and <2 =1 Sum<1 =0).

Development assessment rule	Development
a) Infrastructure operation	**1**
b) Fleet	**1**
c) Administrative buildings	**1**
d) Other (explain in Comments)	**0**
e) None	**0**

PSlw34 - Other contributions to city resilience (-)

The solid waste infrastructure and related services provide other contributions to city resilience in emergency situation, such as:

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Shelter	**1**
b) Medical services	**1**
c) First aid	**1**
d) Food storage	**1**
e) Food cooking and supply	**1**
f) Energy supply	**1**
g) Fuel supply	**1**
h) Emergency transport vehicles	**1**
i) Escape routes	**1**
j) Water storage	**1**
k) Other (e.g. vehicles and personnel to support emergency services, explain in Comments)	**1**
l) None	**0**

PSlw35 - Level of exposure of critical infrastructure assets to the most probable scenario (-)

Identify the critical infrastructure assets for which less than 10% is exposed to different hazards for climate change scenarios

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥3 =3; Sum≥2 and <3 =1; Sum<2 =0). This metric depends on the metric PSlw01 and FSlw43.

Development assessment rule	Development
a) Waste containers	**1**
b) Waste management fleet	**1**
c) Waste storage facilities	**1**
d) Waste management and transfer facilities	**1**
e) Waste treatment facility	**1**
f) Waste recovery facilities	**1**
g) Landfill	**1**
h) Other (explain in Comments)	**0**

PSlw36 - Coverage of expenditure in infrastructure for most probable scenario (%)

Ratio between predicted expenditure with infrastructure affected by climate change scenarios and annual operating budget of last year

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSlw43.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PSlw37 - Time for restoration for most probable scenario (days)

Maximum out-of-service period predicted for all failures in infrastructure, including recovery time, due to different hazards for climate change scenarios

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

This metric depends on the metric FSlw43.

Development assessment rule	Development
Less than or equal to 4	**3**
More than 4 and less than or equal to 7	**2**
More than 7 and less than or equal to 14	**1**

More than 14	**0**

PSlw38 - Implemented infrastructural measures to address climate change mitigation and adaptation (-)

What type of measures were implemented in infrastructure design to address climate change mitigation and adaptation?

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Preparedness for climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Containers stability components (to avoid dumping or displacement)	**1**
b) Buried or semi-buried containers	**1**
c) Time limited disposal in streets of building containers	**1**
d) Separate collection containers	**1**
e) Specific material recovery facility	**1**
f) Renewable energy production equipment	**1**
g) Clean energy vehicles	**1**
h) Separation measures	**1**
i) Other (explain in Comments)	**0**
j) None	**0**

PSlw39 - Planned infrastructural measures to address climate change mitigation and adaptation (-)

What type of measures are being planned in infrastructure design to address climate change mitigation and adaptation?

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Preparedness for climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1.5; Sum<1 =0).

Development assessment rule	Development
a) Containers stability components (to avoid dumping or displacement)	**1**
b) Buried or semi-buried containers	**1**
c) Time limited disposal in streets of building containers	**1**
d) Separate collection containers	**1**
e) Specific material recovery facility	**1**
f) Renewable energy production equipment	**1**
g) Clean energy vehicles	**1**
h) Separation measures	**1**
i) Other (explain in Comments)	**0**
j) None	**0**

PSlw40 - Waste collection infrastructure components failures last relevant event (days)

Number of days waste collection infrastructure components were out of service due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FSlw43.

Development assessment rule	Development
Less than or equal to 4	**3**
More than 4 and less than or equal to 7	**2**
More than 7 and less than or equal to 14	**1**
More than 14	**0**

PSlw41 - Waste management service facilities unavailable in the last relevant event (% of facilities)

Number of waste management service facilities unavailable in the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Consider as "waste management facilities" the sites were waste is received from the waste trucks to be sent to treatment plants, the treatment plants or the sites where trucks or containers maintenance takes place. This metric depends on the metric FSlw43.

Development assessment rule	Development
Less than or equal to 10%	**3**
More than 10% and less than or equal to 20%	**2**
More than 20% and less than or equal to 50%	**1**
More than 50%	**0**

PSlw42 - Waste management fleet failures in the last relevant event (-)

Number of waste management fleet failures due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FSlw43.

Development assessment rule	Development
Less than or equal to 4	**3**
More than 4 and less than or equal to 7	**2**
More than 7 and less than or equal to 14	**1**
More than 14	**0**

PSlw43 - Waste containers dumped or displaced in the last relevant event (% of containers)

Number of waste containers dumped or displaced due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FSlw43. Dumped waste container: whenever it was turned around, with or without spilled solid waste. Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less than or equal to 10%	**3**
More than 10% and less than or equal to 20%	**2**
More than 20% and less than or equal to 50%	**1**
More than 50%	**0**

PSlw44 - Power failures in the last relevant event (days)

Number of days waste management facilities were out of service by power supply interruptions due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Consider as "waste management facilities" the sites were waste is received from the waste trucks to be sent to treatment plants, the treatment plants or the sites where trucks or containers maintenance takes place. This metric depends on the metric FSlw43.

Development assessment rule	Development
Less than or equal to 4	**3**
More than 4 and less than or equal to 7	**2**
More than 7 and less than or equal to 14	**1**
More than 14	**0**

PSlw45 - Laboratory analysis compliance in the last relevant event (%)

Percentage of laboratory analysis that were in accordance to legal or regulatory requirements due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

This metric depends on the metric FSlw43.

Development assessment rule	Development
More or equal to 95%	**3**
More or equal to 75% and less than 95%	**1.5**
Less than 75%	**0**

PSlw46 - Level of failure of critical infrastructure assets in the last relevant event (%)

Percentage of critical infrastructure assets out of order due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metrics PSlw01 and FSlw43.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PSlw47 - Coverage of expenditure in infrastructure in the last relevant event (%)

Ratio between expenditure with infrastructure affected by the last climate-related event, with similar or harsher climate variables than the most probable scenario and annual operating budget of last year

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSlw43.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PSlw48 - Time for restoration in the last relevant event (days)

Maximum out-of-service period for all failures in infrastructure, including recovery time, due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Waste
Resilience objective	Waste infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FSlw43.

Development assessment rule	Development
Less than or equal to 4	**3**
More than 4 and less than or equal to 7	**2**
More than 7 and less than or equal to 14	**1**
More than 14	**0**

PHYSICAL

ENERGY

PI code PI name Unit*

PEne01 - Energy infrastructure critical assets (-)

Are the critical infrastructure assets for service provision identified?

Dimension	Physical
Subdimension	Energy
Resilience objective	Safe energy infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric conditions the metrics PEne02, PEne03, PEne04, PEne30 and PEne39.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

PEne02 - Component importance (-)

The identification of infrastructure critical assets is based in the following:

Dimension	Physical
Subdimension	Energy
Resilience objective	Safe energy infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. Please select one or more of the options provided as answers. Sum of the selected answers and a scale to 3 is made. This metric depends on the metric PEne01.

Development assessment rule	Development
a) Population served	**1**
b) Associated sensitive customers	**1**
c) Location	**1**
d) High dependence on other services infrastructures	**1**
e) Other services infrastructure highly depend on energy infrastructure	**1**
f) Other (explain in Comments)	**1**
g) None	**0**

* (-) without unit or dimensionless

PEne03 - Energy infrastructure critical assets mapping, review and update (-)

Are the infrastructure critical assets identified on hazard maps and included in data on risk?

Dimension	Physical
Subdimension	Energy
Resilience objective	Safe energy infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please specify how often this maps are reviewed and updated, and the data of the last update, in comments. This metric depends on the metric PEne01.

Development assessment rule	Development
Yes	**3**
Partially, not covering the all the hazards or all the infrastructure	**1.5**
No	**0**

PEne04 - Exchange of information (-)

Is there a regular exchange of information regarding infrastructure critical assets, hazard maps and data on risk with the city?

Dimension	Physical
Subdimension	Energy
Resilience objective	Safe energy infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric PEne01.

Development assessment rule	Development
Yes, exchange of information from both sides	**3**
The service is informed by the city	**2**
The city is informed by the service	**1**
No exchange	**0**

PEne05 - Protective buffers mapping and information to the city (-)

Have protective buffers to safeguard infrastructure assets been defined, are they clearly identified on hazard maps and data on risk and is the city informed?

Dimension	Physical
Subdimension	Energy
Resilience objective	Safe energy infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Protecticve buffers are spatial delimited areas surrounding the infrastructure where activities are restricted to protect the strcutural integrity of the assets.

Development assessment rule	Development
Yes	**3**
Partially, or with a time horizon longer than 10 years	**1.5**
No	**0**

PEne06 - Codes and standards for infrastructure (-)

Do codes or standards for infrastructure design and construction exist and are these implemented?

Dimension	Physical
Subdimension	Energy
Resilience objective	Safe energy infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Yes but only applied to infrastructure built at least in the last 10 years	**2**
Only recent use / existence of relevant codes and standards	**1**
No	**0**

PEne07 - Maintenance of infrastructure (-)

Is infrastructure maintained on a regular basis (according to a preventive maintenance plan), resources for corrective maintenance are assured and all maintenance information is continuously registered?

Dimension	Physical
Subdimension	Energy
Resilience objective	Safe energy infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please specify which infrastructure are being maintained.

Development assessment rule	Development
Yes	**3**
Just in some cases or registration is not fully assured	**2**
Preventive maintenance is not in place or corrective maintenance is not effective and efficient	**1**
Maintenance is not in place	**0**

PEne08 - Power station failure last year (days)

Average number of days that power stations were out of service due to infrastructure problems last year

Dimension	Physical
Subdimension	Energy
Resilience objective	Safe energy infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Failure relates to any occurence by which the infrastructure was damaged and may not continue to provide service without previous repair.

Development assessment rule	Development
Less or equal to 0.25	**3**
More than 0.25 and less than 0.5	**2**
More than or equal to 0.5 and less than 1	**1**
More than or equal to 1	**0**

PEne09 - Power substation failure last year (days)

Average number of days that power substations were out of service due to infrastructure problems last year

Dimension	Physical
Subdimension	Energy
Resilience objective	Safe energy infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Failure relates to any occurence by which the infrastructure was damaged and may not continue to provide service without previous repair.

Development assessment rule	Development
Less or equal to 0.25	**3**
More than 0.25 and less than 0.5	**2**
More than or equal to 0.5 and less than 1	**1**
More than or equal to 1	**0**

PEne10 - Power distribution network failures last year (-)

Number of failures in the distribution network last year

Dimension	Physical
Subdimension	Energy
Resilience objective	Safe energy infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Failure relates to any occurence by which the infrastructure was damaged and may not continue to provide service without previous repair.

Development assessment rule	Development
Less or equal to 12	**3**
More than 12 and less than 21	**2**
More than or equal to 21 and less than 30	**1**
More than or equal to 30	**0**

PEne11 - Local power installations failures last year (-)

Number of sectional and transformation power stations and public lighting installations failures last year

Dimension	Physical
Subdimension	Energy
Resilience objective	Safe energy infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Failure relates to any occurence by which the infrastructure was damaged and may not continue to provide service without previous repair.

Development assessment rule	Development
Less or equal to 8	**3**
More than 8 and less than 16	**2**
More than or equal to 16 and less than 25	**1**
More than or equal to 25	**0**

PEne12 - Level of failure of critical infrastructure assets last year (%)

Percentage of critical infrastructure assets out of order by failure last year

Dimension	Physical
Subdimension	Energy
Resilience objective	Safe energy infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Failure relates to any occurence by which the infrastructure was damaged and may not continue to provide service without previous repair.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PEne13 - Coverage of expenditure in infrastructure last year (-)

Ratio between expenditure with rehabilitation, operation and management of infrastructure and annual operating budget of last year

Dimension	Physical
Subdimension	Energy
Resilience objective	Safe energy infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Strategic
Metric type	Single choice

Compares the expenditure (regarding rehabilitation, operation and asset management activities) with the available budget (for the same activities). Please answer with an estimated figure [-] in comments.

Development assessment rule	Development
More than or equal to 1,0 and less than or equal to 1,1	**3**
More than or equal to 0,9 and less than 1,0 or more than 1,1 and less than or equal to 1,2	**1.5**
Less than 0,9 or more than 1,2	**0**

PEne14 - Time for restoration last year (days)

Maximum out-of-service period for all failures in infrastructure, including recovery time, last year

Dimension	Physical
Subdimension	Energy
Resilience objective	Safe energy infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Refers to structural failures on the assets, both having service interruption as a consequence or not. Does not refer to assets that have been decomissioned.

Development assessment rule	Development
Less than or equal to 3	**3**
More than 3 and less than or equal to 5	**2**
More than 5 and less than or equal to 10	**1**
More than 10	**0**

PEne15 - Use of cooling waters (l/kWh)

Water use per year for cooling power stations

Dimension	Physical
Subdimension	Energy
Resilience objective	Safe energy infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Less than or equal to 5	**3**
More than 5 and less than or equal to 50	**2**
More than 50 and less than or equal to 200	**1**
More than 200	**0**

PEne16 - Cascading impacts (-)

There is knowledge concerning potentially cascading failures between the components of the infrastructure and the following infrastructure, under the agreed scenarios:

Dimension	Physical
Subdimension	Energy
Resilience objective	Autonomous and flexible energy infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum≥3 =3; Sum≥2 and <3 =2; Sum≥1 and <2 =1 Sum<1 =0). This metric depends on the metric FEne38.

Development assessment rule	Development
a) Other infrastructure of the energy service	**1**
b) Infrastructure of the wastewater service	**1**
c) Infrastructure of the stormwater service	**1**
d) Infrastructure of the solid waste service	**1**
e) Infrastructure of the water service	**1**
f) Infrastructure of the mobility service	**1**
g) Other (e.g. telecommunication, explain in Comments)	**1**
h) None	**0**

PEne17 - Infrastructure of other services dependency on energy infrastructure (-)

The infrastructure of the following services are dependent on energy infrastructure:

Dimension	Physical
Subdimension	Energy
Resilience objective	Autonomous and flexible energy infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum<2 =3; Sum≥2 and <3 =2; Sum≥3 and <4 =1.5 Sum≥4 =0).

Development assessment rule	Development
a) Infrastructure of the wastewater service	**1**
b) Infrastructure of the stormwater service	**1**
c) Infrastructure of the solid waste service	**1**
d) Infrastructure of the water service	**1**
e) Infrastructure of the mobility service	**1**
f) Other (explain in Comments)	**1**
g) None	**0**

PEne18 - Dependency on infrastructures of other services (-)

The infrastructure of the energy service directly depends on the infrastructure of the following services:

Dimension	Physical
Subdimension	Energy
Resilience objective	Autonomous and flexible energy infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum<2 =3; Sum≥2 and <3 =2; Sum≥3 and <4 =1.5 Sum≥4 =0).

Development assessment rule	Development
a) Infrastructure of the wastewater service	**1**
b) Infrastructure of the stormwater service	**1**
c) Infrastructure of the solid waste service	**1**
d) Infrastructure of the water service	**1**
e) Infrastructure of the mobility service	**1**
f) Other (e.g. gas, fuel, telecommunication, explain in Comments)	**1**
g) None	**0**

PEne19 - Level of dependency (% of customers affected)

Percentage of customers affected by infrastructure dependent on other services

Dimension	Physical
Subdimension	Energy
Resilience objective	Autonomous and flexible energy infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
Less than or equal to 10%	**3**
More than 10% and less than or equal to 20%	**1.5**
More than 20%	**0**

PEne20 - Autonomy from infrastructures of other services (% of infrastructure)

Percentage of infrastructure directly dependent on other services that have an autonomy solution managed by the energy service

Dimension	Physical
Subdimension	Energy
Resilience objective	Autonomous and flexible energy infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

First, analyse what infrastructure depends on other services (e.g pumping stations depend on electricity). After, from this subset identify which percentage has self-autonomy (e.g., the pumping station might have a generator).Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More than or equal to 80%	**3**
More than or equal to 70% and less than 80%	**1.5**
Less than 70%	**0**

PEne21 - Level of autonomy (% of customers covered)

Percentage of customers covered by infrastructure dependent on other services that benefit from autonomy solutions (i.e. customers that benefit/customers affected)

Dimension	Physical
Subdimension	Energy
Resilience objective	Autonomous and flexible energy infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Disaggregating into households, critical facilities/services and other services, if possible, in comments. Please answer with an estimated figure [%] in comments.

Development assessment rule	Development
More than or equal to 80%	**3**
More than or equal to 70% and less than 80%	**1.5**
Less than 70%	**0**

PEne22 - Autonomy activation (-)

How is infrastructure autonomy activated? Specify the time required to activate it, if possible

Dimension	Physical
Subdimension	Energy
Resilience objective	Autonomous and flexible energy infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. The development is obtained throught 4 conditions: If c) is the only selected answer =3; If c) is not selected but b) is selected =2; If c) and b) are not selected but a) is selected =1.5; if the only selected answer is e) = 0.

Development assessment rule	Development
a) Manual operation	**1**
b) Remote operation	**1**
c) Automatic operation	**1**
d) Other (explain in Comments)	**1**
e) None	**0**

PEne23 - Autonomy period (days)

Weighted average of autonomy period (Ti) of each dependent infrastructure (i) i.e. Sum (Ti x level of autonomy i)

Dimension	Physical
Subdimension	Energy
Resilience objective	Autonomous and flexible energy infrastructure
Criteria	Infrastructure assets autonomy
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
More than or equal to 2	**3**
More than or equal to 1.5 and less than 2	**2**
More than or equal to 1 and less tha 1.5	**1**
Less than 1	**0**

PEne24 - Redundancy (-)

Is there an understanding of infrastructure redundancy, clearly identified on hazard maps and data on risk?

Dimension	Physical
Subdimension	Energy
Resilience objective	Autonomous and flexible energy infrastructure
Criteria	Infrastructure assets redundancy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

-

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

PEne25 - Redundancy activation (-)

How is infrastructure redundancy activated? Specify the time required to activate it, if possible

Dimension	Physical
Subdimension	Energy
Resilience objective	Autonomous and flexible energy infrastructure
Criteria	Infrastructure assets redundancy
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. The development is obtained throught 4 conditions: If c) or d) are selected =3; If c) is not selected but b) is selected =2; If c) and b) are not selected but a) is selected =1.5; if the only selected answer is e) = 0.

Development assessment rule	Development
a) Manual operation	**1**
b) Remote operation	**1**
c) Automatic operation	**1**
d) No operation required	**1**
e) Other (explain in Comments)	**1**
f) None	**0**

PEne26 - Level of redundancy (% customers covered)

Percentage of customers covered by redundant infrastructure, i.e., with alternative infrastructure able to provide the service

Dimension	Physical
Subdimension	Energy
Resilience objective	Autonomous and flexible energy infrastructure
Criteria	Infrastructure assets redundancy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Please answer with an estimated figure [%].

Development assessment rule	Development
Equal to 100%	**3**
More than or equal 90% and less than 100%	**2**
More than or equal 80% and less than 90%	**1**
Less than 80%	**0**

PEne27 - Use of design solutions to improve city resilience (-)

The design of the infrastructure incorporate the use of the following solutions to improve city resilience:

Dimension	Physical
Subdimension	Energy
Resilience objective	Energy infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

Design solutions that contribute to the city's resilience that are not a direct component of the infrastructure that provides the service. E.g., any entity in its office buildings may have green roofs or porous floors in the parking lot. Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum≥3 =3; Sum≥2 and <3 =2; Sum≥1 and <2 =1 Sum<1 =0).

Development assessment rule	Development
a) Soakaways and porous pavement	**1**
b) Underground parking garages used as holding tanks for storm water	**1**
c) Parks that function as flood zones	**1**
d) Green roofs	**1**
e) Other (e.g. flood defences, explain in Comments)	**1**
f) None	**0**

PEne28 - Greenhouse gas emission target (-)

Contribution to greenhouse gas emission reduction

Dimension	Physical
Subdimension	Energy
Resilience objective	Energy infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =2; Sum≥1 and <2 =1 Sum<1 =0).

