



LISBON RESILIENCE ACTION PLAN

RESILIENCE TO CLIMATE CHANGE WITH
FOCUS ON URBAN WATER CYCLE

2020-2030

Lisbon Municipality – Atlantic Capital of
Portugal

LISBON RESILIENCE ACTION PLAN

Lisbon City Council

Praça do Município, 1100-038

Lisbon, Portugal

Tel. + 351 21 323 6200

Web site: <https://www.lisboa.pt>

E-mail: dmaevce.daeac.dae@cm-lisboa.pt (Environment, Green Structure, Climate and Energy)

smpc@cm-lisboa.pt (Civil Protection)

Authors and contributors

AUTHORS	INSTITUTION	ROLE
Coordinator: Maria João Telhado Team: Marco Morais	Lisbon City Council https://lisboa.pt	Lisbon Research Site contributions and development
Coordinator: Maria Adriana Cardoso Team: Rita Brito, Cristina Pereira	LNEC http://www.lnec.pt/en	Methodology, contributions and development coordination
Ruth Lopes, João Barreiro Nuno Pimentel Inês Cândido da Silva, Nuno Duarte Maria do Céu Almeida	RESCCUE PT partners Hidra, Lda, http://hidra.pt AdTA, https://www.aguasdotejoatlantico.adp.pt EDP-Distribuição, http://edpdistribuicao.pt/en LNEC, http://www.lnec.pt/en	Stakeholders contribution and development

DATE	VERSION
19/08/2019	1.0 - Proposal of RAP 1st part
17/12/2019	2.0 - Revision and update of RAP 1st part
12/02/2020	3.0 - Addition of proposal of RAP 2nd part
13/05/2020	4.0 - Revision and update of RAP 2nd part
21/05/2020	5.0 - Revision and update of pre-final complete version
02/07/2020	6.0 - Complete version for revision
11/09/2020	Revised version

This plan is based on a template provided by RESCCUE Project (H2020 RESCCUE - RESilience to cope with Climate Change in Urban arEas - a multisectorial approach focusing on water, Grant Agreement no.700174): www.resccue.eu

All images including cover photo are from Lisbon partners. Cover photo: CML, 2019.

To cite this document:

Telhado, M.J., Morais, M., Cardoso, M.A., Brito, R.S., Pereira, C., Lopes, R., Barreiro, J., Pimentel, N., Silva, I.C., Duarte, N., Almeida, M.C. (2020). Lisbon Resilience Action Plan. In Resilience Action Plans of the RESCCUE cities. D6.2 RESCCUE project (Public).

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS	V
EXECUTIVE SUMMARY	VII
1. INTRODUCTION	1
Background	1
About the plan	5
Plan scope, focus and time horizon	5
Addressed urban services	5
Planning process	6
Document structure	7
2. CITY CHARACTERISATION	8
City profile	8
Service profile	13
3. CLIMATE CHANGE SCENARIOS AND HAZARD ASSESSMENT	16
Hazards sources and planning scenarios	16
Hazard assessment	18
4. RESILIENCE ASSESSMENT AND SWOT ANALYSIS	21
Resilience assessment.....	21
SWOT Analysis	26
5. RESILIENCE STRATEGIES	32
Identification of strategies	32
Description of the strategies to be implemented.....	33
Co-benefits and impact on resilience objectives	47
Prioritization	50
Implementation plan	50
6. RAP MONITORING AND REVIEW PROCESS	51
Monitoring.....	51
Review	51
7. FINAL REMARKS	53
Main benefits and challenges	53
Acknowledgements.....	53
REFERENCES	54

ACRONYMS AND ABBREVIATIONS

AML	Lisbon Metropolitan Area (Área Metropolitana de Lisboa)
ANPC PRT	Portuguese National Authority for Civil Protection
BASEMENT	Basic Simulation Environment
C40	Network of the world's megacities committed to addressing climate change, initially with 40 cities
CC	Climate change
CML	Lisbon City Council (Câmara Municipal de Lisboa)
Csa	Hot-summer Mediterranean climate (Köppen climate classification)
CSO	Combined Sewer Overflow
DG	Distributed Generation
DPLAN	Distribution Planning
DRR	Disaster Risk Reduction
EDP D	Energias de Portugal (Distribuição)
EU	European Union
FCUL	Faculty of Sciences of the University of Lisbon
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GIS	Geographic Information System
HFA	Hygo Framework for Action
ICLEI	Local Governments for Sustainability global network
INE	Statistics Portugal (Instituto Nacional de Estatística)
Infoworks ICM	InfoWorks Integrated Catchment Modelling
J&L	Urban drainage catchments of Avenida da Liberdade (J) and Avenida Almirante Reis (L), in Lisbon
LV	Low Voltage
M x	Measure reference number x
MV	Medium Voltage
MVA	Megavolt amperes
NBS	Nature Based Solutions
NUA	New Urban Agenda

- LISBON RESILIENCE ACTION PLAN -

NUTS II	Nomenclature of territorial units for statistics II (basic regions for the application of regional policies)
PGIL	Lisbon Platform for Intelligent Management
PMDFCI	Lisbon Municipal Plan of Forest Defence against Fire
RAF App	Resilience Assessment Framework web-based tool
RAF	Resilience Assessment Framework
RAP	Resilience Action Plan
RCP	Representative Concentration Pathway
REOT	Report on the State of Urban Planning
RESCCUE	RESilience to cope with Climate Change in Urban arEas
RWH	Rainwater Harvesting Systems
S x	Strategy reference number x
SDG	Sustainable Development Goals
SEAP	Sustainable Energy Action Plan
SECAP	Sustainable Energy and Climate Action Plan
SO	Strategies that use the strengths to exploit opportunities
ST	Strategies that exploit strengths to overcome any potential threats
SUDS	Sustainable Drainage Systems
SUMO	Simulation of Urban Mobility
SWMM	Storm Water Management Model
SWOT	SWOT analysis (or SWOT matrix) to identify strengths (S), weaknesses (W), opportunities (O), and threats (T)
TOWS	TOWS analysis to link the different components of a SWOT together to come out with clear actions (SO, WO, ST, WT)
Tx	Return period of x years
UNISDR	Presently UNDRR, United Nations Office for Disaster Risk Reduction
WO	Strategies that mitigate weaknesses, by exploiting opportunities
WT	Strategies attempting to minimise weaknesses to avoid the impact of threats
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY



(CML, 2019)

Lisbon developed the Resilience Action Plan (RAP) considering its city boundaries (urban area). The present planning has a medium/long-term horizon of 10 years, from 2020 to 2030, in articulation with the strategic planning horizons for Lisbon.

The objective of this plan is to provide a roadmap to improve the resilience to climate change with focus on water.

The Lisbon vision is to be one of the best cities of the world to live in, a globally more sustainable city at environmental, economic, social, financial and political levels, to have the resources managed to safeguard its identity and increase its resilience, and to improve the present situation without jeopardizing future generations.

The objectives considered to assess resilience to climate change, including the urban services and their infrastructures, are to achieve: city collective engagement and awareness of citizens and communities, leadership and management, preparedness for basic conditions, climate change, disaster response and recovery and build back, for the organisational dimension of the city; spatial risk management and provision of protective infrastructure and ecosystems, for the spatial dimension of the city; services planning and risk management, autonomy and preparedness for climate change, disaster response and recovery and build back, for the functional dimension of the city; and safe, autonomous and flexible as well as prepared infrastructures, for the physical dimension of the city.

The following strategic urban services, its interactions and contributions to city's resilience are considered in the plan: wastewater drainage and treatment, stormwater drainage, waste collection and treatment, electric energy supply and mobility. Other urban services, such as those related with water supply, telecommunication, emergency sector, among others, are equally relevant for the city, however, are not addressed herein.

The main concerns for the incoming years are the increase of extreme events, in particular intense precipitation and winter storms followed by heavy rain and wind, the increase in frequency and intensity of heat waves and droughts, as well as the increase of days with high temperature ($\geq 35^{\circ}\text{C}$) and tropical nights ($\geq 20^{\circ}\text{C}$). The increase of mean sea level rise is also a concern, especially when combined with storm surge events. These concerns have always been a threat to Lisbon's resilience and are expected to be aggravated by climate change (Pagani et al., 2018). Lisbon city is committed to increase city resilience, particularly reducing vulnerability to the abovementioned hazards, preparing the population and the services for their occurrence and promoting a better articulation between urban services.

The most critical climate-related hazard for Lisbon is flooding. Therefore, future climate scenarios were studied for sea level rise and extreme precipitation, the main drivers for urban flooding events.

A set of strategies expected to have greater impact in the city was planned, namely: S0005 - Adaptation of green infrastructure; S007/S016 - Promoting urban rehabilitation as a tool to increase resilience: sewer systems; S008 - Promoting urban rehabilitation as a tool to increase resilience: facing climate change; S010 - Strengthening collaboration within AML, parishes and municipality departments; S017 - Lisbon urban drainage monitoring and early warning system; S019 - Building protections for urban electrical infrastructure, exposed to estuarine flood. With this set of strategies, Lisbon aims to achieve most of its long-term resilience objectives regarding climate change, with focus on water.



(CML, 2013)

1. INTRODUCTION

BACKGROUND

Lisbon municipality is one of the 18 municipalities that constitute the Lisbon Metropolitan Area (NUTS II), Portugal’s largest urban expanse, stretching on both sides of the Tagus River. The city has the historical medieval centre, the neighbourhoods developing along the main axes of circulation and the more recent developments – following a process of rapid urbanisation and consequent urban sprawl. Within this context, and based on the analyses conducted by both local public stakeholders and international actors working on resilience in Lisbon, it is possible to profile two main strands of urban challenges. One related to a combination of contextual environmental threats with the contingent impacts of climate change, the other linked to the financial crisis (Pagani et al., 2018). The resilience of the city to climate change can be highly related to its urban services resilience, their interdependencies and cascade effects.

Lisbon’s vision is to be one of the best cities of the world to live, a globally more sustainable city at environmental, economic, social, financial and political level, to have the resources managed to safeguard its identity and increase its resilience and to improve the present situation without jeopardizing future generations.

Lisbon Municipality has already developed an intensive work towards resilience and is proactively committed to increase the resilience of the city: from social exclusion to economic stresses and from seismic shocks to flooding. This vision is mirrored not only by international partnerships, such as the Making Cities Resilient campaign’s framework, from UNISDR, the 100 Resilient Cities, hosted by the Rockefeller Foundation, and the C40 Cities Network; but also through several strategic and action plans at local level, such as the Municipal Master Plan and the Municipal Strategy for Climate Change Adaptation. Moreover, Lisbon has been an active partner in several EU Projects, crucial space for experiences and know-how interchange.





SUSTAINABLE DEVELOPMENT GOALS
KNOWLEDGE PLATFORM

SUSTAINABLE DEVELOPMENT GOALS / SDG DASHBOARDS

2015 - 2030

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States, namely Portugal, in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries - developed and developing - in a global partnership. They recognize that ending poverty and other deprivations must go together with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests.

A revised and updated assessment of countries’ distance to achieving the Sustainable Development Goals (SDGs) is assessed in the SDG Index and Dashboards Report 2018 presents a. It includes detailed SDG Dashboards to help identify implementation priorities for the SDGs. The report also provides a ranking of countries by the aggregate SDG Index of overall performance. Portugal is in the 26th ranking place, from 162. [Click here for more information.](#)



LOCAL PROJECT CHALLENGE
(Centre for Sustainable Urban Development)

The aim of Accelerating the SDGs project is to increase awareness of the SDGs and the NUA. In April 2019, it was issued a call for Local Projects that engaged with the SDGs. The intention was to hear from people from all walks of life: in education, the professions and civil society. Lisbon has launched the in the following challenges: “Urban Resilience in action: take part in the Lisbon process”; “Monitoring the municipal water systems”; “RespirAr Lisboa”; “Preserving fish: public health issue”.
[Click on the image for more information.](#)



UNDRR
UN Office for Disaster Risk Reduction

SENDAI FRAMEWORK FOR DISASTER RISK REDUCTION

2015-2030

The Framework is a global agreement to reduce and prevent disaster risks across the globe. It aims to strengthen social and economic resilience to ease the negative effects of climate change, man-made disasters, and natural hazards. The EU played a key role in the negotiations of the agreement and supports EU Member States and non-EU countries in achieving the seven Sendai targets. The European Commission adopted the Communication Post 2015 Hyogo Framework for Action: Managing risks to achieve resilience (COM (2014)215), followed by EU Member States Council Conclusions outlining the EU position. In June 2016, the European Commission published an action plan that aims to guide the implementation of the Sendai Framework in EU policies. Portugal subscribed to the Hyogo Framework for Action (HFA) in 2005 and has taken, since then, concrete steps to integrate and streamline Disaster Risk Reduction (DRR) into national development strategies, recognizing the importance of DRR for the promotion of sustainable economic growth and progress. Also, in humanitarian aid policies DRR has been increasingly included, especially within bilateral cooperation established in this regard with African Portuguese speaking countries. The Sendai Focal Point in Portugal is the Portuguese National Authority for Civil Protection (ANPC PRT). [Click here for more information about the Portuguese participation on this framework and download the handbook “How To Make Cities More Resilient” \(Portuguese version\).](#)



LISBON'S RESILIENCE ACTION PLAN 2017

This document contains the feedback report on the draft local-urban indicators based on its usability, data availability and relevance and it also represents the DRR & Resilience Action plan for the city of Lisbon developed using the pilot local –urban indicators that is inclusive of the strategy.
[Click on the image for more information.](#)



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

EU H2020 Grant Agreement No. 700174

2016 - 2020

The RESCCUE project aims to help urban areas around the world to become more resilient to climate change. More precisely, RESCCUE will bring this objective to practice by providing innovative models and tools to improve the ability of cities to withstand and recover quickly from multiple shocks and stresses and maintain continuity of services. An end-user – city managers and urban service operators – oriented toolkit will have the capability to be deployed to different types of cities, with different climate change pressures.