Development assessment rule	Development
a) Infrastructure operation	**1**
b) Fleet	**1**
c) Administrative buildings	**1**
d) Other (explain in Comments)	**0**
e) None	**0**

PEne29 - Other contributions to city resilience (-)

The energy infrastructure and related services provide other contributions to city resilience in emergency situation, such as:

Dimension	Physical
Subdimension	Energy
Resilience objective	Energy infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Shelter	**1**
b) Medical services	**1**
c) First aid	**1**
d) Food storage	**1**
e) Food cooking and supply	**1**
f) Fuel supply	**1**
g) Emergency transport vehicles	**1**
h) Escape routes	**1**
i) Water storage	**1**
j) Other (e.g. eletrical generators, vehicles and personnel to support emergency services, explain in Comments)	**1**
k) None	**0**

PEne30 - Level of exposure of critical infrastructure assets to the most probable scenario (-)

Identify the critical infrastructure assets for which less than 10% is exposed to different hazards for climate change scenarios

Dimension	Physical
Subdimension	Energy
Resilience objective	Energy infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥3 =3; Sum≥2 and <3 =1; Sum<2 =0). This metric depends on the metrics PEne01 and FEne38.

Development assessment rule	Development
a) Power stations	**1**
b) Power substations	**1**
c) Power distribution network length	**1**
d) Sectional and transformation power stations and public lighting installations	**1**
e) Other (explain in Comments)	**0**
f) None	**0**

PEne31 - Coverage of expenditure in infrastructure for most probable scenario (%)

Ratio between predicted expenditure on infrastructure affected by climate change scenarios and annual operating budget of last year

Dimension	Physical
Subdimension	Energy
Resilience objective	Energy infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

This metric depends on the metric FEne38.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PEne32 - Time for restoration for most probable scenario (days)

Maximum out-of-service period predicted for all failures in infrastructure, including recovery time, due to different hazards for climate change scenarios

Dimension	Physical
Subdimension	Energy
Resilience objective	Energy infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

Failure relates to any occurence by which the infrastructure was damaged and may not continue to provide service without previous repair. This metric depends on the metric FEne38.

Development assessment rule	Development
Less or equal to 0.25	**3**
More than 0.25 and less than 0.5	**2**
More than or equal to 0.5 and less than 1	**1**
More than or equal to 1	**0**

PEne33 - Implemented infrastructural measures to address climate change mitigation and adaptation (-)

What type of measures were implemented in infrastructure design to address climate change mitigation and adaptation?

Dimension	Physical
Subdimension	Energy
Resilience objective	Energy infrastructure preparedness
Criteria	Preparedness for climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Alternative power stations to recur to (e.g. solar pannels, photovoltaics cells, wind turbines)	**1**
b) Decentralised power substations	**1**
c) Mobile equipment for power distribution	**1**
d) Interconnected grid	**1**
e) Other (explain in Comments)	**0**
f) None	**0**

PEne34 - Planned infrastructural measures to address climate change mitigation and adaptation (-)

What type of measures are being planned in infrastructure design to address climate change mitigation and adaptation?

Dimension	Physical
Subdimension	Energy
Resilience objective	Energy infrastructure preparedness
Criteria	Preparedness for climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1.5; Sum<1 =0).

Development assessment rule	Development
a) Alternative power stations to recur to (e.g. solar pannels, photovoltaics cells, wind turbines)	**1**
b) Decentralised power substations	**1**
c) Mobile equipment for power distribution	**1**
d) Interconnected grid	**1**
e) Other (explain in Comments)	**0**
f) None	**0**

PEne35 - Power stations failure in the last relevant event (days)

Average number of days that power stations were out of service by infrastructure problems due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Energy
Resilience objective	Energy infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Failure relates to any occurence by which the infrastructure was damaged and may not continue to provide service without previous repair. This metric depends on the metric FEne38.

Development assessment rule	Development
Less or equal to 0.25	**3**
More than 0.25 and less than 0.5	**2**
More than or equal to 0.5 and less than 1	**1**
More than or equal to 1	**0**

PEne36 - Power substation failure in the last relevant event (days)

Average number of days that power substations were out of service by infrastructure problems due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Energy
Resilience objective	Energy infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Failure relates to any occurence by which the infrastructure was damaged and may not continue to provide service without previous repair. This metric depends on the metric FEne38.

Development assessment rule	Development
Less or equal to 0.25	**3**
More than 0.25 and less than 0.5	**2**
More than or equal to 0.5 and less than 1	**1**
More than or equal to 1	**0**

PEne37 - Power distribution network failures in the last relevant event (-)

Number of failures in the distribution network due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Energy
Resilience objective	Energy infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Failure relates to any occurence by which the infrastructure was damaged and may not continue to provide service without previous repair. This metric depends on the metric FEne38.

Development assessment rule	Development
Less or equal to 0.25	**3**
More than 0.25 and less than 0.5	**2**
More than or equal to 0.5 and less than 1	**1**
More than or equal to 1	**0**

PEne38 - Local power installation failures in the last relevant event (-)

Number of sectional and transformation power stations and public lighting installation failures due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Energy
Resilience objective	Energy infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

Failure relates to any occurence by which the infrastructure was damaged and may not continue to provide service without previous repair. This metric depends on the metric FEne38.

Development assessment rule	Development
Less or equal to 0.25	**3**
More than 0.25 and less than 0.5	**2**
More than or equal to 0.5 and less than 1	**1**
More than or equal to 1	**0**

PEne39 - Level of failure of critical infrastructure assets in the last relevant event (%)

Percentage of critical infrastructure assets out of order by failure due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Energy
Resilience objective	Energy infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Failure relates to any occurence by which the infrastructure was damaged and may not continue to provide service without previous repair. This metric depends on the metrics PEne01 and FEne38.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PEne40 - Coverage of expenditure in infrastructure in the last relevant event (-)

Ratio between expenditure on infrastructure affected by the last climate-related event, with similar or harsher climate variables than the most probable scenario and annual operating budget of last year

Dimension	Physical
Subdimension	Energy
Resilience objective	Energy infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Infrastructure affected means it was damaged and needed repair. This metric depends on the metric FEne38.

Development assessment rule	Development
Less than or equal to 1%	**3**
More than 1% and less than or equal to 5%	**1.5**
More than 5%	**0**

PEne41 - Time for restoration in the last relevant event (days)

Maximum out-of-service period for all failures in infrastructure, including recovery time, due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Energy
Resilience objective	Energy infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Failure relates to any occurence by which the infrastructure was damaged and may not continue to provide service without previous repair. This metric depends on the metric FEne38.

Development assessment rule	Development
Less or equal to 0.25	**3**
More than 0.25 and less than 0.5	**2**
More than or equal to 0.5 and less than 1	**1**
More than or equal to 1	**0**

PHYSICAL

MOBILITY

PI code	PI name	Unit*

PMob01 - Mobility infrastructure critical assets (-)

Are the critical infrastructure assets for mobility identified?

Dimension	Physical
Subdimension	Mobility
Resilience objective	Safe mobility infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Service provision includes road, railway, airport and water based transport. If answer is different from Yes, please specify if any of the mobility services (road, train, air-based or water-based) may answer Yes, in comments. This metric conditions the metrics PMob02, PMob03 and PMob24.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

PMob02 - Component importance for city mobility (-)

The identification of infrastructure critical assets for city mobility is based in the following:

Dimension	Physical
Subdimension	Mobility
Resilience objective	Safe mobility infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Sensitive customers are considered to be e.g. health care facilities, correctional facilities, security forces, firefighters, civil protection, maritime or air traffic management. If other, explain in comments. Please select one or more of the options provided as answers. Sum of the selected answers and a scale to 3 is made. This metric depends on the metric PMob01.

Development assessment rule	Development
a) Population served	**1**
b) Associated sensitive customers	**1**
c) Location	**1**
d) High dependence on other services infrastructures	**1**
e) Traffic during peak hours	**1**
f) Other services infrastructures highly depend on mobility infrastructures	**1**
g) Other (explain in Comments)	**0**

* (-) without unit or dimensionless

PMob03 - Mobility infrastructure critical assets mapping, review and update (-)

Are the infrastructure critical assets identified on hazard maps and included in data on risk?

Dimension	Physical
Subdimension	Mobility
Resilience objective	Safe mobility infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

The infrastructure critical assets are the ones identified as critical for city mobility. Please specify how often this maps are reviewed and updated, and the data of the last update, in comments. If answer is different from Yes, please specify if any of the mobility services may answer Yes, in comments. This metric depends on the metric PMob01.

Development assessment rule	Development
Yes	**3**
Partially, not covering the all the hazards or all the infrastructure	**1.5**
No	**0**

PMob04 - Protective buffers mapping (-)

Have protective buffers to safeguard infrastructure assets been defined, are they clearly identified on hazard maps and data on risk and is the city informed?

Dimension	Physical
Subdimension	Mobility
Resilience objective	Safe mobility infrastructure
Criteria	Infrastructure assets criticality and protection
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Protecticve buffers are spatial delimited areas surrounding the infrastructure where activities are restricted to protect the strcutural integrity of the assets.

Development assessment rule	Development
Yes	**3**
Partially, or with a time horizon longer than 10 years	**1.5**
No	**0**

PMob05 - Codes and standards for infrastructure (-)

Do codes or standards for infrastructure design and construction exist and are these implemented?

Dimension	Physical
Subdimension	Energy
Resilience objective	Safe energy infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

If answer is different from Yes, please specify if any of the mobility services may answer Yes, in comments.

Development assessment rule	Development
Yes	**3**
Yes but only applied to infrastructure built at least in the last 10 years	**2**
Only recent use / existence of relevant codes and standards	**1**
No	**0**

PMob06 - Maintenance of infrastructure (-)

Is infrastructure maintained on a regular basis (according to a preventive maintenance plan), resources for corrective maintenance are assured and all maintenance information is continuously registered?

Dimension	Physical
Subdimension	Mobility
Resilience objective	Safe mobility infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

Please specify which infrastructure are being maintained (road, railway, airport and maritime transport). If answer is different from Yes, please specify if any of the mobility services may answer Yes, in comments.

Development assessment rule	Development
Yes	**3**
Just in some cases or registration is not fully assured	**2**
Preventive maintenance is not in place or corrective maintenance is not effective and efficient	**1**
Maintenance is not in place	**0**

PMob07 - Road and rail routes failures last year (-)

Critical routes were out of order for less than 2h on average last year, for these infrastructures:

Dimension	Physical
Subdimension	Mobility
Resilience objective	Safe mobility infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

The critical routes are identified as critical for city mobility. Out of order means total interruptions of the service due to infrastructural problems. Please select all applicable answers. Sum of the selected options and a scale to 3 is made. If train based mobility does not exist in the city select (b) so as not to undercut the development of the metric. Please answer with correspondent estimated figures [hours] in comments.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**

PMob08 - Transport interfaces failures last year (hours)

Average number of hours that critical transport interfaces were out of order due to infrastructural failures last year

Dimension	Physical
Subdimension	Mobility
Resilience objective	Safe mobility infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

The critical interfaces are identified as critical for city mobility. Please answer with correspondent estimated figure [h] in comments. Out of order means total interruptions of the service due to infrastructural problems.

Development assessment rule	Development
Less or equal to 2	**3**
More than 2 and less than 6	**2**
More than or equal to 6 and less than 24	**1**
More than or equal to 24	**0**

PMob09 - Power related failures in road and rail routes last year (-)

Critical routes were out of order for less than 2h on average, due to power related failures, last year

Dimension	Physical
Subdimension	Mobility
Resilience objective	Safe mobility infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

The critical routes are identified as critical for city mobility. Out of order means total interruptions of the service due to infrastructural problems. Select all applicable and please answer with correspondent estimated figures [hours]. Sum of the selected options and a scale to 3 is made. If train based mobility does not exist in the city select (b) so as not to undercut the development of the metric.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**

PMob10 - Power related failures in transport interfaces last year (hours)

Average number of hours that critical transport interfaces were out of order due to power related failures, last year

Dimension	Physical
Subdimension	Mobility
Resilience objective	Safe mobility infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

The critical interfaces are identified as critical for city mobility. Please answer with correspondent estimated figure [hours], in comments for the others applicable not selected. Out of order means total interruptions of the service due to infrastructural problems.

Development assessment rule	Development
Less or equal to 2	**3**
More than 2 and less than 6	**2**
More than or equal to 6 and less than 24	**1**
More than or equal to 24	**0**

PMob11 - Flooding related failures in road and rail routes last year (-)

Critical routes were out of order for less than 2h on average, due to flooding, last year

Dimension	Physical
Subdimension	Mobility
Resilience objective	Safe mobility infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

The critical routes are identified as critical for city mobility. Out of order means total interruptions of the service due to infrastructural problems. Click to select all applicable and please answer with correspondent estimated figures [hours], in comments for the others applicable not selected. Sum of the selected options and a scale to 3 is made. If train based mobility does not exist in the city select (b) so as not to undercut the development of the metric.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**

PMob12 - Flooding related failures in transport interfaces last year (hours)

Average number of hours that critical transport interfaces were out of order due to flooding related failures on average, last year

Dimension	Physical
Subdimension	Mobility
Resilience objective	Safe mobility infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

The critical interfaces are identified as critical for city mobility. Please answer with correspondent estimated figure [h], in comments. Out of order means total interruptions of the service due to infrastructural problems.

Development assessment rule	Development
Less or equal to 2	**3**
More than 2 and less than 6	**2**
More than or equal to 6 and less than 24	**1**
More than or equal to 24	**0**

PMob13 - Coverage of expenditure in infrastructure last year (-)

Ratio of expenditure with rehabilitation, operation and management of infrastructure (routes and interfaces) and annual operating budget of last year between 0,9 and 1,0 or between 1,1 and 1,2, for these infrastructures:

Dimension	Physical
Subdimension	Mobility
Resilience objective	Safe mobility infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Compares the expenditure (regarding rehabilitation, operation and asset management activities) with the available budget (for the same activities). Click to select all applicable and please answer with correspondent estimated figures [-] in comments for the others applicable not selected, considering infrastructure as networks and terminals. Sum of the selected options and a scale to 3 is made. If train based mobility does not exist in the city select (b) so as not to undercut the development of the metric.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**

PMob14 - Time for restoration last year (-)

Mobility critical infrastructure (routes and interfaces) with a maximum out-of-service period for all failures in infrastructure, including recovery time, less than or equal to 7 hours last year, for these infrastructures:

Dimension	Physical
Subdimension	Mobility
Resilience objective	Safe mobility infrastructure
Criteria	Infrastructure assets robustness
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

Refers to structural failures on the assets, both having service interruption as a consequence or not. Does not refer to assets that have been decomissioned. Out of order means total interruptions of the service due to infrastructural problems. Click to select all applicable and please answer with correspondent estimated figures [hours] in comments for the others applicable not selected, considering infrastructure as networks and terminals. Sum of the selected options and a scale to 3 is made. If train based mobility does not exist in the city select (b) so as not to undercut the development of the metric.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**

PMob15 - Clean fuel public transport (-)

Existence of alternative clean fuel public transport in the city

Dimension	Physical
Subdimension	Mobility
Resilience objective	Safe mobility infrastructure
Criteria	Infrastructure assets robustness
Source	UN-Habitat CRPT 1-2.3.8 (adapted)
Importance	Essential
Level	Strategic
Metric type	Single choice

Clean fuel has zero/minimum effect on the environment. If the answer is Yes, please specify in comments.

Development assessment rule	Development
Yes	**3**
No	**0**

PMob16 - Cascading impacts (-)

There is knowledge concerning potentially cascading failures between the components of the mobility infrastructure [road, train, air and water based transport that applies] and the following infrastructure, under the agreed scenarios:

Dimension	Physical
Subdimension	Mobility
Resilience objective	Autonomous and flexible mobility infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum≥3 =3; Sum≥2 and <3 =2; Sum≥1 and <2 =1 Sum<1 =0).

Development assessment rule	Development
a) Full knowledge between the components of the mobility infrastructure	**1**
b) Partial knowledge between the components of the mobility infrastructure	**0.5**
c) Full knowledge of the infrastructure of the water service	**1**
d) Partial knowledge of the infrastructure of the water service	**0.5**
e) Full knowledge of the infrastructure of the wastewater service	**1**
f) Partial knowledge of of the infrastructure of the wastewater service	**0.5**
g) Full knowledge of the infrastructure of the stormwater service	**1**
h) Partial knowledge of the infrastructure of the stormwater service	**0.5**
i) Full knowledge of the infrastructure of the waste management service	**1**
j) Partial knowledge of the infrastructure of the waste management service	**0.5**
k) Full knowledge of the infrastructure of the energy service	**1**
l) Partial knowledge of the infrastructure of the energy service	**0.5**
m) None	**0**

PMob17 - Infrastructure of other services dependency on mobility infrastructure (-)

The infrastructure of the following services are dependent on mobility infrastructure:

Dimension	Physical
Subdimension	Mobility
Resilience objective	Autonomous and flexible mobility infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum<2 =3; Sum≥2 and <3 =2; Sum≥3 and <4 =1.5 Sum≥4 =0).

Development assessment rule	Development
a) Infrastructure of the water service	**1**
b) Infrastructure of the wastewater service	**1**
c) Infrastructure of the stormwater service	**1**
d) Infrastructure of the solid waste service	**1**
e) Infrastructure of the energy service	**1**
f) Other (explain in Comments)	**0**
g) None	**0**

PMob18 - Dependency on infrastructures of other services (-)

The infrastructure of the mobility service directly depends on the infrastructure of the following services:

Dimension	Physical
Subdimension	Mobility
Resilience objective	Autonomous and flexible mobility infrastructure
Criteria	Infrastructure assets importance to and dependency on other services
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum<2 =3; Sum≥2 and <3 =2; Sum≥3 and <4 =1.5 Sum≥4 =0).

Development assessment rule	Development
a) Infrastructure of the water service	**1**
b) Infrastructure of the wastewater service	**1**
c) Infrastructure of the stormwater service	**1**
d) Infrastructure of the solid waste service	**1**
e) Infrastructure of the energy service	**1**
f) Other (e.g. gas, fuel, telecommunication, explain in Comments)	**0**
g) None	**0**

PMob19 - Energy self production (%)

Percentage of energy consumption coming from self production

Dimension	Physical
Subdimension	Mobility
Resilience objective	Autonomous and flexible mobility infrastructure
Criteria	Infrastructure assets autonomy and redundancy
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Single choice

Please answer with correspondent estimated figures [%] in comments.

Development assessment rule	Development
More than or equal to 30%	**3**
More than or equal to 15% and less than 30%	**2**
More than or equal to 5% and less than 15%	**1**
Less than 5%	**0**

PMob20 - Redundancy (-)

Is there an understanding of infrastructure redundancy, clearly identified on hazard maps and data on risk?

Dimension	Physical
Subdimension	Mobility
Resilience objective	Autonomous and flexible mobility infrastructure
Criteria	Infrastructure assets autonomy and redundancy
Source	-
Importance	Essential
Level	Tactical
Metric type	Single choice

If the answer is different from Yes, please specify if any of the mobility services may answer Yes, in comments.

Development assessment rule	Development
Yes	**3**
Partially	**1.5**
No	**0**

PMob21 - Use of design solutions to improve city resilience (-)

The design of the infrastructure incorporates the use of solutions to improve city resilience:

Dimension	Physical
Subdimension	Mobility
Resilience objective	Mobility infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

Design solutions that contribute to the city's resilience that are not a direct component of the infrastructure that provides the service. E.g., any entity in its office buildings may have green roofs or porous floors in the parking lot. Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum≥3 =3; Sum≥2 and <3 =2; Sum≥1 and <2 =1 Sum<1 =0).

Development assessment rule	Development
a) Renewable energy generation	**1**
b) Water reuse and recycling	**1**
c) Green roofs	**1**
d) Other (e.g. bioretention, pervious surfaces, flood defences, explain in Comments)	**1**
e) None	**0**

PMob22 - Greenhouse gas emission target (-)

There is a prediction of GHG emissions reduction, aiming at the targets defined at the strategic planning level, from the following components of assets:

Dimension	Physical
Subdimension	Mobility
Resilience objective	Mobility infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 4 conditions (Sum≥3 =3; Sum≥2 and <3 =2; Sum≥1 and <2 =1.5; Sum<1 =0).

Development assessment rule	Development
a) Infrastructure operation	**1**
b) Fleet	**1**
c) Administrative buildings	**1**
d) Other (explain in Comments)	**0**
e) None	**0**

PMob23 - Other contributions to city resilience (-)

The mobility infrastructure and related services provide other contributions to city resilience in emergency situation, such as:

Dimension	Physical
Subdimension	Mobility
Resilience objective	Mobility infrastructure preparedness
Criteria	Contribution to city resilience
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multipleple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum<2 and ≥1=1; Sum<1 =0).

Development assessment rule	Development
a) Shelter	**1**
b) Medical services	**1**
c) First aid	**1**
d) Food storage	**1**
e) Food cooking and supply	**1**
f) Energy supply	**1**
g) Fuel supply	**1**
h) Emergency transport vehicles	**1**
i) Escape routes	**1**
j) Water storage	**1**
k) Other (e.g. personnel, explain in comments)	**0**

PMob24 - Level of exposure of mobility infrastructure for climate change scenarios (-)

Identify the critical assets for which less than 10% is exposed to different hazards for climate change scenarios

Dimension	Physical
Subdimension	Mobility
Resilience objective	Mobility infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

The critical routes are identified as critical for city mobility. Click to select all applicable and please answer with correspondent estimated figures [%], in comments for the others applicable not selected. Sum of the selected answers and the development is obtained throught 4 conditions (Sum≥2 =3; Sum<2 and ≥1=1; Sum<1 =0). This metric depends on the metric PMob01.

Development assessment rule	Development
a) Road routes	**1**
b) Train routes	**1**
d) None	**0**

PMob25 - Coverage of expenditure in infrastructure for climate change scenarios (-)

Ratio between predicted expenditure on infrastructure (routes and interfaces) affected by climate change scenarios and annual operating budget of last year between 0,9 and 1,0 or 1,1 and 1,2, for these infrastructures:

Dimension	Physical
Subdimension	Mobility
Resilience objective	Mobility infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Multiple choice

Click to select all applicable and please answer with correspondent estimated figures [-] in comments for the others applicable not selected. Sum of the selected options and a scale to 3 is made. If train based mobility does not exist in the city, select (b) so as not to undercut the development of the metric.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**

PMob26 - Time for restoration for climate change scenarios (-)

Transport networks with maximum out-of-service period for all failures in infrastructure (routes and interfaces), including recovery time, for less than 7 hours, due to different hazards for climate change scenarios, for these infrastructures:

Dimension	Physical
Subdimension	Mobility
Resilience objective	Mobility infrastructure preparedness
Criteria	Infrastructure assets exposure to climate change
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Click to select all applicable and please answer with correspondent estimated figures [hours] in comments for the others applicable not selected, considering infrastructure as networks and terminals. Out of order means total interruptions of the service due to infrastructural problems. Sum of the selected options and a scale to 3 is made. If train based mobility does not exist in the city select (b) so as not to undercut the development of the metric.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**

PMob27 - Implemented infrastructural measures to address climate change mitigation and adaptation (-)

What type of measures were implemented in infrastructure design to address climate change mitigation and adaptation?

Dimension	Physical
Subdimension	Mobility
Resilience objective	Mobility infrastructure preparedness
Criteria	Preparedness for climate change
Source	-
Importance	Essential
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1; Sum<1 =0).

Development assessment rule	Development
a) Physical barriers to overland flows	**1**
b) Decentralised energy supply stations (e.g. electrical, fuel)	**1**
c) Efficient water use devices	**1**
d) Efficient energy use components (e.g. electric vehicles suppliers)	**1**
e) Bicycle pathways	**1**
f) Public sharing bicycle terminals	**1**
g) Public car sharing-car pooling terminals	**1**
h) Soakaways and porous pavement	**1**
i) Other (explain in Comments)	**1**
j) None	**0**

PMob28 - Planned infrastructural measures to address climate change mitigation and adaptation (-)

What type of measures are being planned in infrastructure design to address climate change mitigation and adaptation?

Dimension	Physical
Subdimension	Mobility
Resilience objective	Mobility infrastructure preparedness
Criteria	Preparedness for climate change
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

Please select one or more of the options provided as answers. Sum of the selected answers and the development is obtained throught 3 conditions (Sum≥2 =3; Sum≥1 and <2 =1.5; Sum<1 =0).

Development assessment rule	Development
a) Physical barriers to overland flows	**1**
b) Decentralised energy supply stations (e.g. electrical, fuel)	**1**
c) Efficient water use devices	**1**
d) Efficient energy use components (e.g. electric vehicles suppliers)	**1**
e) Bicycle pathways	**1**
f) Public sharing bicycle terminals	**1**
g) Public car sharing-car pooling terminals	**1**
h) Soakaways and porous pavement	**1**
i) Other (explain in Comments)	**1**
j) None	**0**

PMob29 - Road and rail routes failures in the last relevant event (-)

Critical routes were out of order for less than 2h on average due to the last climate-related event, with similar or harsher climate variables than the most probable scenario, for these infrastructures:

Dimension	Physical
Subdimension	Mobility
Resilience objective	Mobility infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Multiple choice

The critical routes are identified as critical for city mobility. Out of order means total interruptions of the service due to infrastructural problems. Sum of the selected options and a scale to 3 is made. If train based mobility does not exist in the city, select (b) so as not to undercut the development of the metric.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**

PMob30 - Transport interfaces failures in the last relevant event (hours)

Average number of hours that critical transport interfaces were out of order due to infrastructural failures due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Mobility
Resilience objective	Mobility infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Essential
Level	Strategic
Metric type	Single choice

The critical interfaces are identified as critical for city mobility. Please answer with correspondent estimated figure [h] in comments. Out of order means total interruptions of the service due to infrastructural problems.

Development assessment rule	Development
Less or equal to 2	**3**
More than 2 and less than 6	**2**
More than or equal to 6 and less than 24	**1**
More than or equal to 24	**0**

PMob31 - Power related failures in road and rail routes in the last relevant event (-)

Critical routes were out of order for less than 2h on average, by power related failures, due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Mobility
Resilience objective	Mobility infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

The critical routes are identified as critical for city mobility. Click to select all applicable and please answer with correspondent estimated figures [hours], in comments for the others applicable not selected. Out of order means total interruptions of the service due to infrastructural problems. Sum of the selected options and a scale to 3 is made. If train based mobility does not exist in the city, select (b) so as not to undercut the development of the metric.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**

PMob32 - Flooding related failures in road and rail routes in the last relevant event (-)

Critical routes were out of order for less than 2h due to flooding on average, due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Mobility
Resilience objective	Mobility infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Multiple choice

The critical routes are identified as critical for city mobility. Click to select all applicable and please answer with correspondent estimated figures [hours], in comments for the others applicable not selected. Out of order means total interruptions of the service due to infrastructural problems. Sum of the selected options and a scale to 3 is made. If train based mobility does not exist in the city, select (b) so as not to undercut the development of the metric.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**

PMob33 - Flooding related failures in transport interfaces in the last relevant event (hours)

Average number of hours that critical transport interfaces were out of order due to flooding related failures on average, due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Mobility
Resilience objective	Mobility infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Complementary
Level	Tactical
Metric type	Single choice

The critical interfaces are identified as critical for city mobility. Please answer with correspondent estimated figure [h], in comments. Out of order means total interruptions of the service due to infrastructural problems.

Development assessment rule	Development
Less or equal to 2	**3**
More than 2 and less than 6	**2**
More than or equal to 6 and less than 24	**1**
More than or equal to 24	**0**

PMob34 - Power related failures in transport interfaces in the last relevant event (hours)

Average number of hours that critical transport interfaces were out of order by power related failures, due to the last climate-related event, with similar or harsher climate variables than the most probable scenario

Dimension	Physical
Subdimension	Mobility
Resilience objective	Mobility infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Single choice

The critical interfaces are identified as critical for city mobility. Please answer with correspondent estimated figure [hours], in comments. Out of order means total interruptions of the service due to infrastructural problems.

Development assessment rule	Development
Less or equal to 2	**3**
More than 2 and less than 6	**2**
More than or equal to 6 and less than 24	**1**
More than or equal to 24	**0**

PMob35 - Coverage of expenditure in infrastructure in the last relevant event (-)

Ratio of expenditure on rehabilitation, operation and management of infrastructure (routes and interfaces) affected by the last climate-related event, with similar or harsher climate variables than the most probable scenario, and annual operating budget of last year, is between 0.9 and 1.0 or 1.1 and 1.2, for these infrastructures:

Dimension	Physical
Subdimension	Mobility
Resilience objective	Mobility infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Comprehensive
Level	Strategic
Metric type	Multiple choice

Select all applicable and please answer with correspondent estimated figures [-], in comments for the others applicable not selected, considering infrastructure as networks and terminals. Sum of the selected options and a scale to 3 is made. If train based mobility does not exist in the city, select (b) so as not to undercut the development of the metric.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**

PMob36 - Time for restoration in the last relevant event (-)

Mobility critical infrastructure (routes and interfaces) with a maximum out-of-service period for all failures in infrastructure, including recovery time, less than or equal to 7 hours due to the last climate-related event, with similar or harsher climate variables than the most probable scenario, for these infrastructures:

Dimension	Physical
Subdimension	Mobility
Resilience objective	Mobility infrastructure preparedness
Criteria	Preparedness for recovery and build back
Source	-
Importance	Comprehensive
Level	Tactical
Metric type	Multiple choice

Select all applicable and please answer with correspondent estimated figures [h] in comments for the others applicable not selected, considering infrastructure as networks and terminals. Sum of the selected options and a scale to 3 is made. If train based mobility does not exist in the city, select (b) so as not to undercut the development of the metric.

Development assessment rule	Development
a) Road based	**1**
b) Train based	**1**

Annex 2 – Metrics dependencies

Metrics dependencies

Organisational

Metrics	Dependencies
O16 (if 3/2/1 selected)	O17
	O18
O24 (If 3 or 2 selected)	O25
	O26
	O27
	O28
	O29
O38 (if yes)	O39
O30 (if 3/2/1 selected)	O36, O40, O46, O48
O44 (if yes)	O45
O51 (if yes)	O52
	O53
O58 (if 3/2/1 selected)	O59, O60
O63 (if yes)	O64
O54 organisational (if 3/2/1 selected)	S06, S07, S08, S09, S16, S17, S27, S28; FMob12, FMob13, FMob14, FMob15, FMob16, FMob17, FMob35, FMob36, FMob38, FMob39,FMob40, FMob41, FMob42

Spatial

Metrics	Dependencies
S01 (if yes)	S02
S09 (if yes)	S10
S14 (if 3 or 2 or 1 selected)	S15
S22 (if yes or partially)	S23, S24

Functional - Water

Metrics	Dependencies
FWts01 (if yes/partially)	FWts02
	FWts03
FWts06 (if yes)	FWts07
FWts56 (if 3/2/1 selected)	FWts57
FWts48 (if 3/2/1 selected)	FWts14, FWts15, FWts16, FWts17, FWts18, FWts19, FWts20, FWts21, FWts22, FWts23, FWts41, FWts42, FWts49, FWts58 to FWts67; PWts20, PWts36, PWts37, PWts38, PWts41, PWts42, PWts43, PWts44, PWts45, PWts46, PWts47, PWts48, PWts49

Functional - Wastewater

Metrics	Dependencies
FWwt01 (if yes/partially)	FWwt02
	FWwt03
FWwt06 (if yes)	FWwt07
FWwt53 (if 3/2/1 selected)	FWwt54
FWwt45 (if 3/2/1 selected)	FWwt14, FWwt15, FWwt16, FWwt17, FWwt18, FWwt19, FWwt20, FWwt21, FWwt38, FWwt39, FWwt46, FWwt55, FWwt56, FWwt57, FWwt58, FWwt59, FWwt60, FWwt61, FWwt62, FWwt63; PWwt20, PWwt35, PWwt36, PWwt37, PWwt40, PWwt41, PWwt42, PWwt43, PWwt44, PWwt45, PWwt46, PWwt47, PWwt48

Functional - Stormwater

Metrics	Dependencies
FSwt01 (if yes/partially)	FSwt02
	FSwt03
FSwt06 (if yes)	FSwt07
FSwt46 (if 3/2/1 selected)	FSwt47
FSwt38 (if 3/2/1 selected)	FSwt14, FSwt15, FSwt16, FSwt17, FSwt18, FSwt31, FSwt32, FSwt39, FSwt48, FSwt49, FSwt50, FSwt51, FSwt52; PSwt20, PSwt35, PSwt36, PSwt37, PSwt40, PSwt41, PSwt42, PSwt43, PSwt44, PSwt45, PSwt46, PSwt47, PSwt48

Functional - Waste

Metrics	Dependencies
FSlw01 (if yes/partially)	FSlw02
	FSlw03
FSlw06 (if yes)	FSlw07
FSlw51 (if 3/2/1 selected)	FSlw52
FSlw43 (if 3/2/1 selected)	FSlw14, FSlw15, FSlw16, FSlw17, FSlw18, FSlw19,FSlw20, FSlw36, FSlw37, FSlw44, FSlw53, FSlw54, FSlw55, FSlw56, FSlw57, FSlw58, FSlw59, FSlw60; PSlw18, PSlw35, PSlw36, PSlw37, PSlw40, PSlw41, PSlw42, PSlw43, PSlw44, PSlw45, PSlw46, PSlw47, PSlw48

Functional - Energy

Metrics	Dependencies
FEne01 (if yes/partially)	FEne02
	FEne03
FEne06 (if yes)	FEne07
FEne46 (if 3/2/1 selected)	FEne47
FEne38 (if 3/2/1 selected)	FEne14, FEne15, FEne16, FEne17, FEne18, FEne31, FEne32, FEne39, FEne48, FEne49, FEne50, FEne51, FEne52; PEne16, PEne30, PEne31, PEne32, PEne35, PEne36, PEne37, PEne38, PEne39, PEne40, PEne41

Functional - Mobility

Metrics	Dependencies
FMob01 (if existing)	FMob02
	FMob03
	FMob06
	FMob07
	FMob08

Physical - Water

Metrics	Dependencies
PWts01 (if yes/partially)	PWts02
	PWts03
	PWts04
PWts01 (if yes/partially)	PWts36, PWts47

Physical - Wastewater

Metrics	Dependencies
PWwt01 (if yes/partially)	PWwt02
	PWwt03
	PWwt04
PWwt01 (if yes/partially)	PWwt35, PWwt46

Physical - Stormwater

Metrics	Dependencies
PSwt01 (if yes/partially)	PSwt02
	PSwt03
	PSwt04
PSwt01 (if yes/partially)	PSwt35, PSwt46

Physical - Waste

Metrics	Dependencies
PSlw01 (if yes/partially)	PSlw02
	PSlw03
	PSlw04
PSlw01 (if yes/partially)	PSlw35, PSlw46

Physical - Energy

Metrics	Dependencies
PEne01 (if yes/partially)	PEne02
	PEne03
	PEne04
PEne01 (if yes/partially)	PEne30, PEne39

Physical - Mobility

Metrics	Dependencies
PMob01 (if yes/partially)	PMob02
	PMob03
PMob01 (if yes/partially)	PMob24

Annex 3 – Testing results

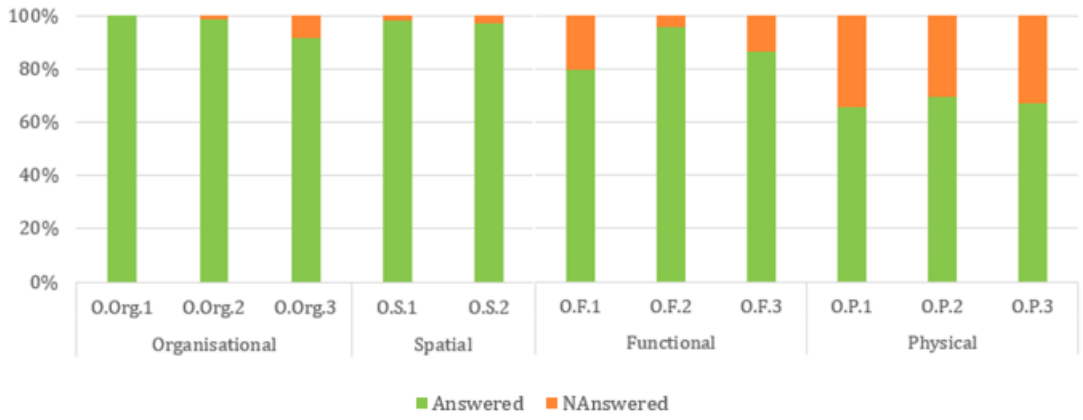


Figure A 1 - Testing results: overall of the three cities | answering to the metrics, considering each dimension and objective

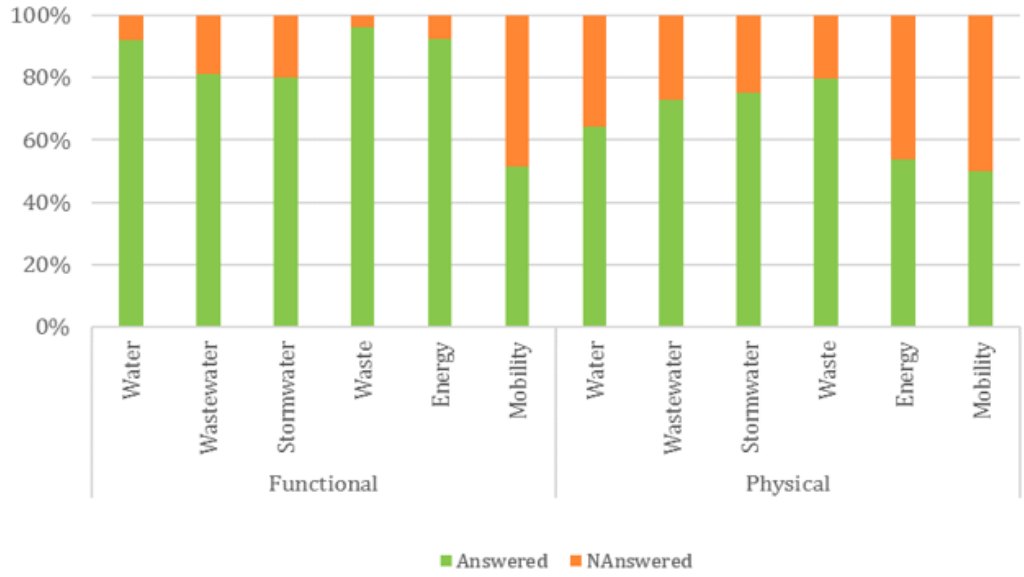
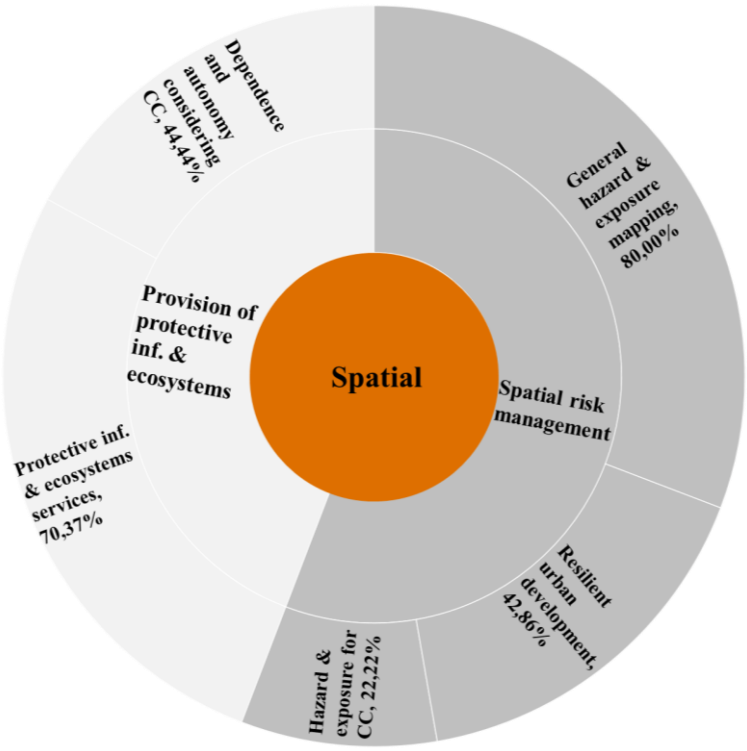