[Click on the logo or title to know more about this project.](#)



INTERCONNECTION WITH FINANCED EU PROJECTS (EXAMPLES)



BINGO - BRINGING INNOVATION TO ONGOING WATER MANAGEMENT – A BETTER FUTURE UNDER CLIMATE CHANGE

EU H2020 Grant Agreement No 641739

2015 – 2019

BINGO aims both at reducing the uncertainty of near-term climate predictions and developing response strategies that may help society to better manage the remaining uncertainty. BINGO will enable a more efficient management of water resources in Europe, contribute to management planning across Europe and contribute to the development of reliable climate services relevant for the water cycle. [Click on the logo or title to know more about this project.](#)



RESILENS – REALISING EUROPEAN RESILIENCE FOR CRITICAL INFRASTRUCTURE

RESILENS

EU H2020 Grant Agreement No. 653260

2015 – 2018

RESILENS has an ambitious but achievable and practically applied research agenda that will result in significant advancements in the resilience of Critical Infrastructures. The project has a wide range of technical objectives, as well as striving to deliver objectives for positive advancements in societal, economic, environmental and organisational resilience. [Click on the logo or title to know more about this project.](#)

INTERCONNECTION WITH NATIONAL PROJECTS

RESILIENT CITIES IN PORTUGAL 2015

This report presents for each of the municipalities participating in the "Making Cities Resilient: My City is getting ready" campaign: the main risks, major past events, examples of good practices implemented and results achieved, in order to disseminate the extensive work already carried out in these municipalities and motivate other municipalities to join this initiative. In Portugal there are currently seven municipalities involved in this campaign: Amadora, Cascais, Funchal, Lisbon, Odivelas, Setúbal and Torres Vedras. [Click on the image or title to get the report for these Portuguese cities.](#)



INTERCONNECTION WITH NATIONAL PROJECTS

The realisation of the vision for Lisbon imposes an agenda that makes the city a globally more sustainable, considering environmental, economic, social, financial and political aspects. It is the cohesion between these different spheres of action that results in a city that manages its resources well, safeguarding its identity, increasing its resilience and improving the present, without endangering future generations. [Click on the image or title to read more about GOP.](#)



GRANDES OPÇÕES DO PLANO 2008 | 2023 DA CIDADE DE LISBOA

Outubro 2009

Parishes play an important role for the execution of the plans in the city. [Click here to know more about Lisbon's parishes.](#)

- LISBON RESILIENCE ACTION PLAN -

The urban water cycle is the scope of this plan, due to the importance of water-related risks and services in the functioning of the city. This RAP is a thematic plan that contributes to the city's global planning and it is related with other planning instruments in Lisbon: (click on each one to find more)

- **Municipal Master Plan (2012, under revision)**
- **Report on the State of Urban Planning (REOT) (2015)**
- **100 Resilient cities (Rockefeller Foundation)**
- **Municipal Strategy for Climate Change Adaptation (2017)**
- **Metropolitan Plan for Climate Change Adaptation 2019**
- **Lisbon Drainage Master Plan 2016 – 2030**
- **Lisbon Municipal Civil Protection Emergency Plan (approved in 2018)**
- **Lisbon Municipal Plan of Forest Defence against Fire 2019-2028 (PMDFCI)**
- **Lisbon Sustainable Energy and Climate Action Plan (SECAP) (2018)**
- **Lisbon Platform for Intelligent Management (PGIL)**
- **Urban water services asset management plans**
- **Business continuity plan for the energy service**
- **Observatórios Lisboa**



(CML, 2019)

ABOUT THE PLAN

Plan scope, focus and time horizon

Lisbon's Resilience Action Plan was developed considering the city boundaries. The present plan has a medium-term horizon of 10 years, from 2020 to 2030, in articulation with the strategic planning horizons for Lisbon. The scope of this plan is resilience to climate change (CC) with focus on the urban water cycle.



(CML, 2014)

Addressed urban services

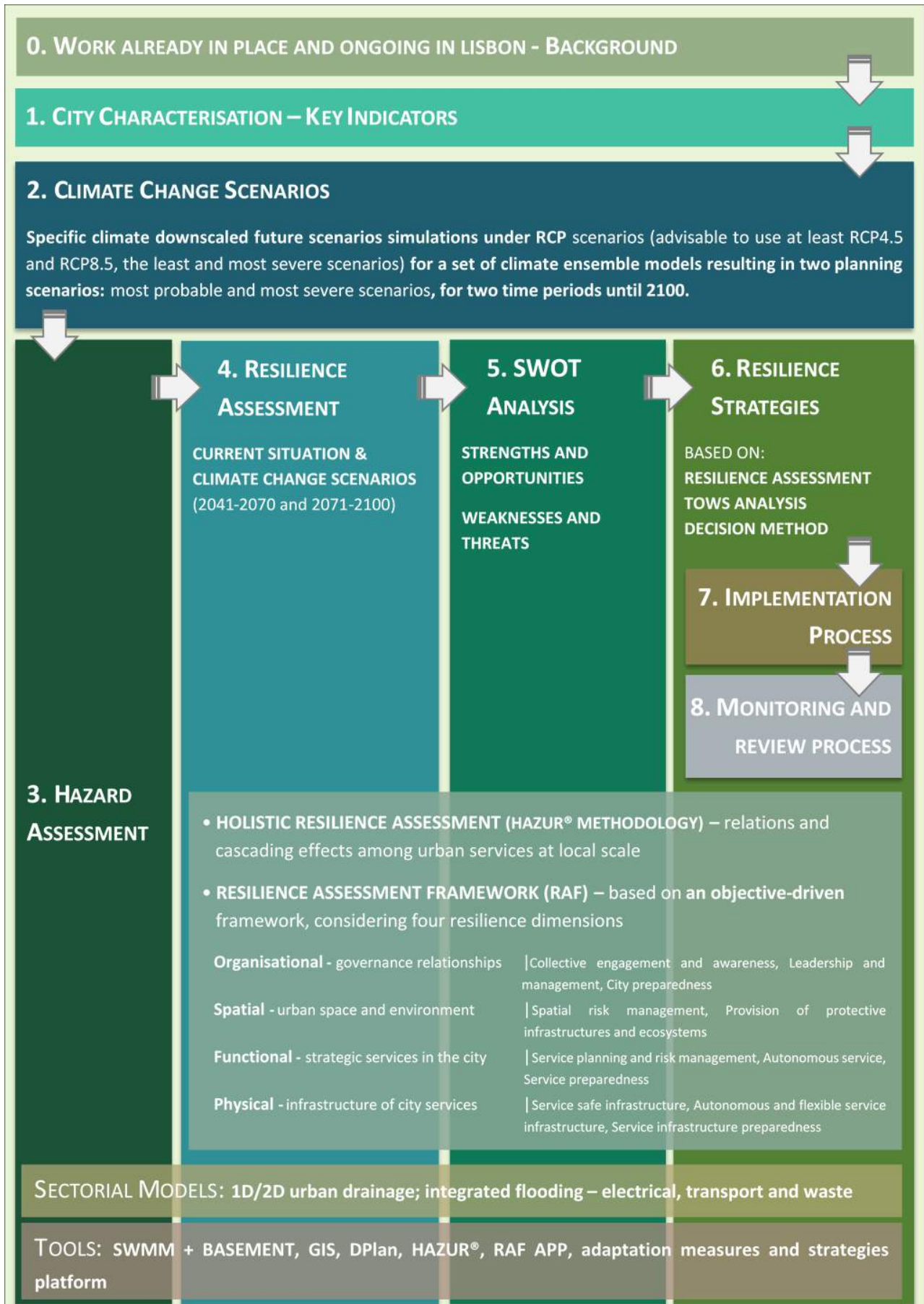
The following urban services, its interactions and contributions to city's resilience are considered in the plan: wastewater drainage and treatment and stormwater drainage, waste collection and treatment, electric energy supply and mobility. These services are within the scope of this plan as they relate with the water cycle, either providing a water service, being affected by these services' performance or affecting their performance.

In the resilience assessment, the services consider the urban area of Lisbon as spatial scope, except for the energy service that considers all the metropolitan area.



(CML, 2013)

Planning process



Document structure

This document provides a ten years' roadmap for resilience, defining a path to enhance resilience of the city and its services regarding climate change, with focus on the urban water cycle. It is based on the intense work and background already existing in Lisbon, the establishment of climate change planning scenarios, the characterisation of the city context and hazards, the risk and resilience assessment and on the development of the strategies that need to be implemented to enhance the resilience of the city to climate change with focus on water. It was supported on the RESCCUE's template, guidelines and results obtained using tools and approaches developed in this project (www.resccue.eu).

The plan is structured in 7 sections. This first introductory section provides the city background, an overview of the plan scope, focus, time horizon, planning process and structure.

In section 2, a brief characterization of the city and of the addressed urban services is provided, focusing on the plan scope.

In section 3, the climate change scenarios considered for the city in this plan are briefly presented, as well as the related hazards, risk and vulnerabilities.

The resilience assessment and a SWOT analysis are presented in section 4, followed by the description and planning of the mitigation and adaptation strategies selected, in section 5.

In section 6, steps for plan monitoring and review are acknowledged and scheduled.

Section 7 presents the final remarks of the plan, with a brief list of identified benefits and future challenges, as well as relevant acknowledgments.

Detailed or additional information is included in the annex.



(CML, 2013)

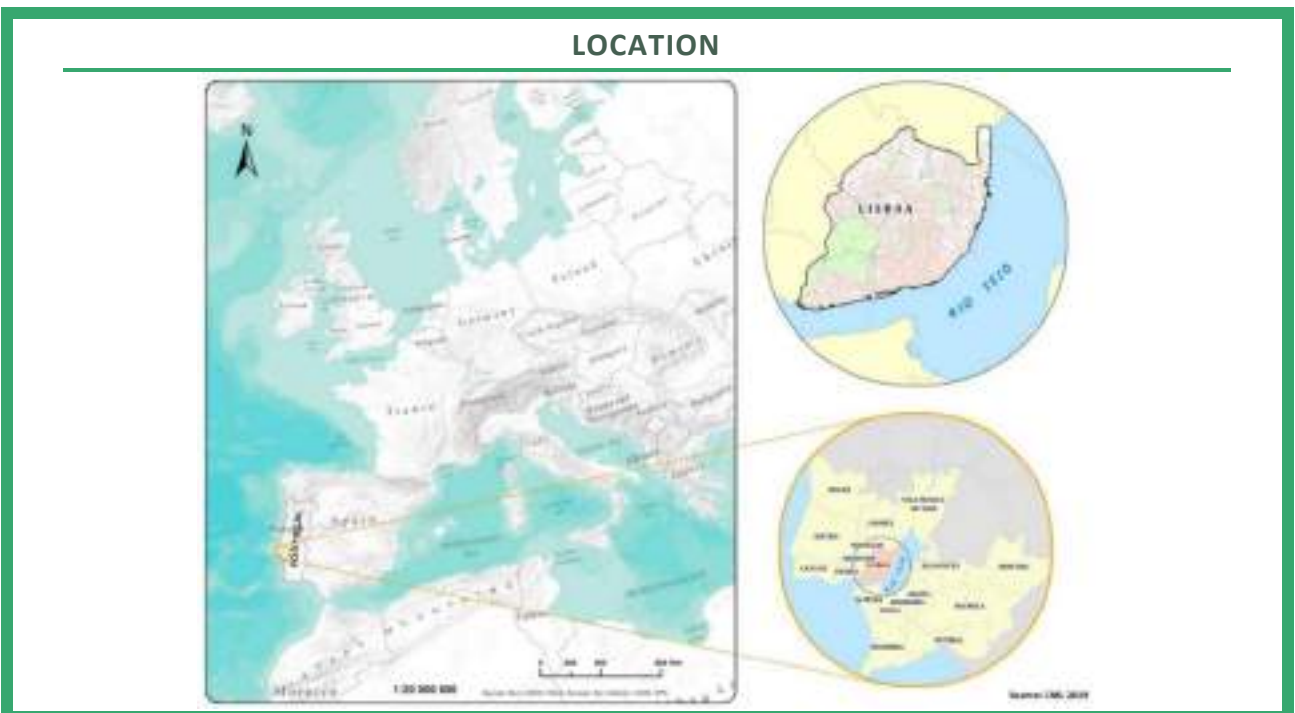
2. CITY CHARACTERISATION



(CML, 2019)

CITY PROFILE

Located on the northern bank of the Tagus River's estuary, Lisbon is the capital of Portugal and the second largest European port on the Atlantic Ocean. The city enjoys a hot summer / Mediterranean Climate (Csa), characterized by dry and hot summers and wet and fresh winter periods with a relatively low precipitation rate compared to other Portuguese cities. Lisbon Metropolitan Area stretches on both sides of the Tagus river, contributing to 37% of the national economic output (Pagani et al., 2018).



GEOGRAPHY

Country: **Portugal**

Region :

Metropolitan area

City: **Lisbon (24 parishes)**

Metropolitan area⁽¹⁾: **2 892 km²**

Urban area⁽¹⁾: **85.9 km²**

Estuarine area⁽¹⁾: **14.2 km²**

Coastal and river front



⁽¹⁾ CML (2015)

⁽²⁾ CML (2019)

⁽³⁾ Antunes et al. (2017)

CLIMATE & METEOROLOGY

Climate type: **Hot-summer / Mediterranean Climate (Csa - Köppen climate classification)**

Average temperature (1982-2010)⁽²⁾:

annual | hottest month | coldest month
17.0 °C | 23.5°C (August) | 10.8°C (January)

Average rainfall (1982-2010)⁽²⁾:

annual | wettest month | driest month
743 mm | 127.6 mm (Nov.) | 4.3 mm (Jul.)

Sea level⁽³⁾:

High Tide Level (2019): **4.48 m**

Mean Tide Level (2019): **2.37 m**

Lowest Tide Level (2019): **0.36 m**

The tide data values presented herein are referred to the vertical reference used in Hydrography. The Hydrographic Zero (ZO) defined for the entire Tagus estuary is 2.08 m relative to the Mean Sea Level of Cascais, so that the tidal levels should be deducted from this value.