Figure A 2 - Testing results: overall of the three cities | answering to the metrics, considering functional and physical dimensions for each service

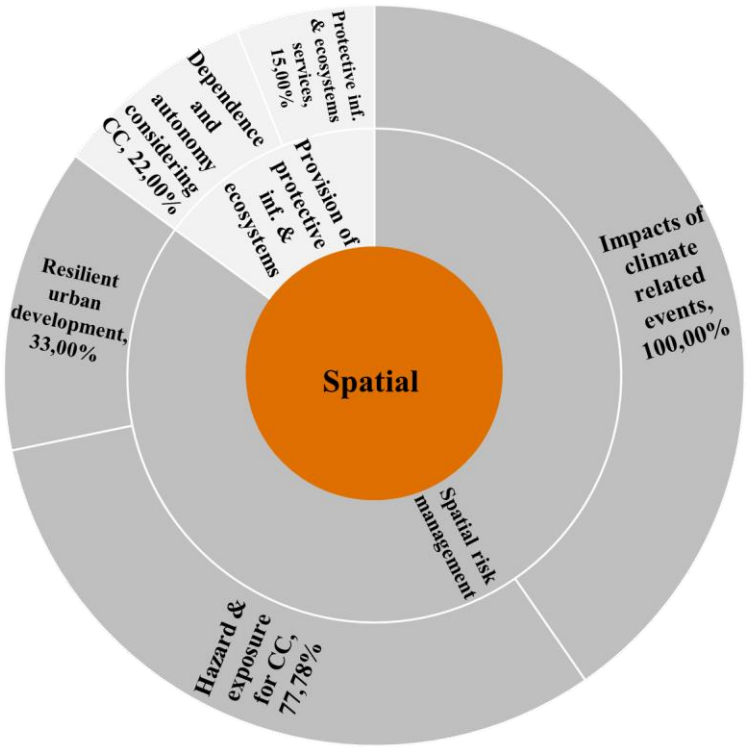
a) % of advanced metrics

b) % of incipient metrics

Figure A 3 - Overall of three cities testing | organisational dimension: development level

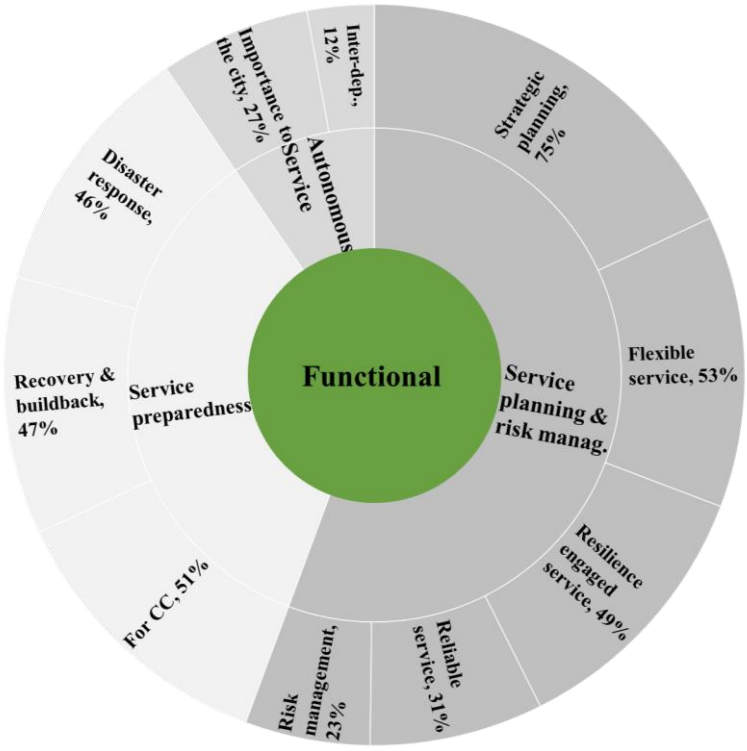


a) % of advanced metrics

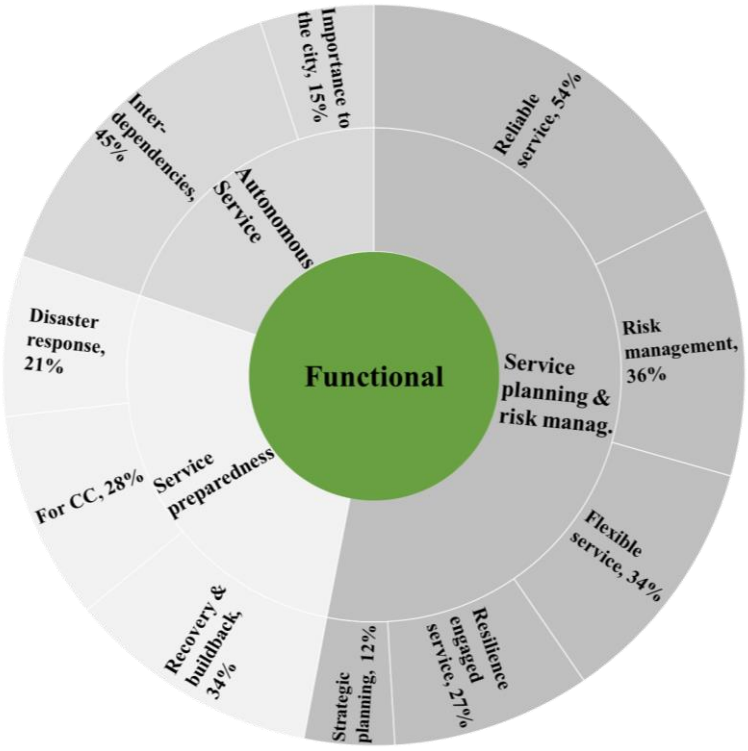


b) % of incipient metrics

Figure A 4 - Overall of three cities testing | spatial dimension: development level

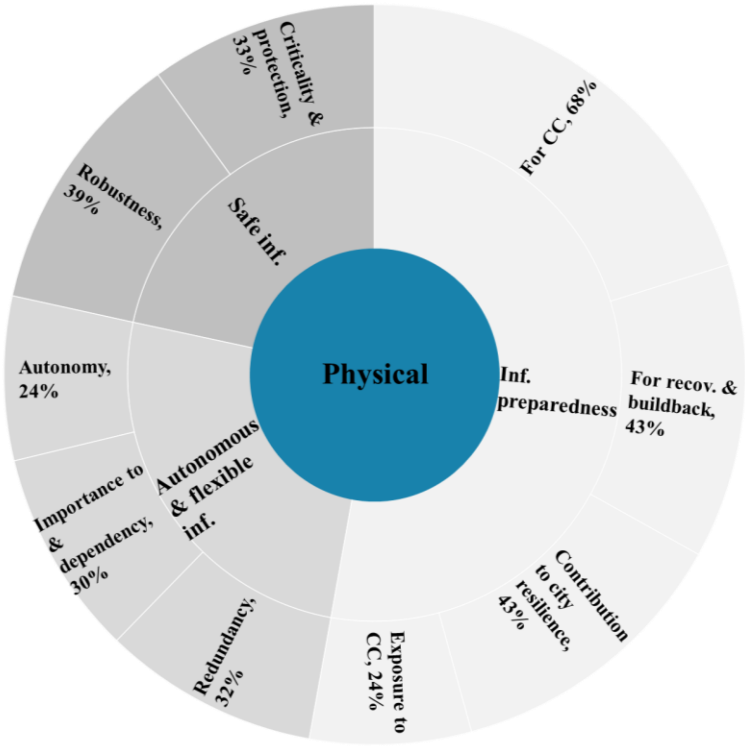


a) % of advanced metrics

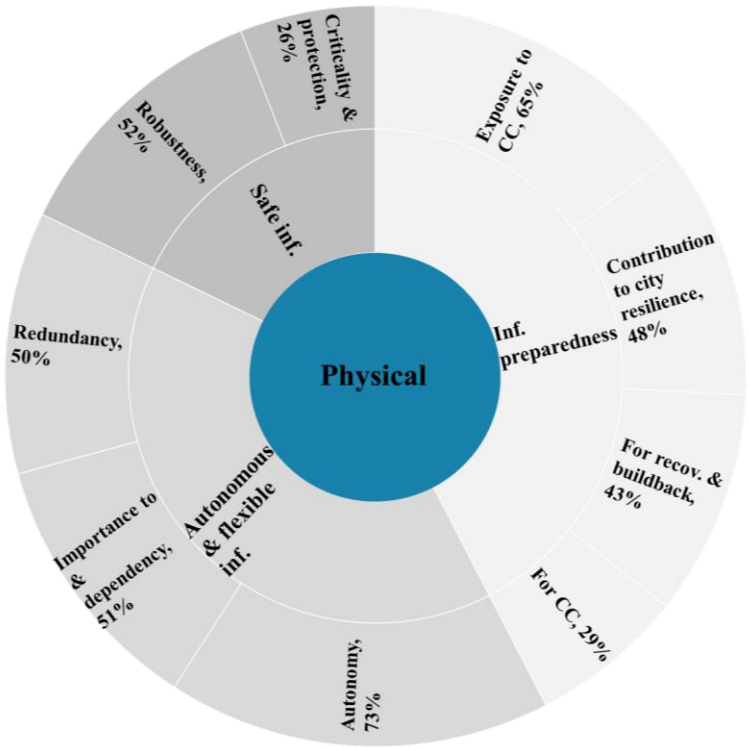


b) % of incipient metrics

Figure A 5 - Overall of three cities testing | functional dimension: development level



a) % of advanced metrics



b) % of incipient metrics

Figure A 6 - Overall of three cities testing | physical dimension: development level

Annex 4 – Links between resilience strategies and the RAF metrics

BARCELONA

	Organisational	Spatial	Functional	Physical
S001BCN Flood impacts reduction in a context of climate change **Measures** ▪ Improvements of surface drainage system (New inlets) ▪ Increase of sewer system capacity (I) (New pipes) ▪ Increase of sewer system capacity (II) (New detention tanks for flooding protection) ▪ SUDs (green roofs, infiltration trenches, detention basins) ▪ Early Warning System ▪ Self– healing algorithm implemented in the electrical distribution grid ▪ Ensure the stability of waste containers	**Obj. O2** – O23, 025, 026, 034 **Obj. O3** – 038, O46, O51, O52, O53, O54, O55, O57, O66, O70	**Obj. S1** – S01, S02, S03, S04, S05, S06, S07, S08, S09, S10 S11, S12, S13, S14, S15, S16, S17 **Obj. S2** – S18, S19, S22, S23, S25, S26	**Obj. FW1** – FWts05, FWts12, FWts13, FWts14, FWts15, FWts16, FWts17, FWts18, FWts19, FWts20, FWts21, FWts22, FWts23, FWts35, FWts36, FWts37 **Obj. FW3** – FWts47, FWts48, FWts49, FWts50, FWts51, FWts52, FWts53, FWts54 **Obj. FWW1** – FWwt01, FWwt02, FWwt03, FWwt04, FWwt05, FWwt07 FWwt12, FWwt13 FWwt14, FWwt15 FWwt16, FWwt17 FWwt18, FWwt19 FWwt20, FWwt21 FWwt32, FWwt33 **Obj. FWW3** – FWwt44, FWwt45 FWwt46, FWwt47 FWwt48, FWwt49 FWwt50, FWwt51 **Obj. FSW1** – FSwt01, FSwt02, FSwt03, FSwt04, FSwt05, FSwt07 FSwt12, FSwt14 FSwt15, FSwt16 FSwt17, FSwt18 FSwt25, FSwt26 **Obj. FSW2** – FSwt31,FSwt32 **Obj. FSW3** – FSwt35,FSwt37, FSwt38, FSwt39, FSwt40, FSwt41, FSwt42, FSwt43, FSwt44 **Obj. FWT1** – FSlw12, FSlw13 FSlw14, FSlw15 FSlw16, FSlw17	**Obj. PW1** – PWts01, PWts03, PWts06, PWts07, PWts17 **Obj. PW3** – PWts33, PWts35, PWts39, PWts40 **Obj. PWW1** – PWwt06, PWwt07 PWwt17 **Obj. PWW3** – PWwt32, PWwt34, PWwt38, PWwt39 **Obj. PSW1** – PSwt01, PSwt03 PSwt06, PSwt07 PSwt17 **Obj. PSW2** –PSwt28 **Obj. PSW3** – PSwt32, PSwt34 PSwt35, PSwt38 PSwt39 **Obj. PWT1** – PSlw06, PSlw07 PSlw11, PSlw13 **Obj. PWT3** – PSlw31, PSlw34, PSlw38, PSlw39 **Obj. PE1** –PEne06, PEne07 **Obj. PE3** – Ene27, PEne29, PEne33, PEne34 **Obj. PM1** – PMob05, PMob06 **Obj. PM3** – PMob21, PMob23 PMob27, PMob28

			FSlw18, FSlw19 FSlw20 **Obj. FWT3** – FSlw42, FSlw43, FSlw44, FSlw45, FSlw46, FSlw47, FSlw48, FSlw49 **Obj. FE1** – FEne12, FEne13, FEne14, FEne15, FEne16, FEne17, FEne18 **Obj. FE3** – FEne37 FEne38, FEne39 FEne40, FEne41 FEne42, FEne43 FEne44 **Obj. FM1** – FMob11, FMob12, FMob13, FMob14, FMob15, FMob16, FMob17 **Obj. FM3** – Mob37	
S002BCN Environmental improvement of receiving water bodies **Measures** ▪ SUDS (green roofs, infiltration trenches, detention basins) ▪ Storage tanks for CSO prevention ▪ Improvements of the capacity of sewer interceptor and WWTP ▪ Early Warning System ▪ End of pipe CSO treatment		**Obj. S1** – S04, S05, S06, S07, S08, S09, S10, S11, S12, S13, S14, S15, S16, S17 **Obj. S2** – S18,S19,S20, S21 S22, S23, S24, S25, S26	**Obj. FW1** – FWts03, FWts07 FWts11, FWts12 FWts13, FWts14 FWts15, FWts16 FWts17, FWts18 FWts19, FWts20 FWts21, FWts22 FWts23, FWts35 FWts36, FWts37 FWts38 **Obj. FW2** – FWts40, FWts41, FWts42 **Obj. FW3** – FWts47, FWts48 FWts49, FWts50 FWts51, FWts52 FWts53, FWts56 FWts57, FWts68 **Obj. FWW1** – FWwt01, FWwt02, FWwt03, FWwt03, FWwt04, FWwt07, FWwt09, FWwt11, FWwt12, FWwt13, FWwt14, FWwt15, FWwt16, FWwt17,	**Obj. PW1** – PWts06, PWts07 PWts17, PWts18 PWts19 **Obj. PW2** – PWts20, PWts21, PWts22, PWts23, PWts24, PWts25 **Obj. PW3** – PWts33, PWts35, PWts36, PWts37, PWts38, PWts39, PWts40 **Obj. PWW1** – PWwt03, PWwt06, PWwt07, PWwt17, PWwt18, PWwt19 **Obj. PWW2** – PWwt20, PWwt21, PWwt22, PWwt23, PWwt24, PWwt25 **Obj. PWW3** – PWwt32, PWwt34, PWwt35, PWwt36, PWwt37, PWwt38, PWwt39

			FWwt18, FWwt19, FWwt20, FWwt21, FWwt32, FWwt33, FWwt34, FWwt35 **Obj. FWW2** – FWwt37, FWwt38, FWwt39 **Obj. FWW3** – FWwt40, FWwt42 FWwt44, FWwt45, FWwt46, FWwt47, FWwt48, FWwt49, FWwt50, FWwt53, FWwt54, FWwt64	**Obj. PSW1** – PSwt01, PSwt03 Pswt06, PSwt07, PSwt17 PSwt18, PSwt19 **Obj. PSW2** – PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25 PSwt28 **Obj. PSW3** – PSwt32, PSwt35, PSwt36, PSwt37, PSwt38 , PSwt39
S003BCN Not a single drop wasted. Alternative water resources **Measures** ▪ Optimize desalinization plant production ▪ Promote the use of grey water in new housing developments ▪ Continue reducing leakage in water distribution networks ▪ Study the feasibility of producing regenerated water at the Besòs WWTP to feed the Besòs aquifer, to maintain the river's ecological flows and feed the purification plant ▪ Exploit the Besòs aquifer resource as potable water and build a purification plant ▪ Utilise regenerated water from the River Llobregat for the industrial uses of the Zona Franca Consortium and for recharging the aquifer	**Obj. O1** – O01, O03, 006 **Obj. O2** – O15, 016, 018, O19, O20, O22, O23, O24, O25, O26, O27, O28, O29 **Obj. O3** – O41, O51, O52, O53, O54, O55, O56, O57, 065, 066, 067	**Obj. S1** – S03, S05, S13, S15 **Obj. S2** – S26	**Obj. FW1** – FWts01, FWts02 FWts03, FWts04 FWts05, FWts06 FWts07, FWts08 FWts09, FWts12 FWts13, FWts14 FWts15, FWts16 FWts17, FWts18 FWts19, FWts20 FWts21, FWts22 FWts23, FWts35 FWts36, FWts37 FWts38 **Obj. FW2** – FWts41, FWts42 **Obj. FW3** – FWts43, FWts44, FWts45, FWts47, FWts48, FWts49, FWts50, FWts51, FWts52, FWts53, FWts54, FWts55, FWts56, FWts57 **Obj. FWW1** – FWwt01, FWwt02 FWwt03, FWwt04 FWwt05, FWwt06 FWwt07, FWwt08 FWwt09, FWwt12 FWwt13, FWwt14 FWwt15, FWwt16 FWwt17, FWwt18 FWwt19, FWwt20 FWwt32, FWwt33 FWwt34, FWwt35 **Obj. FWW3** – FWwt40, FWwt41,	**Obj. PW1** – PWts01, PWts02, PWts03, PWts06, PWts07, PWts17, PWts18, PWts19 **Obj. PW2** – PWts20, PWts21, PWts22, PWts23, PWts24, PWts25 **Obj. PW3** – PWts33, PWts35 PWts37, PWts39 PWts40 **Obj. PWW1** – PWwt01, PWwt02, PWwt03, PWwt05, PWwt06, PWwt07 PWwt17, PWwt18 PWwt19 **Obj. PWW3** – PWwt32, PWwt34, PWwt36, PWwt38, PWwt39 **Obj. PSW1** – PSwt01,PSwt02 PSwt03, PSwt05, PSwt06, PSwt07 **Obj. PSW3** – PSwt32, PSwt34 PSwt36, PSwt38 PSwt39