POPULATION

Urban population density (2011)⁽¹⁾: **6 491 inhab/km²**

Urban permanent population (2011)⁽¹⁾: **547 733 inhab.**

Male: **45.8%** | Female: **54.2%**

Elderly: **23.9%**

Foreign: **5.8%**

Daily commuters (2011)⁽⁴⁾: **378 226 inhab.**

Population of the metropolitan area (2011)⁽¹⁾: **2 821 876 inhab.**

Most Practiced Religion: **Catholicism**



⁽⁴⁾ CML (2016a)

⁽⁵⁾ INE (2017)

ECONOMY & GOVERNANCE

Political system: **Democracy**

Political cycle: **4 years**

Metropolitan area GDP⁽⁴⁾: **66 521 M€**

GINI index (2017)⁽⁵⁾: **32.6% (city), 32.5% (metropolitan area)**



BUILT AND NATURAL ENVIRONMENT & INFRASTRUCTURE

Services in the city: water, wastewater, stormwater, waste, energy, mobility (air, road, rail, maritime transportation)

Protected areas in the city: ecologically or sensitive, cultural or historical heritage, easements

Ecosystem services: permeable areas, green areas for leisure and recreation services, CO₂ sequestration and climate regulation



CLIMATE-RELATED HAZARDS

Flooding - rainfall and sea level induced

Droughts

Heat waves

Cold waves

Windstorms

Combined sewer overflow (CSO)



RELEVANT WEATHER-RELATED EVENTS AND TIME SCOPE OF ANALYSIS

Below are presented relevant extreme weather-related events recorded since 1941. The records sum up a total of 56 events. The complete list of the mentioned events is presented in the annex.



HOT WEATHER/HEAT WAVE

Maximum temperature recorded on
01/08/2003:
42 °C

10 EVENTS



COLD WEATHER/COLD WAVE

Minimum temperature recorded on
11/02/1956:
- 1.2 °C

12 EVENTS



RAINFALL INDUCED FLOODS

Maximum return period associated to the
rainfall intensity recorded on 19/11/1983:
500 years

20 EVENTS



WIND/GUSTS

Maximum wind velocity recorded on
09/01/2014:
108.4 km/h

2 EVENTS



HIGH TIDES/STORM SURGES

Maximum meteorological uprising on
11/02/1979:
4.72 m (+ 61 cm)

8 EVENTS

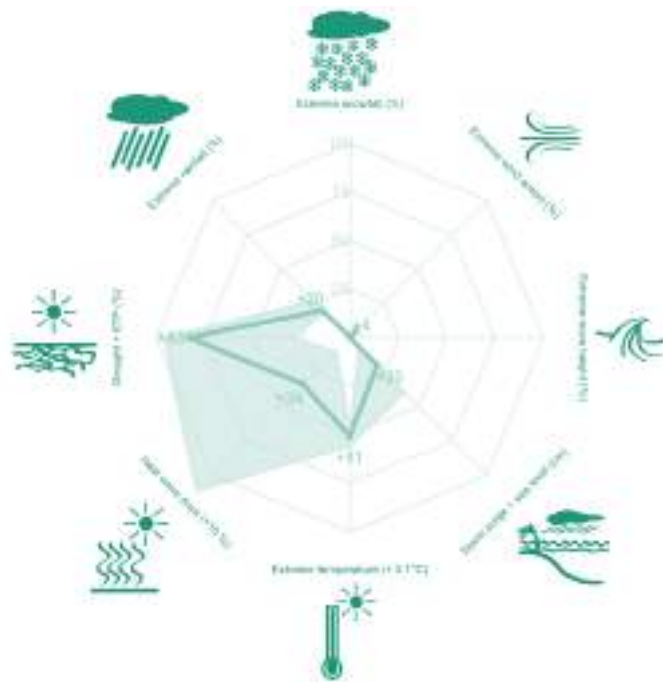


OTHER EVENTS

Hailstorm: 2 events (2011 and 2014)
Tornado: 1 event (2010)
Storm: 1 event (Leslie, 2018)

4 EVENTS

EXTREMES COMPASS ROSE FOR LISBON



Maximum change in climate extreme events along the century (return periods between 2 and 100 years) obtained on RESCCUE Climate Projections (Monjo et al., 2018).

The edge corresponds to an increase of 100%. For heat wave days border is +100% and for extreme temperature border is +10°C.

Median scenario
Uncertainty region (5-95%)

Note that the RAP focuses mostly on the flooding hazard in Lisbon. Consequently, it emphasises the flooding related variables.

PLAYERS AND STAKEHOLDERS

Given this resilience plan thematic scope and focus (climate change and urban water cycle), Lisbon identified relevant players and stakeholders involved in this resilience process. Several players from very different sectors - both public and private - participate in the management of the services and infrastructures, at local, regional and national scales, and several stakeholders are involved in strengthening Lisbon’s resilience-building efforts (Canalias et al., 2017) and in the compliance to overachieve the targets agreed by international commitments.

POLITICAL DECISION-MAKER	Mayor
GROUP NAME	Players
ACTION GROUP FROM THE MUNICIPALITY/CITY COUNCIL	Environment, urban planning, civil protection, fire brigade, urban hygiene, public streetlight, fleet, international relations, mobility, sanitation, finance, human resources, public space, relationship with parishes and media/communication.
RESCCUE ACTION GROUP	<p>CML - Câmara Municipal de Lisboa (Environmental and Energy Division and Civil Protection Department)</p> <p>AdTA - Águas do Tejo Atlântico (wastewater drainage and treatment)</p> <p>EDP Distribuição (exploitation of high, medium and low voltage concession)</p> <p>LNEC - Laboratório Nacional de Engenharia Civil (National Civil Engineering Laboratory)</p> <p>HIDRA, Hidráulica e Ambiente, Lda</p>
RESCCUE STAKEHOLDERS	<p>CIVIL PROTECTION AND PUBLIC SECURITY</p> <p>ANEPC – Autoridade Nacional de Emergência e Proteção Civil (National Authority of Emergency and Civil protection)</p> <p>Distrital de Proteção Civil de Lisboa</p>

EDUCATION, ACADEMIA AND I&D SECTOR

FCUL – Faculdade de Ciências da Universidade de Lisboa
IST – Instituto Superior Técnico da Universidade de Lisboa
INSA - Faculdade de Ciências da Universidade de Lisboa

ELECTRICITY

REN - Redes Energéticas Nacionais, SGPS, S.A

ENVIRONMENT AND CLIMATE

APA – Agência Portuguesa do Ambiente (Portuguese Environment Agency)
IPMA – Instituto Português do Mar e da Atmosfera, IP (Portuguese Institute for Sea and Atmosphere)

HEALTH

DGS – Direção Geral de Saúde (General Directorate for Health)

HERITAGE

DGPC – Direção Geral do Património Cultural (General Directorate for the Cultural Heritage)

MEDIA

ANACOM – Autoridade Nacional de Comunicações (National Communications Authority)
Media operators
Social media
TV/Radio

TRANSPORTS AND MOBILITY SECTOR

ANA – Aeroportos de Portugal, SA (Airport Management)
CARRIS – Companhia Carris de Ferro de Lisboa, SA (bus and tram transport company)
EMEL -Empresa Municipal de Mobilidade e Estacionamento de Lisboa, E.M. S.A (Municipal Mobility and Parking Company of Lisbon).
CP – Comboios de Portugal, EPE (national train company)
Grupo Transtejo, SA (Fluvial transport)
IMT – Instituto da Mobilidade e dos Transportes, IP (Mobility and Transportation Institute)
METRO – Metropolitano de Lisboa, EPE (subway transport)

URBAN PLANNING

DGT – Direção Geral do Território (General Directorate for the Territorial Development)

WASTE SECTOR

Valorsul – Valorização e Tratamento de Resíduos Sólidos das Regiões de Lisboa e do Oeste, SA (Waste treatment and valorisation)

WATER CYCLE SECTOR

EPAL - Empresa Portuguesa das Águas Livres, SA (water abstraction, transportation, storage and distribution)



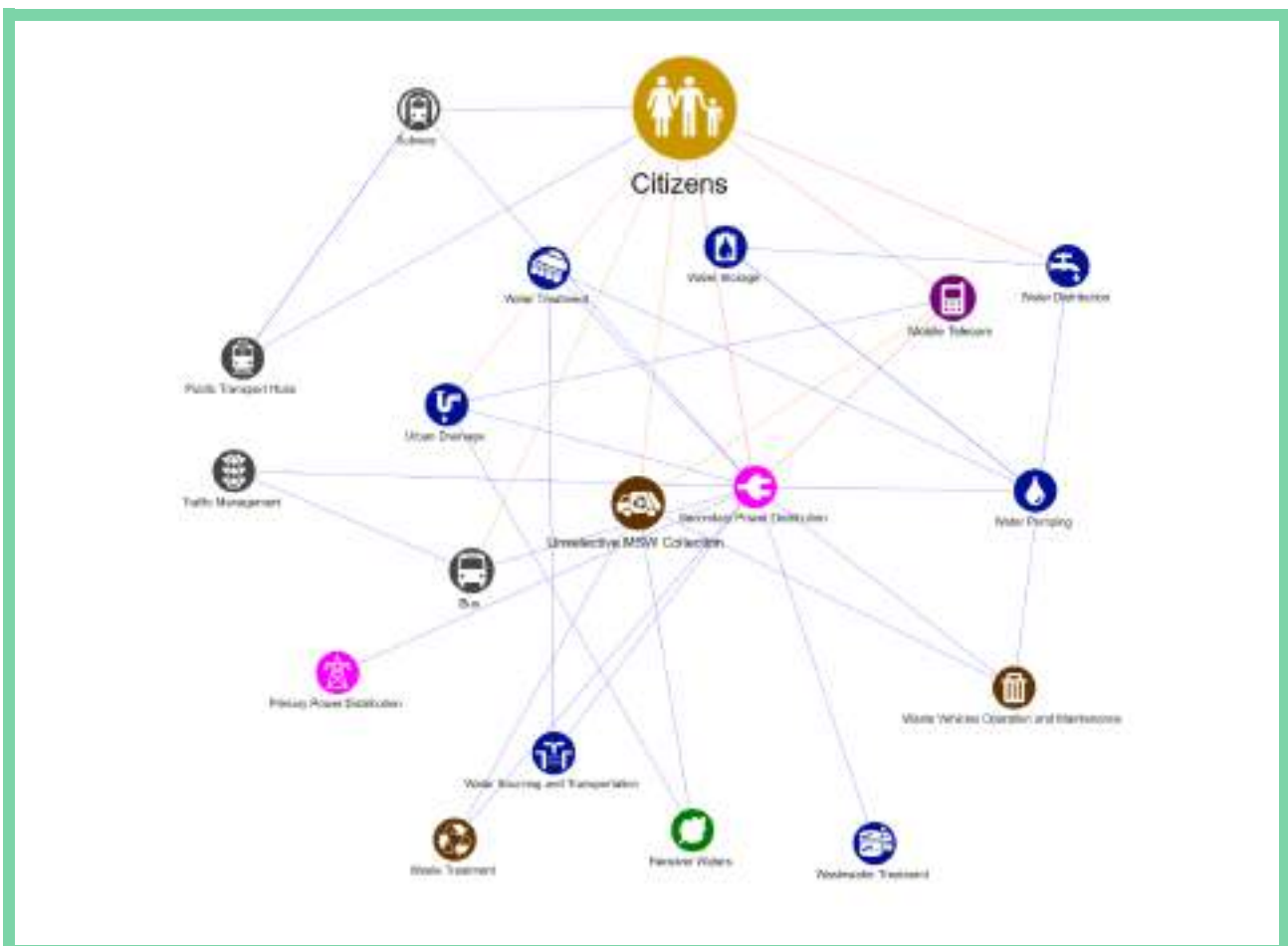
SERVICE PROFILE

Urban services play a very relevant role in city's resilience. The services considered in this plan interact and face their specific challenges due to climate change. Their resilience contributes to Lisbon's resilience. Being a complex and dynamic system of systems, the interdependencies between different services, especially basic services, constitute a daily challenge in the management of the city, involving different decision makers with different visions and priorities of action.

Under RESCCUE project the following strategic urban services (and main infrastructures), its interactions and contributions to city's resilience were considered: wastewater drainage and treatment, stormwater drainage, waste collection and treatment, electric energy supply and mobility. These service profiles are summarized below.

It has to be highlighted, however, that the city has other critical services and infrastructures that are essential for the maintenance of vital societal, health, safety, security, economic and/or social well-being functions. The disruption or destruction of these services/infrastructures would have a significant impact in the city as the provision of those function would cease. Example of these services not contemplated herein are: a) water, b) public administration, c) food, d) banking and finance, e) communication, f) energy (fossil fuels), g) chemical and nuclear industry, h) research and development, i) information technology, j) health, safety and public order. For all these the city has also established objectives and targets to be fulfilled.

RESCCUE INTERDEPENDENCIES ANALYSIS FOR LISBON



- LISBON RESILIENCE ACTION PLAN -

RESCCUE ASSESSED SERVICES

SERVICES CONTEXT CHARACTERIZATION							
	Wastewater		Stormwater	Waste		Energy	Mobility
Utilities	AdTA	CML	CML	CML	VALORSUL	EDP, D.	CARRIS/ METRO
Developed activities	Transport, treatment and discharge ("Bulk" system)	Collection and transport ("Retail" system)	Transport and discharge	Collection	Treatment	Distribution System Operator	Bus and tram transport (CARRIS), and subway transport (METRO)
Inhabitants covered	2.4 M	547 733	547 733	547 733	1.6 M	2.8 M	162 122 374 passengers in 2017
Area covered (km²)	4 230 (23 municipalities)	85.91 (Lisbon Municipality)	85.91 (Lisbon Municipality)	85.91 (Lisbon Municipality)	19 municipalities	3 014	-
Relevant info.	183 037 413 m ³ (treated volume in 2017)	-	-	323 981 dwellings covered	55 ton CO ₂ eq.	5281.51 ton CO ₂ eq.	75 965 ton CO ₂ eq.



Note: Sources and results included in RAF – City and Service profiles

RESCCUE SERVICE INFRASTRUCTURES









WASTEWATER	
Total length of sewers (km)	2 508
Pumping stations (No.)	26
Combined sewer overflows (No.)	23
Treatment plants (No.)	3

STORMWATER	
Total length of sewers (km)	1 216
Pumping stations (No.)	0
Treatment plants (No.)	0
Stormtanks (No.)	0
Rainwater sewer overflows (No.)	0
Detention tanks (No.)	-

WASTE	
Waste containers (No.)	204 004
Waste collection vehicles (No.)	211
Recycling centres (No.)	6262
Transfer stations (No.)	6
Composting plants (No.)	2
Incinerators (No.)	1
Sanitary landfills (No.)	2

ENERGY 		MOBILITY 	
Total length of aerial network (km)	10 457	Total length of road network (No.)	336
Total length of subterranean network (km)	18 418	Total length of cycling network (km)	79
Power stations (No.)	95	Airports (No.)	1
Installed power (MVA)	5 394	Airport passengers (No.)	22 449 000

Note: Sources and results included in RAF – City and Service Profiles

CONSIDERED RESCUE HAZARDS IN THE SERVICES				
HAZARD	Heat wave 	Flooding 	Windstorm 	Combined sewer overflow
SERVICES				
Wastewater 	●	●	●	●
Stormwater 	●	●	●	●
Waste 	●	●	●	●
Energy 	●	●	●	●
Mobility 	●	●	●	●

● Affected ● Not directly affected



(CML, 2014)

3. CLIMATE CHANGE SCENARIOS AND HAZARD ASSESSMENT



Storm event: rain, wind and storm surge (CML, 2018)

HAZARDS SOURCES AND PLANNING SCENARIOS

Several hazards may affect the city, services and infrastructures. In Lisbon, this RAP focuses on the flooding hazard induced by intense precipitation and by sea level rise, for the city and services. For this hazard and related variables, climate change scenarios for assessment are agreed (Antunes et al., 2013, Antunes et al., 2017, Monjo et al., 2018).

A planning scenario corresponds to a hazard condition, described by the characterization of its trigger variables by experts, for comprehensive assessment of the severity, probability of occurrence and its total impact. As a minimum, cities would ideally define two planning scenarios. The Most Probable relates to a hazardous event that causes disruption, assessed by experts to be the most likely to occur. The Most Severe relates to a hazardous event that causes greater disruption, assessed by experts to be the worst case to plan for (based on UNISDR, 2015). These scenarios, agreed under RESCCUE project, are indicated below.

Other variables besides precipitation and sea level, however, are considered in climate change trends for Lisbon City as referred in the table below (CML, 2017, Antunes, et al., 2017). The same applies for other hazards, besides flooding, such as heat and cold waves, wind/gusts, storm surges, for which the city is equally developing and applying strategies to increase overall resilience to climate change.

- LISBON RESILIENCE ACTION PLAN -

CLIMATE PROJECTIONS FOR LISBON

	Average 1976-2005	RCP4.5 2041/2070	RCP4.5 2071/2100	RCP8.5 2041/2070	RCP8.5 2071/2100
Rainfall (mm) (%)	708	-147 (-20.8/-7.2)	-185 (-37.6/-7.6)	-266 (-26.1/-3.8)	-361 (-51/-10.7)
Rainfall (days)	102	-16	-19	-22	-35
Temperature (°C)	15.1	+1.2 /+1.8	+1.2/ +2.4	+1.6/ +2.4	+3.1/ +4.0
Very hot (days)	8.5	+10.7	+12.4	+9.4	+24.4
Heat Waves (days)	28	+70	+63	+82	+93
Mean Sea Level (*) (cm)	208	+28 (+14/+31)	+56 (+31/+53)	+31 (+18/+41)	+78 (+53/+99)
Wind (km/h) (%)	20	+2.1 -0.13 / 0.42	+2.6 -0.05/ 0.5	+2.8 -0.1 / 0.5	+4.5 -0.008 / 0.9

(*) Antunes et al. (2017)

RESCCUE CLIMATE CHANGE SCENARIOS FOR THE CITY AND SERVICES

INTENSE PRECIPITATION & SEA LEVEL RISE

MOST PROBABLE SCENARIO

Rainfall



Return period: 10 years return period
Time period: 2071-2100
Relative change of 1h rainfall intensity in +17%, to account for CC

Sea level



Tide level⁽⁶⁾ = 1.95 m

MOST SEVERE SCENARIO

Rainfall



Return period: 100 years return period
Time period: 2071-2100
Relative change of 1h rainfall intensity in +19%, to account for CC

Sea level



Tide level⁽⁷⁾ = 2.81 m
Time period: 2100

⁽⁶⁾ CML (2016b)

⁽⁷⁾ Russo et al. (2019)

RESCCUE MAIN HAZARD



LISBON CAN EXPECT MORE CLIMATE-RELATED EVENTS IN THE FUTURE



Flooding from intense precipitation, combined with the sea level rise, could cause damage to people, buildings and other facilities as well as infrastructures; affect mobility and disrupt transport services; overwhelm stormwater drainage systems and affect wastewater treatment; and may cause other damages and collapses resulting in interruption of energy supply, affecting all other services and infrastructures' components.

HAZARD ASSESSMENT

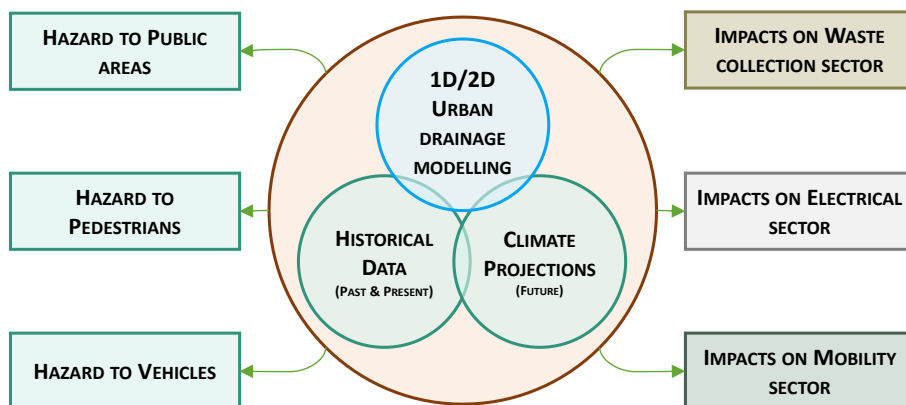
SECTORIAL MODELS IN THE CITY

The sectorial models used in Lisbon were based on historical data and on projections of future climate scenarios, a thorough characterization of the urban services and of their relations with climate variables, detailed analysis of interdependencies and elaboration of hazard maps.

Mathematical modelling of wastewater and stormwater systems was undertaken with SWMM (1D) and Basement (2D), mostly in the downtown area (drainage catchments J&L). DPlan was used in the whole metropolitan area for the energy service. GIS analysis was used for all the other services and city areas.

For different scenarios, considering both the current situation and the future with climate change, flooding exposure and vulnerability of each urban service were characterised, and the respective hazard maps were produced (Russo et al., 2019) and may be visualised in www.toolkit.resccue.eu.

The effects of multiple hazards and interdependencies in the city were also studied, namely flooding/mobility, flooding/energy and flooding/waste (Evans et al., 2019).



CITYWIDE FLOODING HAZARD MAPS



CURRENT SITUATION

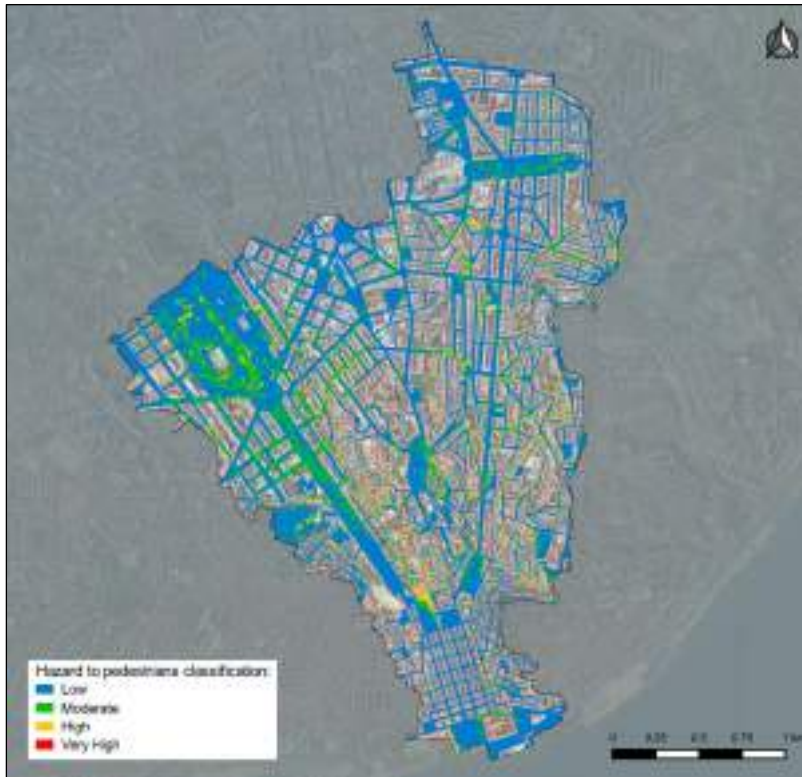
Hazard map for flooding induced by rainfall or estuary tides resulting from multi-criteria analysis including historical events and other natural and man-made factors



CONSIDERING CLIMATE CHANGE

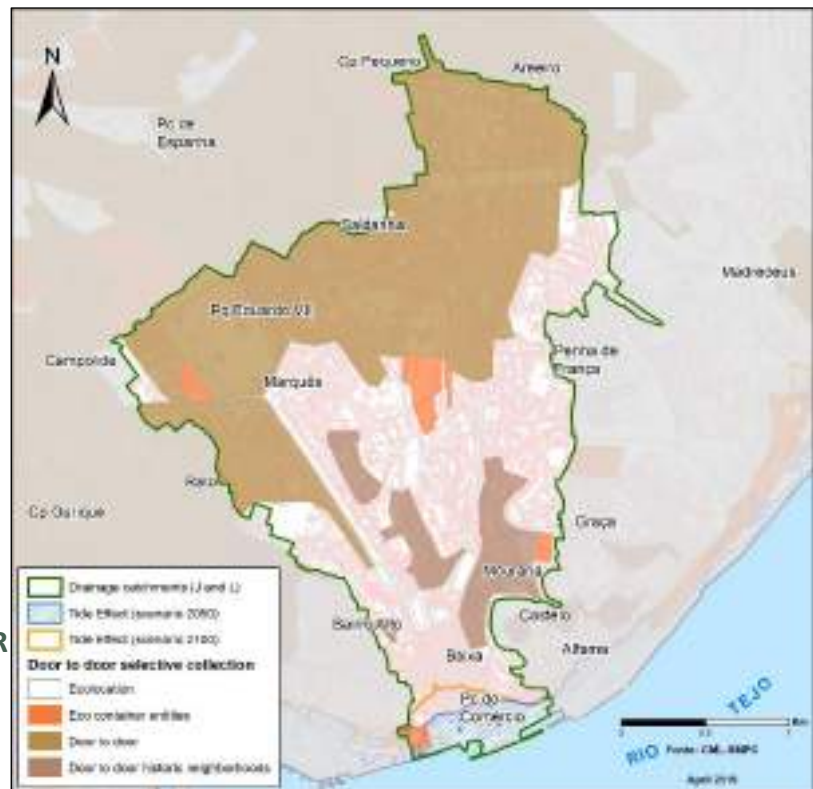
Hazard map for flooding induced by sea level rise for 2050

DRAINAGE CATCHMENTS J&L FLOODING-RELATED HAZARD MAPS



HAZARD TO PEDESTRIANS

Hazard to pedestrians' map for flooding induced by rainfall (T=10 years) for 2100



4. RESILIENCE ASSESSMENT AND SWOT ANALYSIS

RESILIENCE ASSESSMENT

Resilience assessment enables to highlight where Lisbon and the urban services stand today (reference situation), regarding resilience to climate change, and to identify the most critical aspects to be improved, taking into account both the reference situation and the expected impacts of climate change scenarios. The integration of the resilience assessment results provided by all sources of analysis is presented in the SWOT analysis. This supports the identification of resilience measures and strategies for this RAP to be implemented in the city and services.

HOLISTIC APPROACH ASSESSMENT IN LISBON

The holistic approach for resilience assessment was implemented using the HAZUR® methodology and tool. It analyses the cascading effects that have collateral impacts on other strategic urban services and the city. The identification of players, the description of the water related services and infrastructure, the dependencies, the hazards and impacts on recovery time were considered (Canalias et al., 2017). This was a result of collaborative workshops and a collection of historical data and data from the sectorial models.