▪ Promote rainwater collection and its reuse in buildings ▪ Inter– basins connections ▪ Increase the water cost for specific uses			FWwt42, FWwt44, FWwt45, FWwt46, FWwt47, FWwt48, FWwt49, FWwt50, FWwt51, FWwt52 **Obj. FSW1** – FSwt01, FSwt02 FSwt03, FSwt04 FSwt05, FSwt06 FSwt07, FSwt08 FSwt09, FSwt12 FSwt13, FSwt14 FSwt15, FSwt16 FSwt17, FSwt18 FSwt25, FSwt26 FSwt27, FSwt28 **Obj. FSW2** – FSwt30, FSwt31, FSwt32 **Obj. FSW3** – FSwt33, FSwt35 FSwt37, FSwt38 FSwt39, FSwt40 FSwt41, FSwt42 FSwt43	
S004BCN Guarantee security of services supply **Measures** ▪ Perform a Resilience Diagnosis of the city by using RESCCUE methodology and tools ▪ Elaborate a Resilience Action Plan for the city according to RESCCUE methodology ▪ To locate a control centre and a situation room	**Obj. O1** – O01, O02, O03, O04, O05, O06, O07, O08, O09, O10 **Obj. O2** – O11, O12, 013, O14, O15, O16, O17, O18, O19, O20, O21, 022, O23, O24, O25, O26, O27, O28, O29, 031,036,037 **Obj. O3** – O38, O39, O40, O41, O42, O43, O44, O45, O46, O47, O48, O49, O50, O51, O52, O53, O54, 055, 056, O57, 058, 059, 060, 061, 063, 064, O65, O66, O70	**Obj. S1** – S01, S02, S03, S04, S05, S06, S07, S08, S09, S10, S11, S12, S13, S14, S15, S16, S17 **Obj. S2** – S22, S23, S25, S26 S27	**Obj. FW1** – FWts01, FWts02 FWts03, FWts04 FWts05, FWts06 FWts07, FWts08 FWts09, FWts12 FWts13, FWts14 FWts15, FWts16 FWts17, FWts18 FWts19, FWts20 FWts21, FWts22 FWts23, FWts35 FWts36, FWts37 **Obj. FW2** – FWts41, FWts42 **Obj. FW3** – FWts43, FWts44 FWts45, FWts46 FWts50, FWts51 FWts52, FWts53 FWts54, FWts55 **Obj. FWW1** – FWwt01, FWwt02 FWwt03, FWwt04 FWwt05, FWwt06 FWwt07, FWwt08 FWwt09, FWwt12 FWwt13, FWwt14	**Obj. PW1** – PWts03, PWts04 PWts05, PWts07 PWts17 **Obj. PW2** – PWts21, PWts22, PWts23, PWts24, PWts25, **Obj. PW3** – PWts33, PWts35 PWts39, PWts40 **Obj. PWW1** – PWwt03, PWwt04 PWwt05, PWwt06 PWwt07, PWwt17 **Obj. PWW2** – PWwt21, PWwt22 PWwt23, PWwt24 PWwt25 **Obj. PWW3** – PWwt32, PWwt34, PWwt38, PWwt39 **Obj. PSW1** – PSwt03, PSwt04 PSwt05, PSwt06

			FWwt15, FWwt16 FWwt17, FWwt18 FWwt19, FWwt20 FWwt21, FWwt32 FWwt33 **Obj. FWW2** – FWwt38, FWwt39 **Obj. FWW3** – FWwt40, FWwt41, FWwt42, FWwt43, FWwt47, FWwt48, FWwt49, FWwt50, FWwt51, FWwt52, FWwt53, FWwT54 **Obj. FSW1** – FSwt01, FSwt02 FSwt03, FSwt04 FSwt05, FSwt06 FSwt07, FSwt08 FSwt09, FSwt12 FSwt13, FSwt14 FSwt15, FSwt16 FSwt17, FSwt18 FSwt25, FSwt26 **Obj. FSW2** – FSwt31, FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt35, FSwt36 FSwt40, FSwt41 FSwt42, FSwt43 FSwt44, FSwt45 **Obj. FWT1** – FSlw01, FSlw02 FSlw03, FSlw04 FSlw05, FSlw06 FSlw07, FSlw08 FSlw09, FSlw12 FSlw13, FSlw14 FSlw15, FSlw16 FSlw17, FSlw18 FSlw19, FSlw20 **Obj. FWT3** – FSlw36, FSlw37 FSlw38, FSlw39 FSlw40, FSlw41 FSlw45, FSlw46 FSlw47, FSlw48 FSlw49, FSlw50 **Obj. FE1** –FEne01, FEne02, FEne03,	PSwt07, PSwt17 **Obj. PSW2** – PSwt21, PSwt22, PSwt23, PSwt24, PSwt25 **Obj. PSW3** – PSwt32, PSwt34, PSwt38, PSwt39 **Obj. PWT1** – PSlw03, PSlw04 PSlw05, PSlw06 PSlw07, PSlw13 **Obj. PWT2** – PSlw19, PSlw20 PSlw21, PSlw22 PSlw23 **Obj. PWT3** – PSlw3, PSlw34, PSlw38, PSlw39 **Obj. PE1** – PEne03, PEne04 PEne05, PEne06 PEne07 **Obj. PE2** – PEne17, PEne18, PEne19, PEne20, PEne21 **Obj. PE3** – PEne27, PEne29 PEne33, PEne34 **Obj. PM1** – PMob03, PMob04 PMob05, PMob06 **Obj. PM2** – PMob17, PMob18 **Obj. PM3** – PMob21, PMob23 PMob27, PMob28

			FEne04, FEne05, FEne06, FEne07, FEne08, FEne09, FEne12, FEne13, FEne14, FEne15, FEne16, FEne17, FEne18 **Obj. FE2** – FEne31, FEne32 **Obj. FE3** – FEne33, FEne34 FEne35, FEne36 FEne40, FEne41 FEne42, FEne43 FEne44, FEne45 **Obj. FM1** – FMob03, FMob04 FMob05, FMob06 FMob07, FMob08 FMob11, FMob12 FMob13, FMob14 FMob15, FMob16 FMob17 **Obj. FM2** – FMob35, FMob36	
S007BCN Taking care of everyone **Measures** ▪ Provide tax incentives, grants and subsidies for housing energy improvements ▪ Promote the figure of the energy adviser ▪ Prevent electricity cut off, especially for the most vulnerable people ▪ Reduce the nuisance caused by bad smells by improving waste collection and sewage systems in the event of hot weather	**Obj.O3** – O03, O56, O57	**Obj.S1 –** S03 S06, S08, S14, S16 **Obj.S2 –** S25 S26	**Obj. FE1** – FEne06 FEne07, FEne08 FEne12, FEne13 FEne14, FEne15 FEne16, FEne17 FEne18 **Obj. FE3** – FEne48, FEn49	
S008BCN No cuts **Measures**	**Obj.O1** – O03 **Obj.O2** – O16, O18, O23	**Obj.O1** – S06, S08, S16	**Obj. FW1** – FWts12, FWts13 FWts14, FWts15 FWts16, FWts17	**Obj. PWW3** – PWts33, PWts35 PWts39, PWts40

▪ Renovate housing improving insulation to heat and flood, replacing obsolete electrical installations, etc. ▪ Guarantee water and energy supplies and uninterrupted service of various critical facilities and infrastructures ▪ Study the impact that climate change could have on the price of basic supplies and food	**Obj.O3** – O71		FWts18, FWts19 FWts20, FWts21 FWts22, FWts23 FWts35, FWts36 FWts37 **Obj. FW3** –FWts50, FWts51, FWts52 **Obj. FE1** – FEne12 FEne13, FEne14 FEne15, FEne16 FEne17, FEne18 FEne25, FEne26 FEne27 **Obj. FE3** – FEne40, FEne41 FEne42	**Obj. PE3** – PEne27, PEne29, PEne33, PEne34
S009BCN Preventing excessive heat **Measures** ▪ Identify existing and potential climate shelter spaces ▪ Deepen knowledge on how climate change affects health ▪ Deepen knowledge on the urban climate (weather stations, etc.) ▪ Prioritise the cooling actions (green infrastructure, lakes, fountains, etc.) specially in those areas most vulnerable to heat	**Obj.O2 –** O30 **Obj.O3 –** O54, O57	**Obj.S1 –** O03 S04, S13, S16 **Obj.S2 –** S25, S26		
S010BCN Recovering terrace roofs **Measures** ▪ Draw up a by– law to promote productive roofs ▪ Draw up technical guidelines for public buildings that include the use of productive roofs, walls and facades	**Obj.O1 –** O01, O02, O03, O04	**Obj.S1 –** S12 S13, S19 **Obj.S2 –** S25 S26		

▪ Consolidate the green roof competition: one roof per district (annually) ▪ Promote initiatives that publicise and tell people about productive roofs				
S011BCN Planning with a climate focus **Measures** ▪ Adapt the necessary current urban planning regulations ▪ Draw up a design guide with sustainability and resilience criteria ▪ Draft a green and biodiversity charter ▪ Analyse how climate change specifically affects each district	**Obj.O2** – O24, O25, O26, O27, O28, O29 **Obj.O3** – O51, O52, O53, O57	**Obj.S1** – S01, S02, S03, S04 **Obj.S2** – S21, S22, S23		
S012BCN Many more green areas **Measures** ▪ Incorporate CC criteria in the Special Plan for protecting the environment and landscape of the Serra de Collserola nature reserve ▪ Create design criteria and, with public participation, plan the network of urban green corridors ▪ Prioritise the actions planned in the PIVU in those districts and neighbourhoods with fewer green spaces and most exposed to heat	**Obj.O1** – O01, O02, O03 O04, O05, O06, O07, O08, O09, O10	**Obj.S1** – S09 S10, S12, S13 **Obj.S2** – S19 S21, S22, S23 S24, S25, S26		

▪ Consolidate the existing programmes to conserve wildlife vulnerable to CC				
S014BCN Not a single drop wasted. Increase water infiltration **Measures** ▪ Increase soil permeability by defining a sustainable urban drainage strategy ▪ Use drainage paving ▪ Assess and continually monitor the quality of drinking water and groundwater to see if it is affected in periods of drought or heavy rain ▪ Draw up a base map of the city's subsoil to find out the present degree of occupancy and impermeability and create reserve spaces for infiltration	**Obj.O3** – O56, O57	**Obj.S1** – S09 S10, S11, S12, S13 **Obj.S2** – S25, S26	**Obj. FW1** –FWts01, FWts02, FWts03, FWts04, FWts05, FWts06, FWts07, FWts08, FWts09, FWts12, FWts15, FWts17, FWts19, FWts21, FWts23 **Obj. FW3** –FWts43, FWts45, FWts47, FWts48, FWts49, FWts50, FWts51, FWts52 **Obj. FSW1** – FSwt01, FSwt02 FSwt03, FSwt04 FSwt05, FSwt06 FSwt07, FSwt08 FSwt09, FSwt12 **Obj. FSW3** – FSwt33, FSwt35 FSwt37, FSwt38 FSwt39, FSwt40 FSwt41, FSwt42 FSwt43, FSwt44 FSwt45	**Obj. PW3** – FWts33, PWts39, PWts40 **Obj. PSW3** – PSwt3 PSwt38, PSwt39
S015BCN Not a single drop wasted. Guarantee water supply **Measures** ▪ Foster water saving on a municipal level ▪ Incorporate up– to–date climate projections in future editions of the Drought Protocol ▪ Ensure compliance with the protocol for emptying water into naturalised ponds in the event of a drought, to preserve and	**Obj.O3** – O51, O52, O53 O54, O55, O56, O57	**Obj.S2** – S21, S22, S23	**Obj. FW1** – FWts01, FWts02 FWts03, FWts04 FWts05, FWts06 FWts07, FWts08 FWts09, FWts12 FWts13, FWts14 FWts15, FWts16 FWts17, FWts18 FWts19, FWts20 FWts21, FWts22 FWts23, FWts35 **Obj. FW2** – FWts36, FWts37 **Obj. FW3** – FWts43, FWts45 FWts47, FWts48 FWts49, FWts50 FWts51, FWts52 FWts53, FWts54	

protect amphibians and water plants ▪ Have a water supply plan in place			FWts55	
S016BCN Conserving the seafront **Measures** ▪ Carry out further studies on the vulnerability of beaches to erosion and sea flooding ▪ Establish sediment conservation measures ▪ Protecting the specific use of each beach ▪ Redefine existing coastal uses		**Obj.S2** – S21 S22, S23		
S018BCN Cultural action for the climate **Measures** ▪ Establish a specific call for grants to promote the citizen climate agenda, thus rewarding innovation and cooperation ▪ Reinforce the support programmes in schools, shops and local organisations as spaces for climate awareness and action ▪ Highlight the commitments, actions and good practices of the various stakeholders ▪ Put a sustainability reference figure in place in each district	**Obj.O1** – O01, O02, O03, O04, O05, O06, O07, O08, O09, O10 **Obj.O2 –** O11, O33, O37			
S019BCN Let's get organised infrastructure,	**Obj.O1** – O01, O02, O03, O04, O05, O06, O07, O08, O09, O10		**Obj.FW1** – FWts11 **Obj.FWW1** – FWwt11	

exposed to estuarine flood **Measures** ▪ Make public, through Open Data, relevant information on climate impacts and any monitoring action carried out (transparency) ▪ Take part in city networks to foster the exchange of good practices and collaborate with benchmark international institutions ▪ Promote innovation and establish links with research centres to generate new knowledge on climate change ▪ Learn more about the impact of climate change on keeping critical city services and infrastructures going (health services, utility supplies, etc.) and how they depend on each other	**Obj.O2 –** O11, O33, O37		**Obj.FSW1** – FSwt11 **Obj.FWT1** – FSlw11 **Obj.FE1** – FEne11 **Obj.FM1** – FMOB10	

BRISTOL

	Organisational	Spatial	Functional	Physical
S001Bristol Bioretention area		**Obj.S1** – S13 **Obj.S2** – S18 S19, S25, S26	**Obj. FWW1** – FWwt14, FWwt15 FWwt16, FWwt17 FWwt18 **Obj. FWW3** – FWwt48, FWwt49 **Obj. FSW1** – FSwt14, FSwt15 FSwt16, FSwt17 FSwt18, FSwt26	**Obj. PWW3** – PWwt32, PWwt38 PWwt39 **Obj. PSW3** – PSwt32, PSwt38 PSwt39

			Obj. FSW3 – FSwt41, FSwt42	
S002Bristol Data collection for flood recovery		**Obj.S1** – S03 S05, S16, S17	**Obj. FW1** – FWts11, FWts12, FWts13 **Obj. FW2** – FWts40, FWts41 FWts42 **Obj. FW3** – FWts43, FWts44 FWts47, FWts49 FWts50, FWts51 FWts52, FWts53 FWts54, FWts55 FWts56, FWts57 FWts68 **Obj. FWW1** – FWwt11, FWwt12 FWwt13 **Obj. FWW2** – FWwt37, FWwt38 FWwt39 **Obj. FWW3** – FWwt40, FWwt41 FWwt44, FWwt45 FWwt46, FWwt47 FWwt48, FWwt49 FWwt50, FWwt51 FWwt52, FWwt53 FWwt54, FWwt64 **Obj. FSW1** – FSwt03, FSwt11 FSwt12, FSwt13 **Obj. FSW2** – FSwt30, FSwt31 FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt37, FSwt38 FSwt39, FSwt40 FSwt41, FSwt42 FSwt43, FSwt44 FSwt45, FSwt46 FSwt47, FSwt53 **Obj. FWT1** – FSlw11, FSlw12 FSlw13 **Obj. FWT2** – FSlw35, FSlw36	**Obj. PW1** – PWts38 **Obj. PWW2** – PWwt37 **Obj. PSW3** – PSwt37 **Obj. PWT2** – PSlw37 **Obj. PE2** – PEne32 **Obj. PM1** – PMob26

			FSlw37 **Obj. FWT3** – FSlw38, FSlw39 FSlw42, FSlw43 FSlw44, FSlw45 FSlw46, FSlw47 FSlw50, FSlw51 FSlw52, FSlw61 **Obj. FE1** – FEne11, FEne12 FEne13 **Obj. FE2** – FEne30, FEne31 FEne32 **Obj. FE3** – FEne33, FEne34 FEne37, FEne38 FEne39, FEne40 FEne41, FEne42 FEne45, FEne46 FEne47, FEne53 **Obj. PM1** – FMob10, FMob11 FMob12 **Obj. PM2** – FMob16, FMob17 **Obj. PM3** – FMob25, FMob26 FMob34, FMob35 FMob36	
S003Bristol Demountable flood protection barrier		**Obj.S2** – S18 S19, S27	**Obj. FWW1** – FWwt12, FWwt13 FWwt14, FWwt15 FWwt16, FWwt17 FWwt18, FWwt19 FWwt20, FWwt21 **Obj. FWW2** – FWwt37 **Obj. FWW3** – FWwt46, FWwt47 FWwt48, FWwt49 **Obj. FSW1** – FSwt12, FSwt13 FSwt14, FSwt15 FSwt16, FSwt17 FSwt18 **Obj. FSW2** – FSwt30, FSwt31	**Obj. PWW3** – PWwt32, PWwt34 PWwt38, PWwt39 **Obj. PSW3** – PSwt32, PSwt34 PSwt38, PSwt39

			FSwt32 **Obj. FSW3** – FSwt39, FSwt40 FSwt41, FSwt42	
S004Bristol Learn from real– life flooding by recording and investigating events		**Obj.S1** – S03, S05, S16, S17	**Obj. FW1** – FWts11, FWts13 FWts24, FWts25 FWts26, FWts27 FWts28, FWts29 FWts30, FWts31 FWts32, FWts33 FWts34 **Obj. FW3** – FWts56, FWts57 FWts58, FWts59 FWts60, FWts61 FWts62, FWts63 FWts64, FWts65 FWts66, FWts67 FWts68 **Obj. FWW1** – FWwt11, FWwt12 FWwt13, FWwt22 FWwt23, FWwt24 FWwt25, FWwt26 FWwt27, FWwt28 FWwt29, FWwt30 FWwt31 **Obj. FWW3** – FWwt53, FWwt54 FWwt55, FWwt56 FWwt57, FWwt58 FWwt59, FWwt60 FWwt61, FWwt62 FWwt63, FWwt64 **Obj. FSW1** – FSwt11, FSwt12 FSwt13, FSwt19 FSwt20, FSwt21 FSwt22, FSwt23 FSwt24 **Obj. FSW3** – FSwt46, FSwt47 FSwt48, FSwt49 FSwt50, FSwt51 FSwt52, FSwt53 **Obj. FWT1** – FSlw11, FSlw12 FSlw13, FSlw21 FSlw22, FSlw23 FSlw24, FSlw25 FSlw26, FSlw27	**Obj. PW1** – PWts03, PWts04, PWts08, PWts09 PWts10, PWts11 PWts12, PWts13 PWts14, PWts15 PWts16 **Obj. PW2** – PWts20, PWts21, PWts22, PWts23 **Obj. PW3** – PWts41, PWts42, PWts43, PWts44 PWts45, PWts46 PWts47, PWts48 PWts49 **Obj. PWW1** – PWwt03, PWwt04 PWwt08,PWwt09 PWwt10,PWwt11 PWwt12,PWwt13 PWwt14,PWwt15 PWwt16 **Obj. PW2** – PWwt20, PWwt21, PWwt22, PWwt23 **Obj. PWW3** – PWwt40,PWwt41 PWwt42,PWwt43 PWwt44,PWwt45 PWwt46,PWwt47 PWwt48 **Obj. PSW1** – PSwt03, PSwt04, PSwt08, PSwt09 PSwt10, PSwt11 PSwt12, PSwt13 PSwt14, PSwt15 PSwt16 **Obj. PSW2** – PSwt20, PSwt21, PSwt22, PSwt23