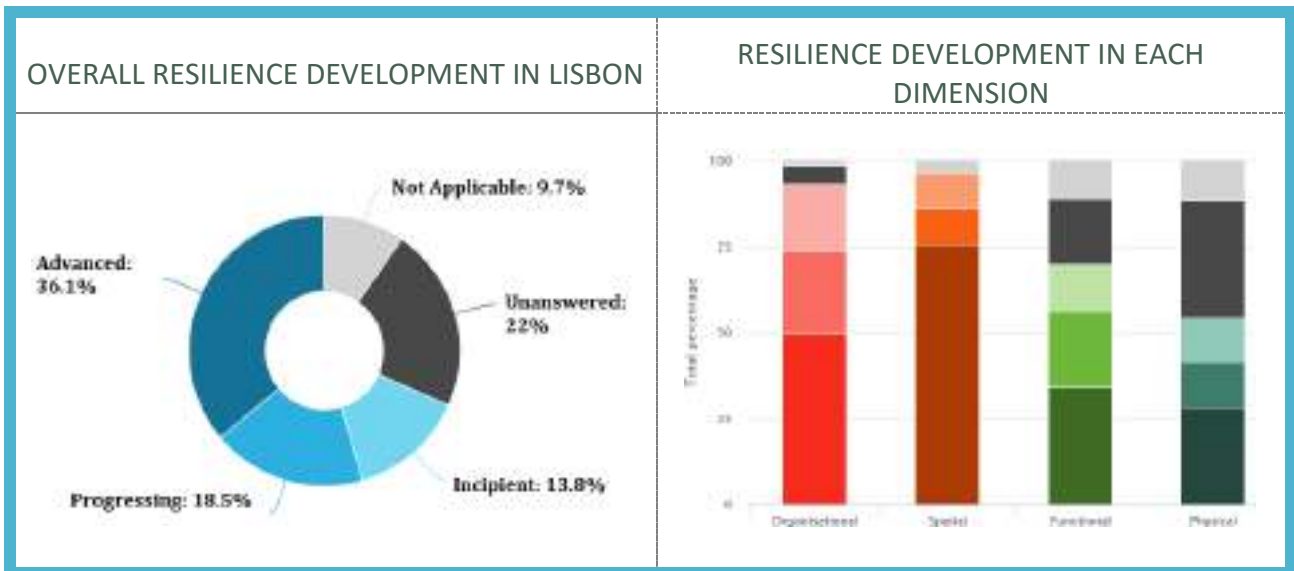
(CML, 2018)

- LISBON RESILIENCE ACTION PLAN -

LISBON OVERALL ASSESSMENT – RESILIENCE ASSESSMENT FRAMEWORK

An overall resilience to climate change was assessed based on an objective-driven framework, considering four resilience dimensions for climate change, with focus on water: organisational, spatial, functional and physical. The resilience assessment framework (RAF) applied to Lisbon, including the services, was the RESCCUE RAF (Cardoso et al., 2018; Cardoso et al., 2020a) supported by the RAF App tool (Cardoso et al., 2020b). These provide the percentage of assessment metrics assigned to a resilience development level – incipient, progressing or developed (represented respectively from a lighter to a darker colour in the figures) – as well as those without information, that were not answered, and the ones not applicable to the city.

In Lisbon, overall resilience development in the city is advanced in more than one third of the aspects assessed. Around a fifth are progressing and the remainder incipient, unanswerable or not applicable. Spatial resilience is overall the most advanced resilience dimension, followed by the organisational dimension. The physical dimension presents the highest percentage of metrics that were not answered, followed by the functional dimension, what may be due to data that is not easily applicable to the metrics provided in the RAF, in some cases, and to lack of information in other cases.



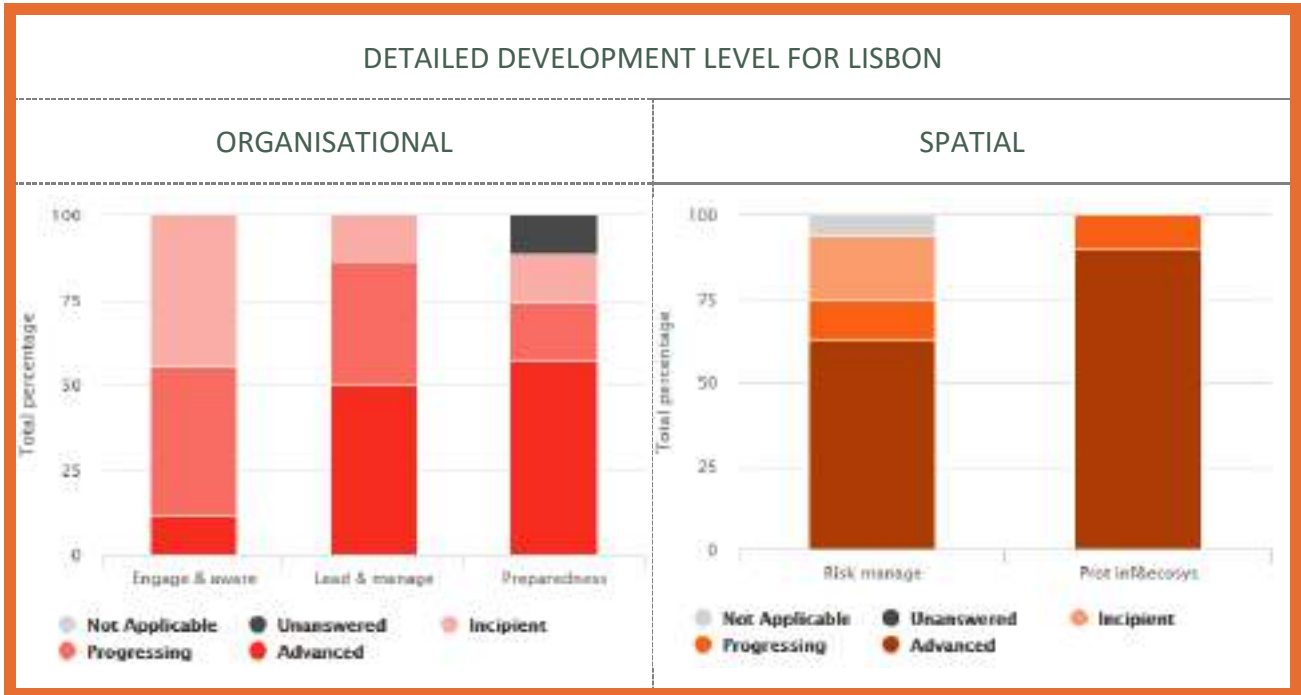
(CML, 2013)

- LISBON RESILIENCE ACTION PLAN -

RAF ASSESSMENT FOR THE ORGANISATIONAL AND SPATIAL RESILIENCE DIMENSIONS

Organisational dimension focuses on city level, analysing governance structures, the stakeholders' involvement and the city's resilience engagement and preparedness for climate change.

Spatial dimension also focuses on city level, analysing herein the urban space, protective infrastructures and ecosystems.



In the Organisational dimension, both objectives Leadership and Management and City Preparedness present aspects with major advanced development level and a considerable ongoing effort, while still presenting opportunities for improvement. The Collective Engagement and Awareness objective is the one presenting a lower advanced level while the progressing development level and opportunities for improvement are the most expressive. Overall, this dimension still presents some opportunities for improvement.

In the Spatial dimension, overall, both objectives Risk Management and Protective Infrastructures and Ecosystems have an appreciable advanced development level, while in the first objective there is still room for improvement.

RAF ASSESSMENT FOR THE FUNCTIONAL AND PHYSICAL RESILIENCE DIMENSIONS

Functional dimension emphasizes each urban service management, autonomy and preparedness for CC. Also, for each urban service, the **Physical dimension** attends infrastructure resilience regarding its safety, autonomy and preparedness for CC. These dimensions also inform about the contribution of each service to Lisbon's resilience. The mobility service and infrastructure translate, in general, shortage in the available information regarding the RAF assessment approach.



Functional resilience of all services presents various aspects with advanced development level, more substantially and reaching half of these aspects for the waste service, followed by the energy and stormwater services with higher than a quarter, and wastewater and mobility showing around a quarter. In general, a significant effort is being developed in all services, while there is still room for improvement. The mobility service translates a significant percentage of metrics not answered. This may be due to data that is not easily applicable to the metrics provided in the RAF, in some cases, and to lack of information in other cases.

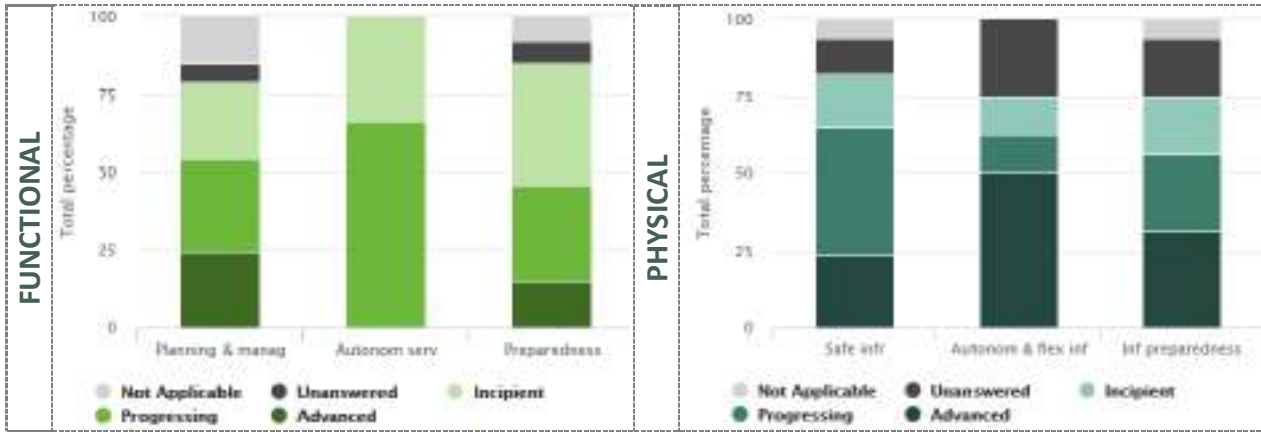
Physical resilience of all services is advanced in between a quarter and a third of the aspects assessed. It is evident the significant progressing development level in the wastewater and mobility services. This dimension translates the highest percentage of metrics that were not answered, for the same reasons above mentioned. This is a general result for all services, with the lowest observed in the wastewater service.

A more detailed assessment for these two dimensions and by service is presented. A more detailed analysis of all dimensions and by service is described in the SWOT analysis, linking the most advanced objectives to

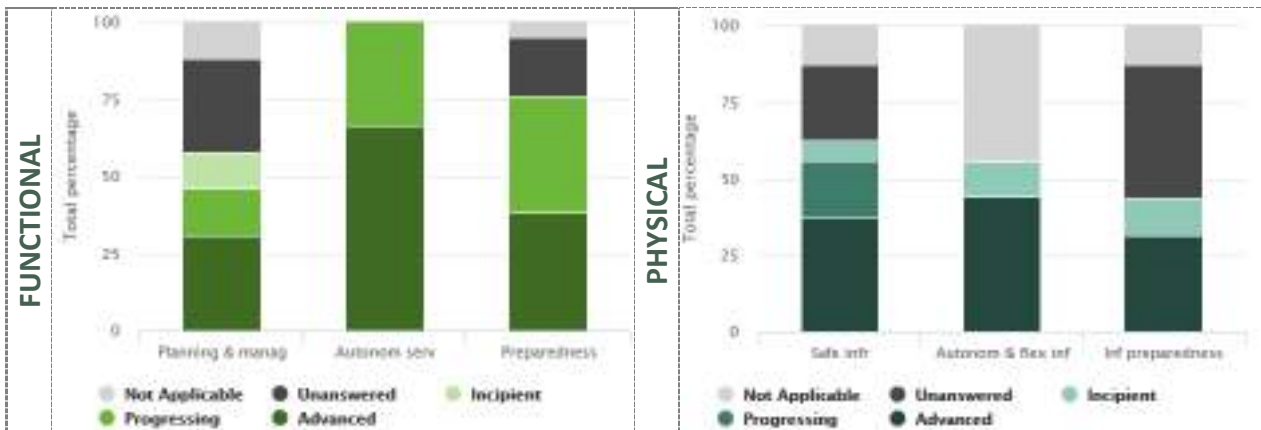
- LISBON RESILIENCE ACTION PLAN -

the city main strengths, and the most incipient to the main weaknesses. Other information was also integrated in the SWOT coming from the different assessments conducted as well as from the analysis of context.