			FSlw28, FSlw29 **Obj. FWT3** – FSlw52, FSlw53 FSlw54, FSlw55 FSlw56, FSlw57 FSlw58, FSlw59 FSlw60, FSlw61 **Obj. FE1** – FEne11 FEne12, FEne13 FEne19, FEne20 FEne21, FEne22 FEne23, FEne24 **Obj. FE3** – FEne47, FEne48 FEne49, FEne50 FEne51, FEne52 FEne53 **Obj. FM1** – FMob10, FMob11 FMob12, FMob20 FMob21, FMob22 FMob23, FMob24 **Obj. FM3** – FMob38, FMob39 FMob40, FMob41 FMob42	**Obj. PSW3** – PSwt40, PSwt41 PSwt42, PSwt43 PSwt44, PSwt45 PSwt46, PSwt47 PSwt48 **Obj. PWT1** – PSlw03, PSlw04, PSlw08, PSlw09 PSlw10, PSlw11 PSlw12, PSlw14 PSlw15, PSlw16 **Obj. PWT2** – PSlw18, PSlw19, PSlwt20, PSlw21 **Obj. PWT3** – PSlw40, PSlw41 PSlw42, PSlw43 PSlw44, PSlw45 PSlw46, PSlw47 PSlw48 **Obj. PE1** – PEne03, PEne04, PEne08, PEne09, PEne10, PEne11, PEne12, PEne13, PEne14 **Obj. PE2** – PEne16, PEne17, PEne18 **Obj. PE3** – PEne35, PEne36 PEne37, PEne38 PEne39, PEne40 PEne41 **Obj. PM1** – PMob02, PMob03, PMob07, PMob08 PMob09, PMob10 PMob11, PMob12 PMob13, PMob14 **Obj. PM2** – PMob16, PMob17, PMob18 **Obj. PM3** –PMob29 PMob30, PMob31, PMob32, PMob33, PMob34, PMob35, PMob36
S005Bristol Gather, manage and share high quality	**Obj.O2** – O23, O24, O25, O28, O29, O30 O31	**Obj.S1** – S03, S05	**Obj. FW1** – FWts04, FWts11, FWts13, FWts14, FWts15,	**Obj. PW1** – PWts03, PWts04 PWts05, PWts17

data to help understand the risk of flooding	O34, O35, O36 **Obj.O3** – O37		FWts16, FWts17, FWts18, FWts19, FWts20, FWts21, FWts22, FWts23 **Obj. FW2** –FWts40, FWts41, FWts42 **Obj. FW3** – FWts43, FWts44 FWts45 **Obj. FWW1** – FWwt04, FWwt11 FWwt12, FWwt13 FWwt14, FWwt15 FWwt16, FWwt17 FWwt18, FWwt19 FWwt20, FWwt21 **Obj. FWW2** – FWwt37, FWwt38 FWwt39 **Obj. FWW3** – FWwt40, FWwt41 FWwt42, FWwt43 FWwt44, FWwt45 FWwt46, FWwt47 FWwt48, FWwt49 FWwt50, FWwt51 FWwt52, FWwt53 FWwt54, FWwt64 **Obj. FSW1** – FSwt03, FSwt04 FSwt11, FSwt12 FSwt13, FSwt14 FSwt15, FSwt16 FSwt17, FSwt18 **Obj. FSW2** – FSwt30, FSwt31 FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt35, FSwt36 FSwt37, FSwt38 FSwt39, FSwt40 FSwt41, FSwt42 FSwt43, FSwt44 FSwt45, FSwt46 FSwt47, FSwt53 **Obj. FWT1 –** FSlw04, FSlw11 FSlw12, FSlw13 FSlw14, FSlw15	**Obj. PW2** – PWts20, PWts21 PWts22, PWts23 PWts24, PWts25 **Obj. PW3** – PWts35, PWts36 PWts37, PWts38 PWts39, PWts40 **Obj. PWW1** – PWwt03, PWwt04 PWwt05, PWwt17 **Obj. PWW2** – PWwt20, PWwt21 PWwt22, PWwt23 PWwt24, PWwt25 **Obj. PWW3** – PWwt34, PWwt35 PWwt36, PWwt37 PWwt38, PWwt39 **Obj. PSW1** – PSwt03, PSwt04 PSwt05, PSwt17 **Obj. PSW2** – PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25 **Obj. PSW3** – PSwt34, PSwt35 PSwt36, PSwt37 PSwt38, PSwt39 **Obj. PWT1** – PSlw03, PSlw04 PSlw05 **Obj. PWT2** – PSlw18, PSlw19 PSlw20, PSlw21 PSlw22, PSlw23 **Obj. PWT3** – PSlw34, PSlw35 PSlw36, PSlw37 PSlw38, PSlw39 **Obj. PE1** – PEne03, PEne04 PEne05, **Obj. PE2** – PEne16, PEne17

			FSlw16, FSlw17 FSlw18, FSlw19 FSlw20 **Obj. FWT2 –** FSlw35, FSlw36 FSlw37 **Obj. FWT3 –** FSlw38, FSlw39 FSlw40, FSlw41 FSlw42, FSlw43 FSlw44, FSlw45 FSlw46, FSlw47 FSlw48, FSlw49 FSlw50, FSlw51 FSlw52, FSlw61 **Obj. FE1** – FEne04, FEne11 FEne12, FEne13 FEne14, FEne15 FEne16, FEne17 FEne18 **Obj. FE2** – FEne30, FEne31, FEne32 **Obj. FE3** – FEne33, FEne34 FEne35, FEne36 FEne37, FEne38 FEne39, FEne40 FEne41, FEne42 FEne43, FEne44 FEne45, FEne46 FEne47, FEne53 **Obj. FM1** – FMob10, FMob11 FMob12, FMob13 FMob14, FMob15 FMob16, FMob17 FMob25, FMob26 **Obj. FM2** – FMob34, FMob35 FMob36	PEne18, PEne19 PEne20, PEne21 **Obj. PE3** – PEne29, PEne30 PEne31, PEne32 PEne33, PEne34 **Obj. PM1** – PMob03, PMob04 **Obj. PM2** – PMob16, PMob17 PMob18 **Obj. PM3** – PMob23, PMob24 PMob25, PMob26 PMob27, PMob28
S006Bristol Create and maintain Flood Risk Asset Registers to identify key flood risk assets and who is responsible for their maintenance	**Obj.O3** – O54, O57	**Obj.S1** – S12, S13	**Obj. FWW1** – FWwt11, FWwt12 FWwt13, FWwt14 FWwt15, FWwt16 FWwt17, FWwt18 FWwt19, FWwt20 FWwt21 **Obj. FWW2** – FWwt37, FWwt38	**Obj. PWW1** – PWwt01, PWwt02 PWwt07, PWwt17 **Obj. PWW2** – PWwt20, PWwt21 PWwt22, PWwt23 PWwt24, PWwt25 **Obj. PWW3** –

			FWwt39 **Obj. FWW3** – FWwt40, FWwt41 FWwt44, FWwt45 FWwt46, FWwt47 FWwt48, FWwt49 FWwt53, FWwt54 FWwt64 **Obj. FSW1** – FSwt03, FSwt11 FSwt12, FSwt13 FSwt14, FSwt15 FSwt16, FSwt17 FSwt18, **Obj. FSW2** – FSwt30, FSwt31 FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt37, FSwt38 FSwt39, FSwt40 FSwt41, FSwt42 FSwt46, FSwt47 FSwt53	PWwt35, PWwt36 PWwt37, PWwt38 PWwt39 **Obj. PSW1 –** PSwt01, PSwt02 PSwt07, PSwt17 **Obj. PSW2 –** PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25 **Obj. PSW3 –** PSwt35, PSwt36 PSwt37, PSwt38 PSwt39
S007Bristol Keep identification of high– risk areas updated by conducting studies involving flood–modelling analysis	**Obj. O2** – O20, O21, O22, O23, O24, O25, O28, O29, O30, O34, O35, O36, O37 **Obj. O3** – O41, O42, O43, O44, O54, O57, O58, O60	**Obj. S1** – S01, S02, S03, S04, S05, S06, S07, S08, S09, S10, S11, S12, S13, S14, S15, S16, S17	**Obj. FW1** – FWts11, FWts12, FWts13, FWts14, FWts15, FWts16, FWts17, FWts18, FWts19, FWts20, FWts21, FWts22, FWts23, **Obj. FW2** – FWts40, FWts41, FWts42 **Obj. FW3** – FWts43, FWts44 FWts49, FWts50, FWts51, FWts52, FWts56, FWts57, FWts68 **Obj. FWW1** – FWwt12, FWwt13, FWwt14, FWwt15, FWwt16, FWwt17, FWwt18, FWwt19, FWwt20, FWwt21 **Obj. FWW2** – FWwt37, FWwt38, FWwt39	**Obj. PW1** – PWts17 **Obj. PW2** – PWts20,PWts21, PWts22,PWts23, PWts24,PWts25, **Obj. PW3** – PWts36, PWts37, PWts38, PWts39, PWts40 **Obj. PWW1** – PWwt17 **Obj. PWW2**– PWwt20,PWwt21, PWwt22,PWwt23, PWwt24, PWwt25 **Obj. PWW3** – PWwt35,PWwt36, PWwt37,PWwt38, PWwt39 **Obj. PSW2** – PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25

			Obj. FWW3 – FWwt40, FWwt41 FWwt44, FWwt45 FWwt46, FWwt47, FWwt49, FWwt53, FWwt54, FWwt64 **Obj. FSW1** – FSwt03, FSwt12, FSwt13, FSwt14, FSwt15 , Swt16, FSwt17, FSwt18, **Obj. FSW2** – FSwt30, FSwt31, FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt37, FSwt38 FSwt39, FSwt40 FSwt41, FSwt42 FSwt46, FSwt47 FSwt53 **Obj. FWT1** – FSlw12, FSlw13, FSlw14, FSlw15, FSlw16, FSlw17, FSlw18, FSlw19, FSlw20 **Obj. FWT2** – FSlw35, FSlw36 FSlw37 **Obj. FWT3** – FSlw38, FSlw39, FSlw42, FSlw43, FSlw44, FSlw45, FSlw46, FSlw47, FSlw51, FSlw52, FSlw61 **Obj. FE1** – FEne12, FEne13, FEne14, FEne15, FEne16, FEne17, FEne18 **Obj. FE2** – FEne30, FEne31, FEne32 **Obj. FE3** – FEne33, FEne34, FEne38, FEne39, FEne40, FEne41, FEne42, FEne45, FEne46, FEne47, FEne53	**Obj. PSW3** – PSwt35, PSwt36 PSwt37, PSwt38 PSwt39 **Obj. PWT2** – PSlw18, PSlw19 PSlw20, PSlw21 PSlw22, PSlw23 **Obj. PWT3** – PSlw35, PSlw36 PSlw37, PSlw38 PSlw39 **Obj. PE2** – PEne16, PEne17 PEne18, PEne19 PEne20, PEne21 **Obj. PE3** – PEne30, PEne31, PEne32, PEne33, PEne34 **Obj. PM2** – PMob16, PMob17 PMob18, PMob24 **Obj. PM3** – PMob25, PMob26 PMob27, PMob28

			Obj. FM1 – FMob10 FMob11, FMob12, FMob13, FMob14, FMob15, FMob16, FMob17 **Obj. FM2** – FMob34 FMob35, FMob36	
S008Bristol Develop community flood plans	**Obj. O1** – O01, O02, O03, O04, O05, O06, O07, O08, O09, O10 **Obj. O2** – O11, O12, O13, O14, O15, O16, O17, O18, O21, O22, O23, O24, O25, 027, O28, O29, O30, O31, O33, O34, O35, O36, O37 **Obj. O3** – 038, 039, 040, O41, O42, O43, O44, O46, O47, 050, 051, 052, O54, O57, O58, O60, O65, O66, O70	**Obj. S1** – S03, S06, S07, S16, S17 **Obj. S2** – S21, S22, S25	**Obj. FW1** – FWts1, FWts13, FWts14, FWts15, FWts16, FWts17, FWts18, FWts20, FWts21, FWts22, FWts23, **Obj. FW2** – FWts39, FWts40, FWts41, FWts42 **Obj. FW3** – FWts43, FWts44, FWts47, FWts49, FWts50, FWts51, FWts52, FWts56, FWts57, FWts68 **Obj. FWW1** – FWwt11, FWwt12 FWwt13, FWwt14 FWwt15, FWwt16 FWwt17, FWwt18 FWwt19, FWwt20 FWwt21 **Obj. FWW2** – FWwt37, FWwt38, FWwt39 **Obj. FWW3** – FWwt40, FWwt41 FWwt44, FWwt45 FWwt46, FWwt47 FWwt48, FWwt49 FWwt53, FWwt54 FWwt64 **Obj. FSW1** – FSwt03, FSwt11 FSwt12, FSwt13 FSwt14, FSwt15 FSwt16, FSwt17 FSwt18 **Obj. FSW2** – FSwt29, FSwt30, FSwt31, FSwt32 **Obj. FSW3** –	**Obj. PW1**–PWts17 **Obj. PW2** – PWts20, PWts21, PWts22, PWts23, PWts24, PWts25 **Obj. PW3** – PWts36, PWts37, PWts38, PWts39, PWts40 **Obj. PWW1** – PWwt17 **Obj. PWW2** – PWwt20, PWwt21 PWwt22, PWwt23 PWwt24, PWwt25 **Obj. PWW3** – PWwt35, PWwt36, PWwt37, PWwt38, PWwt39 **Obj. PSW2** – PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25 **Obj. PSW3** – PSwt35, PSwt36 PSwt37, PSwt38 PSwt39 **Obj. PWT2** – PSlw18, PSlw19 PSlw20, PSlw21 PSlw22, PSlw23 **Obj. PWT3** – PSlw35, PSlw36 PSlw37, PSlw38 PSlw39 **Obj. PE2** – PEne16, PEne17 PEne18, PEne19 PEne20, PEne21 **Obj. PE3** –

			FSwt33, FSwt34 FSwt37, FSwt38 FSwt39, FSwt40 FSwt41, FSwt42 FSwt46, FSwt47 FSwt53 **Obj. FWT1** – FSlw11, FSlw12 FSlw13, FSlw14 FSlw15, FSlw16 FSlw17, FSlw18 FSlw19, FSlw20 **Obj. FWT2** – FSlw35, FSlw36 FSlw37, **Obj. FWT3** – FSlw38, FSlw39, FSlw42, FSlw43, FSlw44, FSlw45, FSlw47, FSlw51, FSlw52, FSlw61 **Obj. FE1** – FEne12 FEne13, FEne14 FEne15, FEne16 FEne17, FEne18 **Obj. FE2** – FEne30, FEne31 FEne32, **Obj. FE3** – FEne33, FEne34, FEne37, FEne38, FEne39, FEne40, FEne42, FEne45, FEne46, FEne47, FEne53 **Obj. FM1** – FMob11, FMob12, FMob13, FMob14, FMob15, FMob16, FMob17 **Obj. FM2** – FMob35, FMob36	PEne30, PEne31 PEne32, PEne33 PEne34 **Obj. PM2** – PMob16, PMob17 PMob18, **Obj. PM3** – PMob24,PMob25, PMob26,PMob27, PMob28
S009Bristol Build riverside flood defence walls		**Obj. S1** – S05, S06, S07, S08, S16, S17 **Obj. S2** – S18, S19, S20 S22, S27	**Obj. FW1** – FWts14, FWts15 FWts16, FWts17 FWts18, FWts19 FWts20, FWts21 FWts22, FWts23 **Obj. FW3** –	**Obj. PW3** – PWts39, PWts40 **Obj. PWW3** – PWwt38, PWwt39 **Obj. PSW3** – PSwt38, PSwt39

			FWts49, FWts51 **Obj. FWW1** – FWwt14, FWwt15 FWwt16, FWwt17 FWwt18, FWwt19 FWwt20, FWwt21 **Obj. FWW3** – FWwt46, FWwt48 **Obj. FSW1** – FSwt14, FSwt15 FSwt16, FSwt17 FSwt18, **Obj. FSW2** – FSwt39, FSwt41, FSwt42 **Obj. FWT1** – FSlw14, FSlw15, FSlw16, FSlw17, FSlw18, FSlw19, FSlw20, **Obj. FWT3** – FSlw44, FSlw46 **Obj. FE1** – FEne14, FEne15, FEne16, FEne17, FEne18 **Obj. FE3** – FEne39, FEne41 **Obj. FM1** – FMob13 FMob14, FMob15, FMob16, FMob17	
S010Bristol Install flood proof fencing		**Obj. S1** – S05 S06, S07, S08 **Obj. S2** – S18 S19, S20, S27		
S011Bristol Highway bioretention pods		**Obj. S1** – S13 **Obj. S2** – S18 S19, S25, S26	**Obj. FWW1** – FWwt14, FWwt15 FWwt16, FWwt17 FWwt18 **Obj. FWW3** – FWwt48, FWwt49 **Obj. FSW1** – FSwt14, FSwt15 FSwt16, FSwt17 FSwt18, FSwt26	**Obj. PWW3** – PWwt32, PWwt38, PWwt39 **Obj. PSW3** – PSwt32, PSwt38 PSwt39

			Obj. FSW3 – FSwt39, FSwt41 FSwt42	
S012Bristol Adding rain gardens before sewer inlet points		**Obj. S1** – S12, S13, **Obj. S2** – S19, S25, S26		**Obj. PW3** – PWts33, PWts39 **Obj. PWW3** – PWwt32,PWwt38 **Obj. PSW3** – PSwt32, PSwt38 **Obj. PWT3** – PSlw31, PSlw38 **Obj. PE3** – PEne27, PEne33 **Obj. PM3** – PMob21, PMob27
S013Bristol Introduce rock armour in rivers to add erosion protection against flood defence assets		**Obj. S1** – S05 S06, S07, S08 S12, S13 **Obj. S2** – S18 S19, S20, S26 S27		

LISBON

	Organisational	**Spatial**	**Functional**	**Physical**
S001Lisbon Improve knowledge: city characteristics and vulnerabilities to flooding **Measures** ▪ Gather, manage and share high quality data to help understand the risk of flooding ▪ Create and maintain Flood Risk Asset Registers to identify key flood risk assets and who is responsible for their maintenance ▪ Identify high risk areas by conducting studies involving flood modelling analysis	**Obj.O2** – O20, O21, O22, O23 O24, O25, O28 O29, O30, O31 O34, O35, O36 O37 **Obj.O3** – O38, O39, O40, O41 O42, O43, O44 O45, O46, O47 O48, O49, O50 O54, O57, O58 O60, O63, O64	**Obj.S1** – S01 S02, S03, S04 S05, S06, S07 S08, S09, S10 S11, S12, S13, S14, S15, S16 S17	**Obj. FWW1** – FWwt04, FWwt11 FWwt12, FWwt13 FWwt14, FWwt15 FWwt16, FWwt17 FWwt18, FWwt19 FWwt20, FWwt21 **Obj. FWW2** – FWwt37, FWwt38 FWwt39 **Obj. FWW3** – FWwt40, FWwt41 FWwt42, FWwt43 FWwt44, FWwt45 FWwt46, FWwt47 FWwt48, FWwt49 FWwt50, FWwt51 FWwt52, FWwt53 FWwt54, FWwt64 **Obj. FSW1** – FSwt03, FSwt04 FSwt11, FSwt12	**Obj. PWW1** – PWwt01, PWwt02 PWwt03, PWwt04 PWwt05, PWwt07 PWwt17 **Obj. PWW2** – PWwt20, PWwt21 PWwt22, PWwt23 PWwt24, PWwt25 **Obj. PWW3** – PWwt34, PWwt35 PWwt36, PWwt37 PWwt38, PWwt39 **Obj. PSW1** – PSwt01, PSwt02 PSwt03, PSwt04 PSwt05, PSwt07 PSwt17 **Obj. PSW2** – PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25

▪ Inspection and cleaning of drains or sewer pipes			FSwt13, FSwt14 FSwt15, FSwt16 FSwt17, FSwt18 **Obj. FSW2** – FSwt30, FSwt31 FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt35, FSwt36 FSwt37, FSwt38 FSwt39, FSwt40 FSwt41, FSwt42 FSwt43, FSwt44 FSwt45, FSwt46 FSwt47, FSwt53 **Obj. FWT1** – FSlw04, FSlw11 FSlw12, FSlw13 FSlw14, FSlw15 FSlw16, FSlw17 FSlw18, FSlw19 FSlw20 **Obj. FWT2** – FSlw35, FSlw36 FSlw37 **Obj. FWT3** – FSlw38, FSlw39 FSlw40, FSlw41 FSlw42, FSlw43 FSlw44, FSlw45 FSlw46, FSlw47 FSlw48, FSlw49 FSlw50, FSlw51 FSlw52, FSlw61 **Obj. FE1** – FEne04 FEne11, FEne12 FEne13, FEne14 FEne15, FEne16 FEne17, FEne18 **Obj. FE2** – FEne30 FEne31, FEne32 **Obj. FE3** – FEne33 FEne34, FEne35 FEne36, FEne37 FEne38, FEne39 FEne40, FEne41 FEne42, FEne43 FEne44, FEne45 FEne46, FEne47 FEne53	**Obj. PSW3** – PSwt34, PSwt35 PSwt36, PSwt37 PSwt38, PSwt39 **Obj. PWT1** – PSlw01, PSlw02 PSlw03, PSlw04 PSlw05, PSlw07 PSlw18, PSlw19 **Obj. PWT2** – PSlw20, PSlw21 PSlw22, PSlw23 **Obj. PWT3** – PSlw34, PSlw35 PSlw36, PSlw37 PSlw38, PSlw39 **Obj. PE1** – PEne01, PEne02 PEne03, PEne04 PEne05, PEne07 **Obj. PE2** – PEne16, PEne17 PEne18, PEne19 PEne20, PEne21 **Obj. PE3** – PEne29, PEne30 PEne31, PEne32 PEne33, PEne34 **Obj. PM1** – PMob01, PMob02 PMob03, PMob04 PMob06 **Obj. PM2** – PMob16, PMob17 PMob18, **Obj. PM3** – PMob23, PMob24 PMob25, PMob26 PMob27, PMob28

			Obj. FM1 – FMob10, FMob11 FMob12, FMob13 FMob14, FMob15 FMob16, FMob17 FMob25, FMob26 **Obj. FM2** – FMob34, FMob35 FMob36	
S002Lisbon Redesign urban landscape to enhance the water cycle functions: nature based solutions **Measures** ▪ Adding rain gardens before sewer inlet points ▪ Filter strip ▪ Provide flood storage areas via detention, retention or infiltration basins ▪ Ponds and wetlands	**Obj.O3** – O55, O56, O57	**Obj.S1** – S12 S13 **Obj.S2** – S18, S19, S25, S26	**Obj. FWW1** – FWwt33 **Obj. FWW3** – FWwt48, FWwt49 **Obj. FSW1** – FSwt14, FSwt15 FSwt16, FSwt17 FSwt18, FSwt26 **Obj. FSW3** – FSwt39, FSwt41 FSwt42	**Obj. PW1** – PWts19 **Obj. PW3** – PWts33, PWts34 PWts39, PWts40 PWwt19, PWwt32 PWwt33, PWwt38 PWwt39 **Obj. PSW1** – PSwt19 **Obj. PSW3** – PSwt32, PSwt33 PSwt38, PSwt39
S003Lisbon Redesign urban landscape to enhance the water cycle functions: structural solutions **Measures** ▪ Provide flood storage areas via detention, retention or infiltration basins ▪ Increase the network of waterways ▪ Raise kerb or curb ▪ Enlargement of treatment capacity in WWTP (wet weather lines) along with the collection capacity (including pumping stations)	**Obj.O3** – O51 O52, O53, O54 O55, O56, O57	**Obj.S1** – S03 S09, S10, S11 S12, S13, S14 S15, S16, S17 **Obj.S2** – S18 S19, S23, S25 S26	**Obj. FWW1** – FWwt01, FWwt02 FWwt03, FWwt04 FWwt05, FWwt06 FWwt07, FWwt08 FWwt09, FWwt11 FWwt12, FWwt13 FWwt14, FWwt15 FWwt16, FWwt17 FWwt18, FWwt19 FWwt20, FWwt21 FWwt32, FWwt33 **Obj. FWW2** – FWwt37, FWwt38 FWwt39 **Obj. FWW3** – FWwt40, FWwt41 FWwt42, FWwt44 FWwt45, FWwt46 FWwt47, FWwt48 FWwt49, FWwt52 FWwt53, FWwt54 FWwt64 **Obj. FSW1** – FSwt01, FSwt02 FSwt03, FSwt04 FSwt05, FSwt06	**Obj. PWW1** – PWwt17, PWwt19 **Obj. PWW2** – PWwt20, PWwt21 PWwt22, PWwt23 PWwt24, PWwt25 **Obj. PWW3** – PWwt32, PWwt33 PWwt34, PWwt35 PWwt36, PWwt37 PWwt38, PWwt39 **Obj. PSW1** – PSwt19 **Obj. PSW2** – PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25 **Obj. PSW3** – PSwt32, PSwt33 PSwt34, PSwt35 PSwt36, PSwt37 PSwt38, PSwt39

			FSwt07, FSwt08 FSwt09, FSwt11 FSwt12, FSwt13 FSwt14, FSwt15 FSwt16, FSwt17 FSwt18, FSwt25 FSwt26 **Obj. FSW2** – FSwt30, FSwt31 FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt35, FSwt37 FSwt38, FSwt39 FSwt40, FSwt41 FSwt42, FSwt45 FSwt46, FSwt47 FSwt53	
S004Lisbon Improve the resilience level at riverfront **Measures** ▪ Install flood proof fencing ▪ Emergency response plans and procedures ▪ Check valve and non–return valve ▪ Build riverside flood defence walls	**Obj.O2** – O24 O25, O26, O27, O28, O29 **Obj.O3** – O38 O39, O40, O41 O51, O52, O53 O57	**Obj.S1** – S05 S06, S07, S08 S09, S10 **Obj.S2** – S18 S19, S20, S27	**Obj. FWW1** – FWwt01, FWwt02 FWwt03, FWwt04 FWwt05, FWwt06 FWwt07, FWwt08 FWwt09, FWwt12 **Obj. FWW2** – FWwt40, FWwt41 FWwt42 **Obj. FWW3** – FWwt43, FWwt46 FWwt47, FWwt49 FWwt50, FWwt51 FWwt52 **Obj. FSW1** – FSwt01, FSwt02 FSwt03, FSwt04 FSwt05, FSwt06 FSwt07, FSwt08 FSwt09, FSwt12 **Obj. FSW3** – FSwt33, FSwt34 FSwt35, FSwt36 FSwt39, FSwt40 FSwt42, FSwt43 FSwt44, FSwt45	**Obj. PWW1** – PWwt06, PWwt07 PWwt17 **Obj. PWW3** – PWwt34,PWwt39 **Obj. PSW1** – PSwt06,PSwt07 PSwt17 **Obj. PSW3** – PSwt34, PSwt39
S005Lisbon Adaptation of green infrastructure **Measures** ▪ Bioretention area	**Obj. O3** – O52, O53, O54, O55, O56, O57	**Obj. S1** – S01, S02, S03, S04, S05, S06, S07, S08, S09, S10, S11, S12, S13, S14, S15, S16, S17	**Obj. FW1 –** FWts12, FWts13 FWts14, FWts15 FWts16, FWts17 FWts18, FWts32, FWts35, FWts36	**Obj. PW2** – PWts16, PWts17 PWts19 **Obj. PSW1** – PSwt04, PSwt05, PSwt19

▪ Implementation of Rainwater Harvesting systems (RWH) ▪ Prioritize water allocation in a stress situation ▪ Build and promote urban forest and park		**Obj. S2** – S18 S19, S21, S22 S23, S24, S25 S26	**Obj. FW3 –** FWts47, FWts51, FWts2 **Obj. FSW1 –** FSwt12, FSwt13 FSwt14, FSwt15 FSwt16, FSwt17 FSwt18, FSwt25 FSwt26, FSwt27 FSwt28, **Obj. FSW2 –** FSwt31, FSwt32, **Obj. FSW3 –** FSwt37, FSwt38, FSwt39, FSwt40, FSwt41, FSwt42, FSwt43, FSwt44	**Obj. PSW3** – PSwt32, PSwt33 PSwt34, PSwt38 PSwt39
S006Lisbon Increase ecosystem services: human well–being **Measures** ▪ Adding rain gardens before sewer inlet points ▪ Implementation of Rainwater Harvesting systems (RWH) ▪ Ponds and wetlands ▪ Increase the network of waterways	**Obj. O3** – O51, O52, O53, O54, O55, O56, O57	**Obj.S1** – S03 S09, S10, S12 S13, S16, S17 **Obj.S2** – S18 S19, S23, S25 S26	**Obj. FWW1** – FWwt01, FWwt02 FWwt03, FWwt04 FWwt05, FWwt06 FWwt07, FWwt08 FWwt09, FWwt11 FWwt12, FWwt13 FWwt14, FWwt15 FWwt16, FWwt17 FWwt18, FWwt19 FWwt20, FWwt21 FWwt32, FWwt33 **Obj. FWW2** – FWwt37, FWwt38 FWwt39 **Obj. FWW3** – FWwt40, FWwt41 FWwt42, FWwt44 FWwt45, FWwt46 FWwt47, FWwt48 FWwt49, FWwt52 FWwt53, FWwt54 FWwt64 **Obj. FSW1** – FSwt01, FSwt02 FSwt03, FSwt04 FSwt05, FSwt06 FSwt07, FSwt08 FSwt09, FSwt11 FSwt12, FSwt13 FSwt14, FSwt15 FSwt16, FSwt17 FSwt18, FSwt25 FSwt26	**Obj. PWW1** – PWwt17, PWwt19 **Obj. PWW2** – PWwt20, PWwt21 PWwt22, PWwt23 PWwt24, PWwt25 **Obj. PWW3** – PWwt32, PWwt33 PWwt34, PWwt35 PWwt36, PWwt37 PWwt38, PWwt39 **Obj. PSW1** – PSwt19 **Obj. PSW2** – PSwt20, PSwt21, PSwt22, PSwt23 PSwt24, PSwt25 **Obj. PSW3** – PSwt32, PSwt33 PSwt34, PSwt35 PSwt36, PSwt37 PSwt38, PSwt39

			Obj. FSW2 – FSwt30, FSwt31 FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt35, FSwt37 FSwt38, FSwt39 FSwt40, FSwt41 FSwt42, FSwt45 FSwt46, FSwt47 FSwt53	
S007Lisbon/S016 Lisbon Promote urban rehabilitation as a tool to increase resilience: sewer systems **Measures** ▪ Rehabilitate sewer pipes ▪ Inlets increase ▪ On– source sediment traps ▪ Construction of diversion tunnels ▪ Construction of anti–pollution basins	**Obj. O2** – O23 **Obj. O3** – O66		**Obj. FWW1** – FWwt12, FWwt13 FWwt14, FWwt15 FWwt16, FWwt17 FWwt18, FWwt19 FWwt20, FWwt21 **Obj. FWW3** – FWwt48, FWwt49 **Obj. FSW1** – FSwt12, FSwt13 FSwt14, FSwt15 FSwt16, FSwt17 FSwt18 **Obj. FSW3** – FSwt41, FSwt42	**Obj. PWW1** – PWwt06, PWwt07 PWwt17 **Obj. PWW3** – PWwt32,PWwt35, PWwt38,PWwt39 **Obj. PSW1** – PSwt06, PSwt07, PSwt17 **Obj. PSW3** – PSwt32, PSwt35, PSwt38, PSwt39
S008Lisbon Promote urban rehabilitation as a tool to increase resilience: facing climate change **Measures** ▪ Use of non– potable water in compatible uses ▪ Green roof ▪ Increase integration of renewable energy by Distributed Generation (DG) ▪ Restriction on land–use areas vulnerable to flooding events	**Obj. O2** – O15, O23 **Obj. O3** – O38 O39, O40, O41 O42, O43, O44 O45, O46, O47 O48, O49, O50 O51, O52, O53 O54, O55, O56 O57, O65, O66 O70	**Obj. S1** – S01, S02, S03, S04, S05, S06, S07, S08, S09, S10, S11, S12, S13, S14, S15, S16, S17 **Obj. S2** – S18, S19, S22, S23, S25, S26, S27, S28	**Obj. FWW1** – FWwt05, FWwt12 FWwt13, FWwt14 FWwt15, FWwt16 FWwt17, FWwt18 FWwt19, FWwt20 FWwt21, FWwt32 FWwt33, FWwt34 FWwt35, **Obj. FWW2** – FWwt38, FWwt39 **Obj. FWW3** – FWwt40, FWwt41, FWwt42, FWwt43, FWwt44, FWwt45, FWwt46, FWwt47, FWwt48, FWwt49, FWwt50, FWwt51 **Obj. FSW1** – FSwt05, FSwt12 FSwt13, FSwt14 FSwt15, FSwt16 FSwt17, FSwt18 FSwt25, FSwt26 FSwt27, FSwt28	**Obj. PWW1** – PWwt18,PWwt19 **Obj. PWW2** – PWwt21, PWwt22 PWwt23, PWwt24 PWwt25, PWwt26 PWwt27, PWwt28 PWwt29, PWwt30 PWwt31 **Obj. PWW3** – PWwt32,PWwt34 PWwt38,PWwt39 **Obj. PSW1** – PSwt18, PSwt19 **Obj. PSW2** – PSwt21, PSwt22 PSwt23, PSwt24 PSwt25, PSwt26 PSwt27, PSwt28 PSwt29, PSwt30 PSwt31 **Obj. PSW3** – PSwt32, PSwt34 PSwt38, PSwt39

			Obj. FSW2 – FSwt31, FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt35, FSwt36 FSwt37, FSwt38 FSwt39, FSwt40 FSwt41, FSwt42 FSwt43, FSwt44 **Obj. FWT1** – FSlw05, FSlw12 FSlw13, FSlw14 FSlw15, FSlw16 FSlw17, FSlw18 FSlw19, FSlw20 FSlw30, FSlw31 FSlw32, FSlw33 **Obj. FWT2** – FSlw36, FSlw37 **Obj. FWT3** – FSlw38, FSlw39 FSlw40, FSlw41 FSlw42, FSlw43 FSlw44, FSlw45 FSlw46, FSlw47 FSlw48, FSlw49 **Obj. FE1** – FEne05, FEne12, FEne13, FEne14, FEne15, FEne16, FEne17, FEne18, FEne25, FEne26, FEne27, FEne28 **Obj. FE2** – FEne31, FEne32 **Obj. FE3** – FEne33, FEne34, FEne35, FEne36, FEne37, FEne38, FEne39, FEne40, FEne41, FEne42, FEne43, FEne44 **Obj. FM1** – FMob05, FMob11 FMob12, FMob13 FMob14, FMob15 FMob16, FMob17 FMob27, FMob28 FMob29, FMob30 FMob31, FMob32	**Obj. PWT1** – PSlw17 **Obj. PWT2** – PSlw19, PSlw20 PSlw21, PSlw22, PSlw23, PSlw24, PSlw25, PSlw26, PSlw27, PSlw28, PSlw29, PSlw30 **Obj. PWT3** – PSlw31, PSlw34 PSlw38, PSlw39 **Obj. PE1** – PEne15 **Obj. PE2** – PEne17, PEne18, PEne19, PEne20, PEne21, PEne22, PEne23, PEne24, PEne25, PEne26 **Obj. PE3** – PEne27, PEne29, PEne33, PEne34 **Obj. PM1** – PMob15 **Obj. PM2** – PMob17 PMob18, PMob19, PMob20 **Obj. PM3** – PMob21, PMob23, PMob27, PMob28

			Obj. FM2 – FMob35, FMob36 **Obj. FM3** – FMob37	
S009Lisbon Promote citizenship and create networks to involve key stakeholders **Measures** ▪ Develop community flood plans ▪ Increase commitment to develop risk management strategies ▪ Opportunities for citizens to participate in preparedness and response ▪ Public awareness, information, education and communication	**Obj.O1** – O01 O02, O03, O04 O05, O06, O07 O08, O09, O10 **Obj.O2** – O16 O17, O18, O19 O20			
S010Lisbon Strengthening collaboration within AML, Parishes and municipality departments **Measures** ▪ Increase commitment to develop risk management strategies ▪ Effective communication of risk, considering power relations among actors ▪ Training, exercises and education to transfer scientific and operational knowledge to practitioners ▪ Opportunities for citizens to participate in preparedness and response	**Obj. O1** – O01, O02, O03, O04, O05, O06, O07, O08, O09, O10 **Obj. O2** – O11, O12, O14, O15, O16, O17, O18, O19, O20, O21, O22, O23, O24, O25, O26, O27, O28, O29, O30, O31, O34, O35, O36, O37 **Obj. O3** – O39, O40, O41, O42, O43, O44, O45, O46, O47, O48, O49, O50, O51, O52, O53, O54, O57, O58 O60, O64	**Obj. S1** – S01, S02, S03 S04, S05, S06 S07, S08, S09 S10, S11, S12 S13, S14, S15 S16, S17 **Obj. S2** – S21 S27	**Obj. FW1 –** FWts04, FWts05 FWts06, FWts10, FWts11 **Obj. FW2 –** FWts36 **Obj. FW3 –** FWts44, FWts46 **Obj. FWW1 –** FWwt04, FWwt05 FWwt06, FWwt10, FWwt11 **Obj. FWW2 –** FWwt36 **Obj. FWW3 –** FWwt41 FWwt43 **Obj. FSW1 –** FSwt04, FSwt05 FSwt06, FSwt10, FSwt11, **Obj. FSW2** FSwt29	**Obj. PWW1** – PWwt04, PWwt05 **Obj. PSW1** – PSwt04, PSwt05 **Obj. PWT1** – PSlw04 PSlw05, **Obj. PE1** – PEne04, PEne05 **Obj. PM1** – PMob04, PMob05

			Obj. FSW3 – FSwt34, FSwt36 **Obj. FWT1 –** FSlw04, FSlw05, FSlw06, FSlw10, FSlw11 **Obj. FWT2 –** FSlw34 **Obj. FWT3 –** FSlw39 FSlw41 **Obj. FE1 –** FEne03, FEne04, FEne05 **Obj. FE2 –** Fene29 **Obj. FE3 –** FEne34, Fene36 **Obj. FM1 –** FMob09 FMob10, FMob11 **Obj. FM2 –** FMob33	
S011Lisbon Improving drainage in the underground components of the electrical infrastructure **Measures** ▪ Install flood proof fencing ▪ Learn from real– life flooding by recording and investigating events ▪ Emergency response plans and procedures ▪ Increase pumping capacity	**Obj.O2** – O31 O34, O35, O36 O37 **Obj.O3** – O38, O39 O51 O52, O53, O54 O57, O58, O60 O61, O63, O64	**Obj.S2** – S18 S19, S20, S23 S25, S26, S27	**Obj. FWW1** FWwt11, FWwt12 FWwt13, FWwt14 FWwt15, FWwt16 FWwt17, FWwt18 FWwt19, FWwt20 FWwt21, FWwt32 FWwt33, FWwt34 FWwt35 **Obj. FWW2** – FWwt37, FWwt38 FWwt39 **Obj. FWW3** – FWwt40, FWwt41 FWwt42, FWwt43 FWwt44, FWwt45 FWwt46, FWwt47 FWwt48, FWwt49 FWwt50, FWwt51 FWwt52, FWwt53 FWwt54, FWwt64 **Obj. FSW1** – FSwt11, FSwt12 FSwt13, FSwt14 FSwt15, FSwt16 FSwt17, FSwt18 FSwt25, FSwt26 FSwt27, FSwt28	**Obj. PWW1** – PWwt06, PWwt07 PWwt17, PWwt18 PWwt19 **Obj. PWW2** – PWwt20,PWwt21 PWwt22, PWwt23 PWwt24, PWwt25 **Obj. PWW3** – PWwt32, PWwt34 PWwt35, PWwt36 PWwt37, PWwt38 PWwt39 **Obj. PSW1** – PSwt06, PSwt07 PSwt17, PSwt18 PSwt19 **Obj. PSW2** – PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25 **Obj. PSW3** – PSwt32, PSwt34 PSwt35, PSwt36 PSwt37, PSwt38 PSwt39