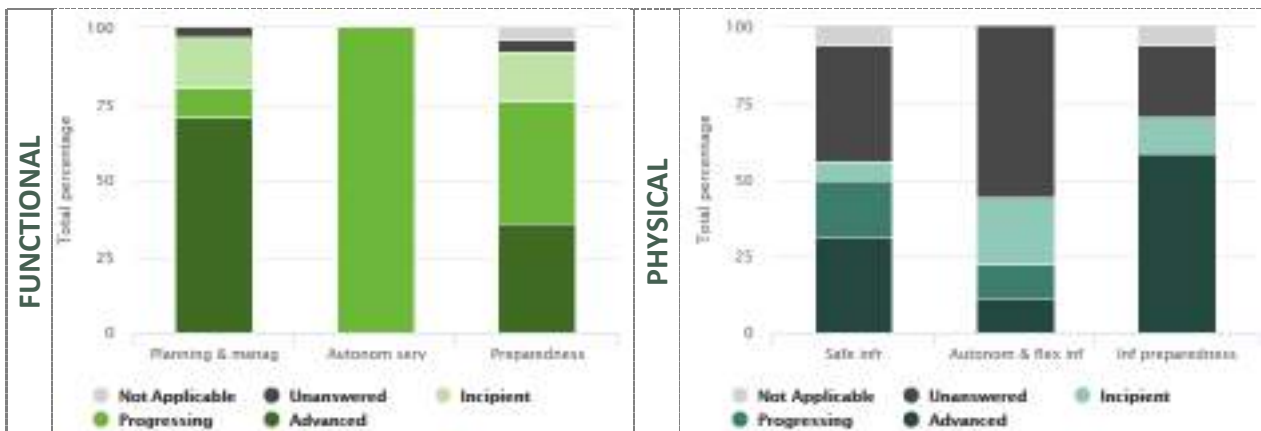
WASTEWATER



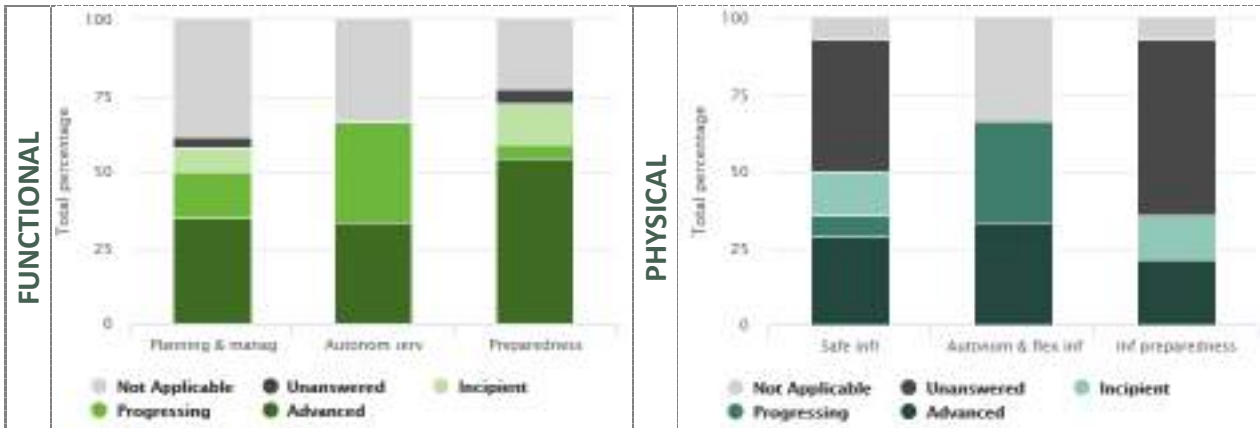
STORMWATER



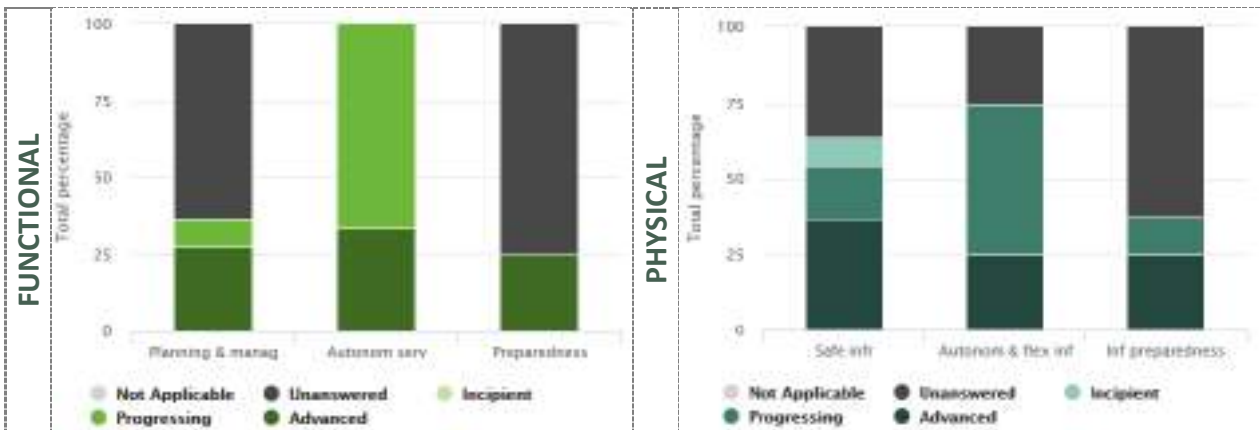
WASTE



ENERGY



MOBILITY



More complete graphical analysis for each objective, namely by assessment criteria for each urban service, is presented in the annex.

SWOT ANALYSIS

The diagnosis includes the integration of the resilience assessment results provided by all sources of analysis (Russo et al., 2018, Russo et al., 2019, Evans et al., 2018, Evans et al., 2019, Canalias et al., 2017, Pagani et al., 2018, Cardoso et al., 2020a,b). Aligned with objectives, a SWOT analysis (Strengths, Weakness, Opportunities and Threats) summarises this information by identifying the city's and the service's internal strengths and weaknesses, as well as the external opportunities and main threats (McClinton, 2015), following the planning process presented before, as proposed in Cardoso et al. (2020a). From a resilience to climate change perspective, a SWOT analysis for Lisbon is presented.

- LISBON RESILIENCE ACTION PLAN -

SWOT ANALYSIS FOR LISBON FROM A RESILIENCE TO CLIMATE CHANGE PERSPECTIVE

This SWOT table identifies the aspects related to the city’s main strengths and main weaknesses, in the respective columns. Those that are underlined are included in the TOWS analysis that follows.

+ STRENGTHS	<i>RAF objectives Perspective of analysis</i>	— WEAKNESSES
<ul style="list-style-type: none"> - <u>Engagement and social inclusion of vulnerable groups (elderly and homeless)</u> - Awareness and training 	<p>Collective engagement and awareness <i>Citizens and communities’ engagement, awareness and training</i></p>	<ul style="list-style-type: none"> - <u>Awareness of key grassroots organizations on importance of DRR without active participation on response or planning</u>
<ul style="list-style-type: none"> - Strong and participative government decision making - Existing significant background on resilience-oriented strategy and historical data of meteorological events 	<p>Leadership and management <i>Government decision-making and finance</i></p>	<ul style="list-style-type: none"> - <u>Municipal financial plans and budgets for resilience to CC are spread among departments (difficult analysis from cost-benefit point of view)</u> - Budget structured in a different perspective
<ul style="list-style-type: none"> - <u>Multi-stakeholder collaboration</u> - Bottom-up and top-down approaches - Periodical sectorial meetings - PGIL and other transversal apps - Several commitments ongoing 	<p><i>Coordination and communication with stakeholders</i></p>	<ul style="list-style-type: none"> - Incompatibility between tools - Provision of structured georeferenced data
<ul style="list-style-type: none"> - Master Plan making, implementation, monitoring and review - Existing hazards and risk assessments, including damage and loss estimation - Existing agreed scenarios for resilience - <u>Critical infrastructure is a priority in the city</u> - <u>Existing portal for data sharing</u> - <u>International agreements approved</u> - Highlighted in the Municipal Main Planning Options (GOP) has priority - International recognition as case of study - Integration in networks and frameworks - <u>Recent approval of planning instruments</u> - Legal support and municipal regulations 	<p><i>Resilience engaged city</i></p>	<ul style="list-style-type: none"> - Limited understanding of cascading impacts in the city (in a transversal point of view and with proceedings implemented) - <u>Lack of data for regular monitoring proceedings and detailed studies</u> - Duplicated efforts on studies - Difficulty in harmonising solutions addressing all the city dimensions.

- LISBON RESILIENCE ACTION PLAN -

<ul style="list-style-type: none"> - Existing <ul style="list-style-type: none"> ▪ <u>early warning system for monitoring and forecasting</u> ▪ knowledge of resources and equipment needs, volunteers and civil society organizations as focal points ▪ <u>disaster/preparedness/emergency plans</u> ▪ <u>clear coordination for response and post event recovery, learning loops and a system to provide damage and loss post-event assessment</u> - <u>Lisbon preparedness for CC, including mitigation</u> - Redundancies systems implemented at several sectors (energy, communications and water supply) - Proceedings to activate “availability levels” for the services 	<p>City preparedness <i>Lisbon preparedness for disaster response, climate change and recovery and build back</i></p>	<ul style="list-style-type: none"> - <u>Limited population reachable by early warning systems</u>, insufficient definition of equipment and supply needs (political decision at national level for warnings’ emission by the closest antenna, by SMS, involving all the communication suppliers – High costs) - Limited level of insurance and post event recovery plans/strategies (legal imposition for services of the state. Private operators with loans are obliged to have multi-risk insurances) - Data gaps on capabilities of healthcare to deal with major injuries in CC scenarios and to continue providing food, shelter, staple goods and fuel supply after a disaster event and regarding the assessment of lessons learnt
<ul style="list-style-type: none"> - Availability and access to water, wastewater, stormwater, waste, electrical energy and mobility services: 100% of the population is served - Wi-Fi communication system 	<p><i>Availability and access to basic services</i></p>	<ul style="list-style-type: none"> - Data gaps on alternative electric energy sources to households - Municipal VPN accesses to displaced working conditions
<ul style="list-style-type: none"> - General hazard and exposure mapping - No population displacement for “most severe” CC scenario - <u>Resilient urban development</u> - Services restoration in 48h maximum 	<p>Spatial risk management <i>Resilient urban development, hazard and exposure including climate change</i></p>	<ul style="list-style-type: none"> - Urban footprint and economic activities at risk for CC scenarios - Real time information pooling platform/app
<ul style="list-style-type: none"> - <u>Existing and well-maintained protective infrastructures and ecosystems services</u> with autonomy regarding other services considering CC, such as barriers and elevation. - Possibility to increase land elevation and implement physical protections 	<p>Provision of protective infrastructures and ecosystems <i>Protective infrastructures and ecosystems and climate change impacts</i></p>	<ul style="list-style-type: none"> - Impacts of climate related events with occasional failures in the communication, energy, gas and water supply
<ul style="list-style-type: none"> - <u>Strong development of stormwater, waste and energy strategic planning</u> - Regular exchange of information to the city - Strong land use zoning compliance in wastewater and mobility services - Several municipal plans and regulations approved and in force 	<p>Service Planning and Risk Management <i>Strategic planning</i></p>	<ul style="list-style-type: none"> - <u>Undeveloped wastewater strategic plan</u> - <u>Outdated regulations</u> - Non-compliances with land use and zoning regulation of some energy specific plans - <u>No periodical monitoring and review of stormwater strategic plan</u> - Data gaps on mobility strategic planning
<ul style="list-style-type: none"> - <u>Developed wastewater, stormwater and energy business continuity plan</u> - Strong links with other similar services in the city for wastewater, stormwater, waste, energy and mobility services - Learning from other services in stormwater, energy and mobility 	<p><i>Resilience engaged service</i></p>	<ul style="list-style-type: none"> - <u>Undeveloped wastewater resilience plan and waste business continuity plan</u> - Waste resilience plan not considering CC - Undeveloped learning from other waste services - <u>No clear financial plan for resilience actions in the energy service</u>
<ul style="list-style-type: none"> - Good performance in the daily functioning of the waste service - Limited consequences of wastewater treatment failures - Developed risk information in the waste service regarding CC scenarios 	<p><i>Risk management</i></p>	<ul style="list-style-type: none"> - Some performance problems in the daily functioning of wastewater service - <u>Limited wastewater, stormwater, energy and mobility systematised and published risk information regarding consequences of CC scenarios</u> - Specific waste service plans do not include risk information related to the service

- LISBON RESILIENCE ACTION PLAN -

<ul style="list-style-type: none"> - Good knowledge of waste performance in the daily functioning - Proper wastewater, stormwater, waste and energy service management - Strong flexibility in waste disposal - <u>Variety of energy sources</u> and of mobility solutions 	<p><i>Reliable and flexible service</i></p>	<ul style="list-style-type: none"> - <u>Limited flexibility in wastewater and stormwater disposal</u> - Data gaps on: <ul style="list-style-type: none"> ▪ <u>knowledge of stormwater</u>, waste, energy and mobility performance in the daily functioning ▪ mobility modal split for city road-based solutions and mobility management tools
<ul style="list-style-type: none"> - <u>Strong knowledge of stormwater cascading impacts</u> - <u>Total autonomy of stormwater</u> and energy services from other services - Low dependency of other services from the wastewater service in case of failure 	<p>Autonomous service <i>Service importance to the city and inter-dependency with other services considering CC</i></p>	<ul style="list-style-type: none"> - Limited knowledge of waste cascading impacts - Minor autonomy of the wastewater and waste services from other services - Minor autonomy of the mobility service from other services in case of drought - <u>Generalised high dependence of all sectors on electrical and communication sectors</u>
<ul style="list-style-type: none"> - Yearly practices and drills in wastewater and energy service - Strong preparedness for disaster response in the energy and stormwater services - Stormwater service has a post-event assessment in place - High redundancy between electrical infrastructures - Business continuity plans regarding the assurance of energy supply - Internal municipal procedures for periodical testing of power generators and definition of contact lists for activation according to alert level 	<p>Services and infrastructure preparedness <i>Services and infrastructure preparedness for disaster response and recovery and build back</i></p>	<ul style="list-style-type: none"> - Only occasional practices and drills in stormwater and waste services - Limited preparedness in the wastewater and waste services for disaster response - Limited preparedness in the wastewater, stormwater and energy services for recovery and build back - Inexistent post-event assessment in place and insurance cover in the waste service - Limited preparedness for recovery and build back in the wastewater infrastructure - Data gaps on stormwater, energy, waste and mobility infrastructure preparedness for recovery and build back
<ul style="list-style-type: none"> - <u>Strong preparedness in the stormwater service for CC</u> - Planned CC mitigation and adaptation measures in the wastewater and waste services - Strong knowledge of exposure and service vulnerability for CC scenarios and adequate equipment capacity in the waste service - Strong preparedness of waste, energy and mobility infrastructures for CC - <u>Planned wastewater and stormwater infrastructural measures to address CC</u> 	<p><i>Services and infrastructure preparedness for CC</i></p>	<ul style="list-style-type: none"> - Limited preparedness in the wastewater and energy services for CC - Equipment and staffing capacity in the wastewater and stormwater services not ensured in emergency situations - Data gaps on mobility regarding CC
<ul style="list-style-type: none"> - Wastewater, stormwater, waste, energy and mobility infrastructure critical assets identified regular exchange of information on this with the city in the former two and with regular revisions and updates in stormwater. - Existence of protective buffers to safeguard infrastructure assets in the stormwater and mobility services - National Critical Information Infrastructure and Critical Infrastructure Survey - Handbook “Critical Infrastructure Resilience Good Practices - Private and Business Sector of the State” published in 2017 under the scope of the National Platform for Disaster Risk Reduction, coordinated by ANPC 	<p>Safe infrastructure <i>Infrastructure assets criticality and protection</i></p>	<ul style="list-style-type: none"> - Inexistence of protective buffers in the wastewater and energy infrastructure - No regular exchange of information with the city regarding energy infrastructure critical assets