			Obj. FSW2 – FSwt30, FSwt31 FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt35, FSwt36 FSwt37, FSwt38 FSwt39, FSwt40 FSwt41, FSwt42 FSwt43, FSwt44 FSwt45, FSwt46 FSwt47, FSwt53	
S012Lisbon Engaging people in citizenship campaigns **Measures** ▪ Build and promote urban forest and park ▪ Use of non– potable water in compatible uses ▪ Increase the reflectance index of city pavements and terraces		**Obj.S1** – S09 S10, S11, S12 S13, S14, S15 **Obj.S2** – S18 S19, S20, S23 S25, S26, S27	**Obj. FW1** – FWts35 **Obj. FWW1** – FWwt32, FWwt33 FWwt34, FWwt35 **Obj. FWW3** – FWwt46, FWwt47 FWwt48, FWwt49 **Obj. FSW1** – FSwt25, FSwt26 FSwt27, FSwt28 **Obj. FSW2** – FSwt31, FSwt32 **Obj. FSW3** – FSwt39, FSwt40 FSwt41, FSwt42	**Obj. PWW1** – PWwt06, PWwt18 PWwt19 **Obj. PWW3** – PWwt32, PWwt34 PWwt38, PWwt39 **Obj. PSW1** – PSwt06, PSwt18 PSwt19 **Obj. PSW3** – PSwt32, PSwt34 PSwt38, PSwt39
S013Lisbon Awareness Campaigns about Floods risk **Measures** ▪ Learn from real– life flooding by recording and investigating events ▪ Effective communication of risk, considering power relations among actors ▪ Training, exercises and education to transfer scientific and operational knowledge to practitioners	**Obj.O1** – O01 O02, O03, O04 O05, O06, O07 O08, O09, O10 **Obj.O2** – O16 O17, O18, O22 O23, O31, O34 O35, O36, O37 **Obj.O3** – O41 O54, O57, O58 O60, O61, O63 O64	**Obj.S1** – S17	**Obj. FWW1** – FWwt11, FWwt12 FWwt13, FWwt14 FWwt15, FWwt16 FWwt17, FWwt18 FWwt19, FWwt20 FWwt21 **Obj. FWW2** – FWwt37, FWwt38 FWwt39 **Obj. FWW3** – FWwt40, FWwt41 FWwt42, FWwt44 FWwt45, FWwt46 FWwt47, FWwt48 FWwt49, FWwt50 FWwt51, FWwt52 FWwt53, FWwt54 FWwt64 **Obj. FSW1** – FSwt11, FSwt12 FSwt13, FSwt14	

			FSwt15, FSwt16 FSwt17, FSwt18 **Obj. FSW2** – FSwt30, FSwt31 FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt35, FSwt37 FSwt38, FSwt39 FSwt40, FSwt41 FSwt42, FSwt43 FSwt44, FSwt45 FSwt46, FSwt47 FSwt53 **Obj. FWT1** – FSlw11, FSlw12 FSlw13, FSlw14 FSlw15, FSlw16 FSlw17, FSlw18 FSlw19, FSlw20 **Obj. FWT2** – FSlw35, FSlw36 FSlw37 **Obj. FWT3** – FSlw38, FSlw39 FSlw40, FSlw42 FSlw43, FSlw44 FSlw45, FSlw46 FSlw47, FSlw50 FSlw51, FSlw52 FSlw61 **Obj. FE1** – FEne11, FEne12 FEne13, FEne14 FEne15, FEne16 FEne17, FEne18 **Obj. FE2** – FEne30, FEne31 FEne32 **Obj. FE3** – FEne33, FEne34 FEne35, FEne37 FEne38, FEne39 FEne40, FEne41 FEne42, FEne45 FEne46, FEne47 FEne53 **Obj. FM1** – FMob10, FMob11 FMob12, FMob13 FMob14, FMob15	

			FMob16, FMob17 FMob25, FMob26 **Obj. FM2** – FMob34, FMob35 FMob36	
S014Lisbon Update risk maps **Measures** ▪ Analyse the social perception of the effects of climate change on the coast ▪ Level up or relocate substations near coastal and river areas (energy) ▪ Build riverside flood defence walls ▪ Flood forecasting and warning	**Obj.O1** – O01 O02, O03, O04 O05, O06, O07 O08, O09, O10	**Obj.S2** – S18 S19, S20	**Obj. FWW1** – FWwt11, FWwt12 FWwt13, FWwt14 FWwt15, FWwt16 FWwt17, FWwt18 FWwt19, FWwt20 FWwt21, FWwt32 FWwt33, FWwt34 FWwt35 **Obj. FWW2** – FWwt37, FWwt38 FWwt39 **Obj. FWW3** – FWwt40, FWwt41 FWwt44, FWwt45 FWwt46, FWwt47 FWwt48, FWwt49 FWwt53, FWwt54 FWwt64 **Obj. FSW1** – FSwt03, FSwt11 FSwt12, FSwt13 FSwt14, FSwt15 FSwt16, FSwt17 FSwt18, FSwt25 FSwt26, FSwt27 FSwt28 **Obj. FSW2** – FSwt30, FSwt31 FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt37, FSwt38 FSwt39, FSwt40 FSwt41, FSwt42 FSwt46, FSwt47 FSwt53 **Obj. FE1** – FEne11, FEne12 FEne13, FEne14 FEne15, FEne16 FEne17, FEne18 FEne25, FEne26 FEne27, FEne28 **Obj. FE2** – FEne30, FEne31	**Obj. PWW1** – PWwt17, PWwt18 PWwt19 **Obj. PWW2** – PWwt20, PWwt21 PWwt22, PWwt23 PWwt24, PWwt25 **Obj. PWW3** – PWwt32, PWwt34 PWwt35, PWwt36 PWwt37, PWwt38 PWwt39 **Obj. PSW1** – PSwt18, PSwt19 **Obj. PSW2** – PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25 **Obj. PSW3** – PSwt32, PSwt34 PSwt35, PSwt36 PSwt37, PSwt38 PSwt39 **Obj. PE2** – PEne16, PEne17 PEne18, PEne19 PEne20, PEne21 **Obj. PE3** – PEne27, PEne29 PEne30, PEne31 PEne32, PEne33 PEne34

			FEne32 **Obj. FE3** – FEne33, FEne34 FEne37, FEne38 FEne39, FEne40 FEne41, FEne42 FEne45, FEne46 FEne47, FEne53	
S015Lisbon Peak flow attenuation through the construction of two retention basins **Measures** ▪ Identify high risk areas by conducting studies involving flood modelling analysis ▪ Provide flood storage areas via detention, retention or infiltration basins ▪ Create multi–purpose areas on flood storage areas	**Obj.O2** – O19, O20, O21, O22, O23, O24, O25, O28, O29, O30, O34, O35, O36, O37 **Obj.O3** – O41 O42, O43, O44 O54, O55, O56 O57, O58, O60		**Obj. FWW1** – FWwt11, FWwt12 FWwt13, FWwt14 FWwt15, FWwt16 FWwt17, FWwt18 FWwt19, FWwt20 FWwt21, FWwt33 **Obj. FWW2** – FWwt37, FWwt38 FWwt39 **Obj. FWW3** – FWwt40, FWwt41 FWwt44, FWwt45 FWwt46, FWwt47 FWwt48, FWwt49 FWwt53, FWwt54 FWwt64 **Obj. FSW1** – FSwt03, FSwt11 FSwt12, FSwt13 FSwt14, FSwt15 FSwt16, FSwt17 FSwt18, FSwt26 **Obj. FSW2** – FSwt30, FSwt31 FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt37, FSwt38 FSwt39, FSwt40 FSwt41, FSwt42 FSwt46, FSwt47 FSwt53 **Obj. FWT1** – FSlw11, FSlw12 FSlw13, FSlw14 FSlw15, FSlw16 FSlw17, FSlw18 FSlw19, FSlw20 FSlw31 **Obj. FWT2** – FSlw35, FSlw36 FSlw37	**Obj. PWW2** – PWwt20, PWwt21 PWwt22, PWwt23 PWwt24, PWwt25 **Obj. PWW3** – PWwt32, PWwt35 PWwt36, PWwt37 PWwt38, PWwt39 **Obj. PSW2** – PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25 **Obj. PSW3** – PSwt32, PSwt35 PSwt36, PSwt37 PSwt38, PSwt39 **Obj. PWT2** – PSlw18, PSlw19 PSlw20, PSlw21 PSlw22, PSlw23 **Obj. PWT3** – PSlw31, PSlw35 PSlw36, PSlw37 PSlw38, PSlw39 **Obj. PE2** – PEne16, PEne17 PEne18, PEne19 PEne20, PEne21 **Obj. PE3** – PEne30, PEne31 PEne32, PEne33 PEne34 **Obj. PM2** – PMob16, PMob17 PMob18 **Obj. PM3** – PMob21 PMob24 PMob25, PMob26 PMob27, PMob28

			Obj. FWT3 – FSlw38, FSlw39 FSlw42, FSlw43 FSlw44, FSlw45 FSlw46, FSlw47 FSlw51, FSlw52 FSlw61 **Obj. FE1** – FEne11, FEne12 FEne13, FEne14 FEne15, FEne16 FEne17, FEne18 **Obj. FE2** – FEne30, FEne31 FEne32 **Obj. FE3** – FEne33, FEne34 FEne37, FEne38 FEne39, FEne40 FEne41, FEne42 FEne45, FEne46 FEne47, FEne53 **Obj. FM1** – FMob10, FMob11 FMob12, FMob13 FMob14, FMob15 FMob16, FMob17 FMob27 **Obj. FM2** – FMob34, FMob35 FMob36	
S017Lisbon Lisbon drainage monitoring and early– warning system **Measures** ▪ Learn from real– life flooding by recording and investigating events ▪ Implement monitoring program and warning systems on drainage system ▪ Flood forecasting and warning	**Obj. O1** – O01, O02, O03, O04, O05, O06, O07, O08, O09, O10 **Obj. O2** – O11, O15, O16, O17, O18, O20, O21, O23, O24, O25, O28, O29, O30, O31, O34, O35, O36, O37 **Obj. O3** – O38, O39, O40, O41, O42, O43, O44, O46, O47, O50, O53 O54, O57, O58, O60, O61, O63, O64, O65, O66, O70	**Obj. S1** – S01, S02, S03, S04, S05, S06, S07, S08, S09, S10, S11, S12, S13, S14, S15, S16, S17 **Obj. S2** – S21 S22, S25	**Obj. FWW1** – FWwt03, FWwt04 FWwt07, FWwt11 FWwt12, FWwt13 FWwt14, FWwt15 FWwt16, FWwt17 FWwt18, FWwt19 FWwt20, FWwt21 **Obj. FWW2** – FWwt37, FWwt38 FWwt39 **Obj. FWW3** – FWwt40, FWwt41, FWwt42, FWwt44, FWwt45, FWwt46, FWwt47, FWwt48, FWwt49, FWwt50, FWwt51, FWwt53, FWwt54, FWwt64	**Obj. PWW1** – PWwt03,PWwt04 PWwt05,PWwt17 **Obj. PWW2** – PWwt20,PWwt21 PWwt22,PWwt23 PWwt24,PWwt25 **Obj. PWW3** – PWwt35,PWwt36 PWwt37,PWwt38 PWwt39 **Obj. PSW1** – PSwt03, PSwt04 PSwt05, PSwt17 **Obj. PSW2** – PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25

			Obj. FSW1 – FSwt03, FSwt04 FSwt07, FSwt11 FSwt12, FSwt13 FSwt14, FSwt15 FSwt16, FSwt17 FSwt18, **Obj. FSW2** – FSwt30, FSwt31, FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt35, FSwt37 FSwt38, FSwt39 FSwt40, FSwt41 FSwt42, FSwt43 FSwt44, FSwt46 FSwt47, FSwt53	**Obj. PSW3** – PSwt35, PSwt36 PSwt37, PSwt38 PSwt39
S018Lisbon Architecture integration/solutions adaptations for urban electrical infrastructure to face overland flows or coastal water overtopping **Measures** ▪ Install flood proof fencing ▪ Learn from real– life flooding by recording and investigating events ▪ Emergency response plans and procedures ▪ Build riverside flood defence walls	**Obj. O2** – O18, O19, O20, O22, O23, O24, O25, O26, O27, O28, O29, O30, O31, O34, O35, O36, O37 **Obj. O3** – O38 O39, O40, O41 O42, O43, O44 O45, O46, O48 O49, O50, O51 O52, O53, O54 O57, O58, O60 O61, O63, O64 O65, O66, O70	**Obj. S1** – S01, S02, S03, S04, S05, S06, S07, S08, S09, S10, S11, S12, S13, S14, S15, S16, S17 **Obj. S2** – S18, S19, S20 S22, S25, S27	**Obj. FWW1** – FWwt01, FWwt02 FWwt03, FWwt04 FWwt05, FWwt06 FWwt07, FWwt08 FWwt09, FWwt11 FWwt12, FWwt13 FWwt14, FWwt15 FWwt16, FWwt17 FWwt18, FWwt19 FWwt20, FWwt21 **Obj. FWW2** – FWwt37, FWwt38 FWwt39 **Obj. FWW3** – FWwt40, FWwt41, FWwt42, FWwt43, FWwt44, FWwt45, FWwt46, FWwt47, FWwt48, FWwt49, FWwt50, FWwt51, FWwt52, FWwt53, FWwt54, FWwt64 **Obj. FSW1** – FSwt01, FSwt02 FSwt03, FSwt04 FSwt05, FSwt06 FSwt07, FSwt08 FSwt09, FSwt11 FSwt12, FSwt13 FSwt14, FSwt15 FSwt16, FSwt17 FSwt18,	**Obj. PWW1** – PWwt04, PWwt05 PWwt17 **Obj. PWW2** – PWwt20, PWwt21 PWwt22, PWwt23 PWwt24, PWwt25 **Obj. PWW3** – PWwt34, PWwt35, PWwt36, PWwt37, PWwt38, PWwt39 **Obj. PSW1** – PSwt04, PSwt05 PSwt17 **Obj. PSW2** – PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25 **Obj. PSW3** – PSwt34, PSwt35, PSwt36, PSwt37, PSwt38, PSwt39 **Obj. PE1** – PEne04, PEne05 **Obj. PE2** – PEne16, PEne17 PEne18, PEne19 PEne20, PEne21 **Obj. PE3** – PEne29, PEne30

			Obj. FSW2 – FSwt30, FSwt31, FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt35, FSwt36 FSwt37, FSwt39 FSwt40, FSwt41 FSwt42, FSwt43 FSwt44, FSwt45 FSwt46, FSwt47 FSwt53 **Obj. FE1** – FEne01, FEne02, FEne03, FEne04, FEne05, FEne06, FEne07, FEne08, FEne09, FEne11, FEne12, FEne13, FEne14, FEne15, FEne16, FEne17, FEne18 **Obj. FE2** – FEne30 FEne31, FEne32 **Obj. FE3** – FEne33, FEne34, FEne35, FEne36, FEne37, FEne38, FEne39, FEne40, FEne41, FEne42, FEne43, FEne44, FEne45, FEne46, FEne47, FEne53	PEne31, PEne32 PEne33, PEne34
S019Lisbon Building protections for urban electrical infrastructure, exposed to estuarine flood **Measures** ▪ Install flood proof fencing ▪ Learn from real– life flooding by recording and investigating events ▪ Emergency response plans and procedures ▪ Build riverside flood defence walls	**Obj. O2** – O18, O19, O20, O22, O23, O24, O25, O26, O27, O28, O29, O30, O31, O34, O35, O36, O37 **Obj. O3** – O39, O40, O41 O42, O43, O44 O45, O46, O48 O49, O50, O51 O52, O53, O54 O57, O58, O60 O61, O63, O64 O65, O66, O70	**Obj. S1** – S01, S02, S03, S04, S05, S06, S07, S08, S09, S10, S11, S12, S13, S14, S15, S16, S17 **Obj. S2** – S18, S19, S20 S22, S27	**Obj. FWW1** – FWwt01, FWwt02 FWwt03, FWwt04 FWwt05, FWwt06 FWwt07, FWwt08 FWwt09, FWwt11 FWwt12, FWwt13 FWwt14, FWwt15 FWwt16, FWwt17 FWwt18, FWwt19 FWwt20, FWwt21 **Obj. FWW2** – FWwt37, FWwt38 FWwt39 **Obj. FWW3** – FWwt40, FWwt41, FWwt42, FWwt43, FWwt44, FWwt45, FWwt46, FWwt47, FWwt48, FWwt49,	**Obj. PWW1** – PWwt04, PWwt05 PWwt17 **Obj. PWW2** – PWwt20, PWwt21 PWwt22, PWwt23 PWwt24, PWwt25 **Obj. PWW3** – PWwt34, PWwt35, PWwt36, PWwt37, PWwt38, PWwt39 **Obj. PSW1** – PSwt04, PSwt05 PSwt17 **Obj. PSW2** –

			FWwt50, FWwt51, FWwt52, FWwt53, FWwt54, FWwt64 **Obj. FSW1** – FSwt01, FSwt02 FSwt03, FSwt04 FSwt05, FSwt06 FSwt07, FSwt08 FSwt09, FSwt11 FSwt12, FSwt13 FSwt14, FSwt15 FSwt16, FSwt17 FSwt18, **Obj. FSW2** – FSwt30, FSwt31, FSwt32 **Obj. FSW3** – FSwt33, FSwt34 FSwt35, FSwt36 FSwt37, FSwt39 FSwt40, FSwt41 FSwt42, FSwt43 FSwt44, FSwt45 FSwt46, FSwt47 FSwt53 **Obj. FE1** – FEne01, FEne02, FEne03, FEne04, FEne05, FEne06, FEne07, FEne08, FEne09, Fene10, FEne11, FEne12, FEne13, FEne14, FEne15, FEne16, FEne17, FEne18 **Obj. FE2** –FEne30 FEne31, FEne32 **Obj. FE3** –FEne33, FEne34, FEne35, FEne36, FEne37, FEne38, FEne39, FEne40, FEne41, FEne42, FEne43, FEne44, FEne45, FEne46, FEne47, FEne53	PSwt20, PSwt21 PSwt22, PSwt23 PSwt24, PSwt25 **Obj. PSW3** – PSwt34, PSwt35, PSwt36, PSwt37, PSwt38, PSwt39 **Obj. PE1** – PEne04, PEne05, PEne08, PEne09 PEne10, PEne011, PEne12 PEne13 PEne14 **Obj. PE2** – PEne16, PEne17 PEne18, PEne19 PEne20, PEne21 **Obj. PE3** – PEne29, PEne30 PEne31, PEne32 PEne33, PEne34
S020Lisbon Use alternatives water sources taking into account severe droughts	**Obj. O2** – 016, 018	**Obj. S1** – S03, S05, S15	**Obj. FW1** – FWts01, FWts02 FWts03, FWts04 FWts05, FWts06 FWts07, FWts08 FWts09, FWts12 FWts13, FWts14 FWts15, FWts16	**Obj. PW1 –** PWts17, PWts18 PWts19 **Obj. PW1 –** PWts33, PWts35 PWts39, PWts40

Measures ▪ Improved preparedness ▪ Improve interoperability of the crisis management actors by development or implementation of practical standards ▪ Prioritize water allocation in a stress situation ▪ Use of non– potable water in compatible uses			FWts17, FWts18 FWts19, FWts20 FWts21, FWts22 FWts23, FWts35 FWts36, FWts37 FWts38, **Obj. FW3** – FWts43, FWts45, FWts50, FWts51, FWts52, FWts55 **Obj. FWW1** – FWwt01, FWwt02 FWwt03, FWwt04 FWwt05, FWwt06 FWwt07, FWwt08 FWwt09, FWwt12 FWwt13, FWwt14 FWwt15, FWwt16 FWwt17, FWwt18 FWwt19, FWwt20 FWwt32, FWwt33 FWwt34, FWwt35 **Obj. FWW3** – FWwt40, FWwt42 FWwt47, FWwt48 FWwt49, FWwt52	