- LISBON RESILIENCE ACTION PLAN -

<ul style="list-style-type: none"> - Existence of: <ul style="list-style-type: none"> ▪ codes and standards for wastewater, stormwater and energy infrastructures ▪ Existence of alternative clean fuel public transport in the city - Maintenance of waste, energy and mobility infrastructures 	<p><i>Infrastructure assets robustness</i></p>	<ul style="list-style-type: none"> - <u>Data gaps on the knowledge of wastewater, stormwater</u>, waste, energy and mobility infrastructures performance and costs in the daily functioning
<ul style="list-style-type: none"> - Strong knowledge of <ul style="list-style-type: none"> ▪ <u>cascading impacts</u> in wastewater, <u>stormwater</u> and waste infrastructure ▪ <u>similar infrastructures dependency on stormwater, energy</u> and mobility 	<p>Autonomous and flexible infrastructure <i>Infrastructure assets importance to and dependency on other services</i></p>	<ul style="list-style-type: none"> - Significant percentage of customers are affected by wastewater infrastructure dependent on other services - Data gap on <ul style="list-style-type: none"> ▪ waste infrastructure dependency on other services and assets autonomy ▪ mobility infrastructure cascading impacts
<ul style="list-style-type: none"> - High percentage of wastewater customers covered by infrastructure that benefit from autonomy solutions - High percentage of energy customers covered by infrastructure that benefit from redundancy 	<p><i>Infrastructure assets autonomy and redundancy</i></p>	<ul style="list-style-type: none"> - <u>Limited stormwater infrastructure assets autonomy</u> - Limited redundancy in wastewater, <u>stormwater</u> and waste infrastructures - Data gap on wastewater infrastructure assets autonomy
<ul style="list-style-type: none"> - <u>Stormwater infrastructure contributes with design solutions to city resilience</u> 	<p>Infrastructure preparedness <i>Infrastructure contribution to city resilience</i></p>	<ul style="list-style-type: none"> - Limited solutions to improve city resilience in the wastewater, energy, waste and mobility infrastructures
<ul style="list-style-type: none"> - Low level of exposure of critical waste infrastructure assets - Low vulnerability of waste containers for the current situation and for CC - Use of locking systems in waste containers 	<p><i>Infrastructure assets exposure to climate change</i></p>	<ul style="list-style-type: none"> - <u>Some stormwater critical infrastructure assets exposed to different hazards</u> - Data gaps on: <ul style="list-style-type: none"> ▪ wastewater, energy and mobility infrastructure assets autonomy and exposure to CC ▪ Coverage of expenditure for CC scenarios in the waste infrastructure
<ul style="list-style-type: none"> - Significant area with low hazard level to vehicles to the most severe CC 		<ul style="list-style-type: none"> - <u>Sewers with insufficient capacity at the downstream areas due to tide level for low rainfall return periods and in the upstream branches for higher return periods</u> - <u>Excessive percentage of total sewer lengths with high flooding hazard level for CC</u>
<ul style="list-style-type: none"> - Existence of contingency plans for the energy service and general patterns for continuity of service respected for CC 		<ul style="list-style-type: none"> - Sewer discharge conditions strongly dependent on the tide level
<ul style="list-style-type: none"> - Conditioned traffic to the central areas 		<ul style="list-style-type: none"> - Excessive velocities in sewers
<ul style="list-style-type: none"> - All general patterns established for continuity of energy service were respected in MV and LV, in the three quality zones of service (A, B and C) for CC 		<ul style="list-style-type: none"> - <u>Downtown area very prone to flooding</u>
<ul style="list-style-type: none"> - <u>Existence of Business continuity plans regarding the assurance of energy supply</u> 		<ul style="list-style-type: none"> - <u>High percentage of road length are exposed and level crossings exposure to rainfall induced flooding hazards is significant</u>
<ul style="list-style-type: none"> - <u>Significant area with risk to children and elderly pedestrians for CC</u> 		<ul style="list-style-type: none"> - <u>Significant area with risk to children and elderly pedestrians for CC</u>
<ul style="list-style-type: none"> - <u>Infrastructures ageing</u> 		<ul style="list-style-type: none"> - <u>Infrastructures ageing</u>




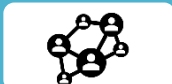


- LISBON RESILIENCE ACTION PLAN -

	<ul style="list-style-type: none"> - <u>Significant percentage of buildings affected and resident population exposed</u> in some parishes by rain induced flooding
	<ul style="list-style-type: none"> - Significant costs of damages in buildings and expected increase for CC
	<ul style="list-style-type: none"> - High dependency of the wastewater service from other services (energy for example) which a failure is likely to occur in case of failure of other service.
+ OPPORTUNITIES	— THREATS
<ul style="list-style-type: none"> - Coastal area 	<ul style="list-style-type: none"> - <u>Coastal area</u>
<ul style="list-style-type: none"> - High percentage of daily commuters 	<ul style="list-style-type: none"> - <u>High percentage of daily commuters</u>
<ul style="list-style-type: none"> - <u>Financial opportunities</u> (e.g. European frameworks, National Strategies) 	<ul style="list-style-type: none"> - Socio-economics crises
<ul style="list-style-type: none"> - <u>National and international recognition and awareness of resilience to CC emergency</u> 	<ul style="list-style-type: none"> - Windstorms
<ul style="list-style-type: none"> - <u>Wastewater reuse</u> 	<ul style="list-style-type: none"> - <u>Changes in rainfall patterns (decrease in summer precipitations and more intense)</u>
<ul style="list-style-type: none"> - Sub-products from the wastewater resource recovery facilities 	<ul style="list-style-type: none"> - <u>Sea level rise</u>
<ul style="list-style-type: none"> - <u>Ambitious agenda on SDGs and urban resilience facing CC</u> 	<ul style="list-style-type: none"> - High range of altitude
<ul style="list-style-type: none"> - Lisbon work towards the top ranking of cities to live 	<ul style="list-style-type: none"> - <u>Heat and cold waves</u>
<ul style="list-style-type: none"> - Experts exchange 	<ul style="list-style-type: none"> - <u>Temperature increase by 2050</u>
<ul style="list-style-type: none"> - <u>Integrated Communication Plan</u> 	<ul style="list-style-type: none"> - Contribution to new legal diplomas
<ul style="list-style-type: none"> - <u>Results sharing in several tools and frameworks (UN HABITAT Scorecard, SECAP, C40, Making Cities Resilient Campaign)</u> 	<ul style="list-style-type: none"> - <u>Compatibilization of communication proceedings and circuits</u>
<ul style="list-style-type: none"> - Reinforce the municipal strategy with the inclusion of new sectors (e.g. health and social media) 	<ul style="list-style-type: none"> - Concepts harmonisation
<ul style="list-style-type: none"> - <u>Monitoring commitment's goals</u> 	<ul style="list-style-type: none"> - Lack of translation into Portuguese of international results with consequently low replicability chances in Portuguese-speaking countries
<ul style="list-style-type: none"> - <u>European green capital 2020</u> 	<ul style="list-style-type: none"> - GDPR obstacles (General Data Protection Regulation)
<ul style="list-style-type: none"> - <u>Reinforce bottom-up policies and strengthen local power</u> 	<ul style="list-style-type: none"> - Different profiles for data access - <u>Open data policies</u>
<ul style="list-style-type: none"> - Update proceedings 	
<ul style="list-style-type: none"> - Reinforce the analytic component of PGIL 	
<ul style="list-style-type: none"> - Present results in decentralised public sessions 	
<ul style="list-style-type: none"> - Present results in periodical municipal reports with the reinforcement between political intentions and technical-scientific solutions 	
<ul style="list-style-type: none"> - Review scholar programmes 	

5. RESILIENCE STRATEGIES

IDENTIFICATION OF STRATEGIES

The identification of the strategies that reduce Lisbon's threats (**T**), overcome weaknesses (**W**) and exploit strengths (**S**) and opportunities (**O**) was supported by a **TOWS** analysis (Wehrich, 1982), following the planning process presented before, as proposed in Cardoso et al. (2020a). The topics addressed are underlined in the SWOT table to facilitate identification. In this RAP, to address these aspects, a set of strategies was identified, mainly targeted for flooding hazard reduction, as follows:

	-S005 Adaptation of green infrastructure
	-S007/S016 Promoting urban rehabilitation as a tool to increase resilience: sewer systems
	-S008 Promoting urban rehabilitation as a tool to increase resilience: facing climate change
	-S010 Strengthening collaboration within AML (Lisbon Metropolitan Area), Parishes and municipality departments
	-S017 Lisbon urban drainage monitoring and early-warning system
	-S019 Building protections for urban electrical infrastructure, exposed to estuarine flood

The identification of the strategies (S###) comes from the strategy's platform (Martínez et al., 2017). Strategy S007/S016 results from merging both strategies S007 and S016 due to their similarity.

Some challenges identified in the SWOT are still to be addressed in the future, namely some other threats (windstorms, socio-economics crises, contribution to new legal diplomas, concepts harmonisation and General Data Protection Regulation obstacles) and weaknesses (related to budget and insurance, data gaps, services resilience planning, wastewater service autonomy, services and infrastructures preparedness for CC, costs of damages in buildings, compatibility between different tools and structured georeferenced data).

TOWS ANALYSIS FOR LISBON FROM A RESILIENCE TO CLIMATE CHANGE PERSPECTIVE

The set of strategies is globally beneficial for the city, considering strategies that use strengths to exploit opportunities (SO), others that use strengths to avoid or face threats (ST), strategies that overcome weaknesses by taking advantage of opportunities (WO) and others that minimise weaknesses and avoid threats (WT), what is clearly identified next. The TOWS analysis detailing strengths, weaknesses, opportunities and threats specifically addressed in each strategy is presented in the respective description.

	OPPORTUNITIES	THREATS
STRENGTHS	<ul style="list-style-type: none"> • S005 - Adaptation of green infrastructure • S007 - Promoting urban rehabilitation as a tool to increase resilience: sewer systems • S008 - Promoting urban rehabilitation as a tool to increase resilience: facing climate change • S017 - Lisbon urban drainage monitoring and early-warning system • S019 - Building protections for urban electrical infrastructure, exposed to estuarine flood 	<ul style="list-style-type: none"> • S005 - Adaptation of green infrastructure • S007 - Promoting urban rehabilitation as a tool to increase resilience: sewer systems • S010 - Strengthening collaboration within AML, Parishes and municipality departments • S016 - Construction of new components in urban drainage system • S017 - Lisbon urban drainage monitoring and early-warning system • S019 - Building protections for urban electrical infrastructure, exposed to estuarine flood
WEAKNESSES	<ul style="list-style-type: none"> • S007 - Promoting urban rehabilitation as a tool to increase resilience: sewer systems • S008 - Promoting urban rehabilitation as a tool to increase resilience: facing climate change • S016 - Construction of new components in urban drainage system • S017 - Lisbon urban drainage monitoring and early-warning system 	<ul style="list-style-type: none"> • S005 - Adaptation of green infrastructure • S010 - Strengthening collaboration within AML, Parishes and municipality departments

DESCRIPTION OF THE STRATEGIES TO BE IMPLEMENTED

The strategies to be implemented are described in the following tables, supported by information from Martínez-Gomariz et al. (2017) and Martínez-Gomariz et al. (2019). The timeline of the strategies' implementation is accounted considering the RAP horizon (2020 – 2030). It is important to highlight that, in general, all the strategies will affect directly or indirectly the services under analysis, since these services are crucial and basic services for the city. This effect can occur on construction and/or operational phase. The services mentioned below as "RESCCUE Services Impacted" are the ones which performance is considered to be enhanced or a reduction in hazardousness is expected in the context of water-related risks. Additionally, strategies demand agreed investment and maintenance frameworks within a context of social, technical and environmental innovation.

S005 – Adaptation of green infrastructure



DESCRIPTION:

Adaptation of green infrastructure by improved management and increase of green areas.

TOWS ANALYSIS:

Strengths/Opportunities Existing protective infrastructures and ecosystems in the city are used to exploit the opportunities of Lisbon as European Green Capital 2020 with new financial opportunities, ambitious agenda on SDGs and urban resilience facing CC, sharing results in several tools and frameworks (UN HABITAT Scorecard, SECAP, C40, Making Cities Resilient Campaign) and national and international recognition and awareness of resilience to CC emergency.	Strengths/Threats Exploit the strong city engagement with resilience, particularly international agreements and recent planning instruments approved, the existing and maintained protective infrastructures and ecosystems services, and city and stormwater infrastructure preparedness, regarding contributions to Lisbon resilience and to mitigate CC effects, to overcome threats related to changes in rainfall patterns, particularly more intense precipitation, heat waves and temperature increase by 2050.
Weaknesses/Opportunities -	Weaknesses/Threats Minimise insufficient sewers capacity, to avoid the impact of threats related to changes in rainfall patterns, particularly more intense precipitation.

Typology

NBS and ecosystem services



TOWS perspective

SO, ST, WT

	O	T
S	SO	ST
W	WO	WT

Implementation phase

In development

Timeline

4 years

Addressed Hazards

Flooding and Heat waves

Accounted Variables

Rainfall and Temperature



Responsible Body

Lisbon City Council

Involved Players

Lisbon City Council, Parishes

RESCCUE Services Impacted

Stormwater

Estimated Costs

Short-term: 100.000 – 1.000.000 €

Mid-term: > 1.000.000 €

MEASURES:

M001FLOOD	Bioretention area
M014FLOOD	Implementation of Rainwater Harvesting systems (RWH)
M003DROUGHT	Prioritize water allocation in a stress situation
M002HEATWAVE	Build and promote urban forest and park

- LISBON RESILIENCE ACTION PLAN -

CO-BENEFITS: Relevant contribution | Slight contribution

ECONOMIC	SOCIAL	ENVIRONMENTAL
<p>Cost savings Reduced energy losses Job creation Possible reduction in prices Increased labour productivity Increased economic production Increased property values</p>	<p>Reduced mortality impacts Reduced health impacts Reduced mortality from diseases Enhanced public amenity Reduced impacts on vulnerable groups Reduced number of householders, businesses forced from homes, places of work Social inclusion</p>	<p>Improved air quality Improved water quantity Reduced aquifer depletion Reduced water pollution Reduced land contamination Improved biodiversity and ecosystems Maintained and increased green space Reduced environmental impacts through associated awareness Increased biodiversity and ecosystem services Effective/uninterrupted water collection and security Erosion control</p>



Retention basin in Alto da Ajuda (HIDRA, 2020)



Green corridor in Bela Vista, Marvila (CML, 2017)



2001



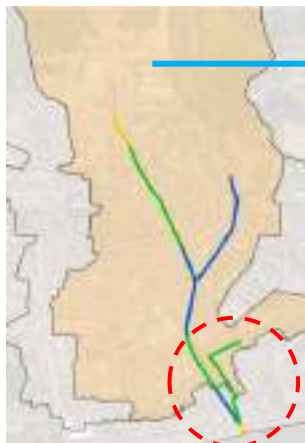
2007



2020

Evolution of Green Corridor in Monsanto (Google Earth)

EXAMPLE OF IMPACT STUDY ON HAZARD ASSESSMENT:



**Future Situation
Business as usual***



**Future Situation with
Retention basin in Alto da Ajuda**



Sewer capacity use (C) induced by rainfall (T=10 years) for 2100
 *no strategy applied

Additional information on risk assessment impacts may be visualised in www.toolkit.resccue.eu.

S007/S016 – Promoting urban rehabilitation as a tool to increase resilience: sewer systems



DESCRIPTION:

This strategy results from the Lisbon Drainage Master Plan 2016-2030, being the main infrastructural strategy identified in this plan. The main measure contemplates the construction of two major diversion tunnels, Tunnel Monsanto - Santa Apolónia (TMSA) (which includes an anti-pollution basin of about 16 000 m³, allowing to accommodate combined flows and to avoid its untreated discharge into the receiving waters) and Tunnel Chelas - Beato (TCB).

TOWS ANALYSIS:

<p>Strengths/Opportunities</p> <p>Existing recent approval of planning instruments such the Lisbon Drainage Master Plan 2016-2030 is used to exploit the opportunities of Lisbon as European Green Capital 2020 with new financial opportunities and national and international recognition and awareness of resilience to CC emergency.</p>	<p>Strengths/Threats</p> <p>Exploit stormwater service strengths, particularly regarding strategic planning, knowledge of its importance to the city and interdependency with other services and infrastructures considering CC, as well as its infrastructure preparedness for CC to avoid the impact of threats related to changes in rainfall patterns, particularly more intense precipitation.</p>									
<p>Weaknesses/Opportunities</p> <p>Shortcomings in spatial risk management, limited stormwater infrastructure assets autonomy and redundancy, significant exposure to rainfall induced flooding of its critical assets, road length and level crossings, buildings and resident population, with risk to children and elderly pedestrians, as well as insufficient sewers capacity and aged infrastructures, are reduced by exploiting financial opportunities and national and international recognition and awareness of resilience to CC emergency.</p>	<p>Weaknesses/Threats</p> <p style="text-align: center;">-</p>									
<p>Typology</p> <p>Infrastructural construction or rehabilitation </p>	<p>TOWS perspective</p> <p style="text-align: center;">SO, WO, ST</p> <table border="1" data-bbox="1289 1332 1423 1422"> <tr> <td></td> <td>O</td> <td>T</td> </tr> <tr> <td>S</td> <td>SO</td> <td>ST</td> </tr> <tr> <td>W</td> <td>WO</td> <td>WT</td> </tr> </table>		O	T	S	SO	ST	W	WO	WT
	O	T								
S	SO	ST								
W	WO	WT								
<p>Implementation phase</p> <p style="text-align: center;">On going</p>	<p>Timeline</p> <p style="text-align: center;">2016 - 2030</p>									
<p>Addressed Hazards</p> <p style="text-align: center;">Flooding and CSO</p>	<p>Accounted Variables</p> <p style="text-align: center;">Rainfall and Sea level rise </p>									
<p>Responsible Body</p> <p style="text-align: center;">Lisbon City Council</p>	<p>Involved Players</p> <p style="text-align: center;">Lisbon City Council, AdTA</p>									
<p>RESCCUE Services Impacted</p> <p style="text-align: center;">Stormwater Wastewater</p>										

Estimated Costs

Short-term: > 1.000.000 €

Mid-term: > 1.000.000 €

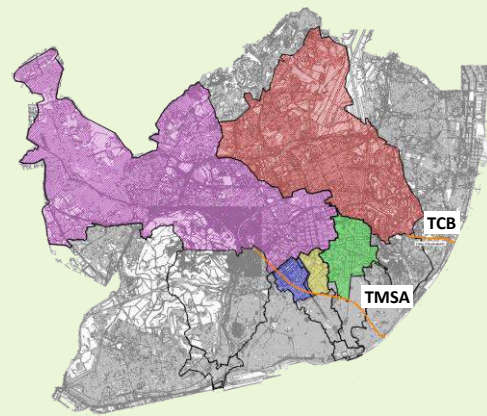
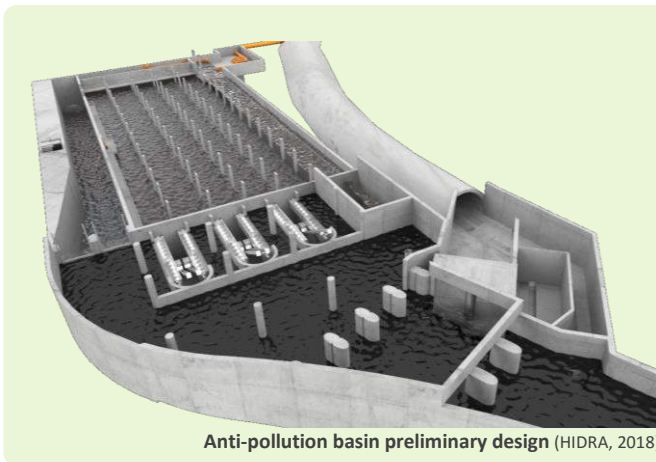
- LISBON RESILIENCE ACTION PLAN -

MEASURES:

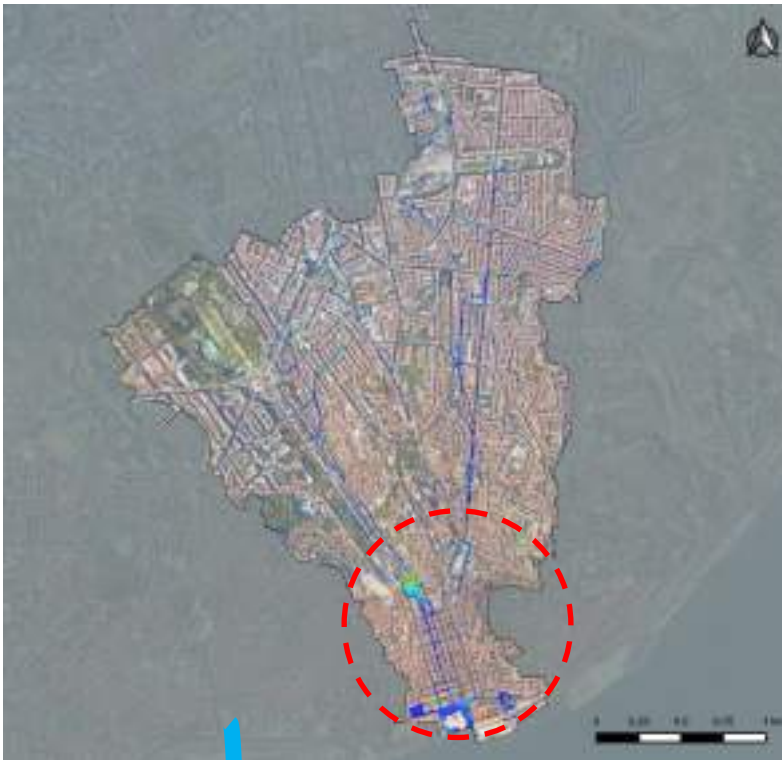
M016FLOOD	Rehabilitate sewer pipes
M017FLOOD	Inlets increase
M019FLOOD	On-source sediment traps
M023FLOOD	Construction of diversion tunnels
M027FLOOD	Construction of anti-pollution basins

CO-BENEFITS: Relevant contribution | Slight contribution

ECONOMIC	SOCIAL	ENVIRONMENTAL
<p>Cost savings Job creation Increased labour productivity Increased economic production Increased property values</p>	<p>Reduced mortality impacts Reduced health impacts Reduced mortality from diseases Enhanced public amenity Reduced impacts on vulnerable groups Reduced number of householders, businesses forced from homes, places of work</p>	<p>Improved air quality Reduced water pollution Improved biodiversity and ecosystems Reduced environmental impacts through associated awareness Effective/uninterrupted water collection and security Erosion control</p>

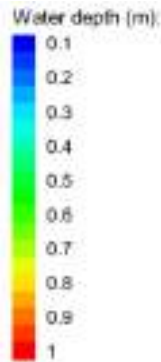


EXAMPLE OF IMPACT STUDY ON HAZARD ASSESSMENT:



**FUTURE SITUATION
BUSINESS AS USUAL***

Maximum water depth for flooding induced by rainfall (T=10 years) for 2100
*no strategy applied



**FUTURE SITUATION
S07/S016 IMPLEMENTATION**

Maximum water depth for flooding induced by rainfall (T=10 years) for 2100

Additional information on risk assessment impacts may be visualised in www.toolkit.resccue.eu.

S008 – Promoting urban rehabilitation as a tool to increase resilience: facing climate change



DESCRIPTION:

Adaptation and mitigation of the city and services to cope with climate change.

TOWS ANALYSIS:

<p>Strengths/Opportunities</p> <p>Strong spatial risk management and resilient urban development, city preparedness for CC, energy resilience engaged service considering business continuity, strategic planning, risk management, flexibility regarding diversity of energy sources and the strong knowledge on the importance of its infrastructure to other services are used to exploit the opportunities of Lisbon as European Green Capital 2020 with new financial opportunities, ambitious agenda on SDGs and urban resilience facing CC, sharing results in several tools and frameworks (UN HABITAT Scorecard, SECAP, C40, Making Cities Resilient Campaign), wastewater reuse in Lisbon, national and international recognition and awareness of resilience to CC emergency.</p>	<p>Strengths/Threats</p> <p>-</p>
<p>Weaknesses/Opportunities</p> <p>Minimise insufficient capacity in sewers by exploiting opportunities of Lisbon as European Green Capital 2020 with new financial opportunities, ambitious agenda on SDGs and urban resilience facing CC, sharing results in several tools and frameworks. Similarly, minimise shortcomings in financial planning for resilience actions in the energy service and undeveloped wastewater service planning and risk management, by exploiting the potential of wastewater reuse in Lisbon, financial opportunities and national and international recognition and awareness of resilience to CC emergency.</p>	<p>Weaknesses/Threats</p> <p>-</p>

<p>Typology</p> <p>Infrastructural construction or rehabilitation </p>	<p>TOWS perspective</p> <p>SO, WO</p> <table border="1" data-bbox="1273 1581 1414 1671"> <tr> <td></td> <td>O</td> <td>T</td> </tr> <tr> <td>S</td> <td>SO</td> <td>ST</td> </tr> <tr> <td>w</td> <td>WO</td> <td>WT</td> </tr> </table>		O	T	S	SO	ST	w	WO	WT
	O	T								
S	SO	ST								
w	WO	WT								
<p>Implementation phase</p> <p>Planned</p>	<p>Timeline</p> <p>10 years</p>									
<p>Addressed Hazards</p> <p>Flooding, Drought and Heat waves</p>	<p>Accounted Variables</p> <p>Rainfall and Temperature </p>									
<p>Responsible Body</p> <p>Lisbon City Council</p>	<p>Involved Players</p> <p>Lisbon City Council, EDP Distribuição, AdTA, Lisboa E-Nova, Research Centres</p>									

- LISBON RESILIENCE ACTION PLAN -

RESCCUE Services Impacted

Energy
Waste

Estimated Costs

Short-term: 100.000 – 1.000.000 €

Mid-term: > 1.000.000 €

MEASURES:

- M001DROUGHT Use of non-potable water in compatible uses
- M025FLOOD Green roof
- M009MULTIPLE Increase integration of renewable energy by Distributed Generation (DG)
- M066FLOOD Restriction on land-use areas vulnerable to flooding events

CO-BENEFITS: Relevant contribution | Slight contribution

ECONOMIC	SOCIAL	ENVIRONMENTAL
<p>Cost savings Reduced energy losses Job creation Possible reduction in prices Increased labour productivity Increased economic production Increased property values</p>	<p>Reduced mortality impacts Reduced health impacts Reduced mortality from diseases Enhanced public amenity Reduced impacts on vulnerable groups Reduced number of householders, businesses forced from homes, places of work Social inclusion</p>	<p>Improved air quality Improved water quantity Reduced aquifer depletion Reduced water pollution Reduced land contamination Improved biodiversity and ecosystems Maintained and increased green space Reduced environmental impacts through associated awareness Increased biodiversity and ecosystem services Effective/uninterrupted water collection and security Erosion control</p>

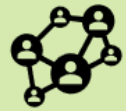


Green roof of WWTP in Alcântara (AdTA, 2018)



Photovoltaic panels in FCUL (CML, 2019)

S010 – Strengthening collaboration within AML, parishes and municipality departments



TOWS ANALYSIS:

Strengths/Opportunities -	Strengths/Threats Exploit the strong engagement of vulnerable groups, coordination and communication with stakeholders and Lisbon preparedness concerning disaster, preparedness or emergency plans as well as a clear coordination for response and post event recovery to avoid the impact of threats related to CC and to lack of harmonised and consistent communication procedures and circuits at local, regional and national levels.
---	---

Weaknesses/Opportunities	Weaknesses/Threats Minimise limitations in collective engagement and awareness to avoid the impact of threats related to CC and to lack of harmonised and consistent communication procedures and circuits at local, regional and national levels.
---------------------------------	---

Typology Citizens and stakeholders 	TOWS perspective ST, WT	<table border="1" style="font-size: small;"> <tr> <td></td> <td style="background-color: #e1f5fe;">O</td> <td style="background-color: #e1f5fe;">T</td> </tr> <tr> <td style="background-color: #e1f5fe;">S</td> <td>SO</td> <td>ST</td> </tr> <tr> <td style="background-color: #e1f5fe;">W</td> <td>WO</td> <td>WT</td> </tr> </table>		O	T	S	SO	ST	W	WO	WT
	O	T									
S	SO	ST									
W	WO	WT									

Implementation phase Planned	Timeline 10 years
--	---------------------------------

Addressed Hazard -	Accounted Variables -
----------------------------------	-------------------------------------

Responsible Body Lisbon City Council	Involved Players Lisbon City Council, AML, Parishes, Stakeholders
--	---

RESCCUE Services Impacted		
Wastewater Energy	Stormwater Mobility	Waste

Estimated Costs Short-term: 100.000 – 1.000.000 € Mid-term: 100.000 – 1.000.000 €	
--	--

- LISBON RESILIENCE ACTION PLAN -

MEASURES:

M021FLOOD	Increase commitment to develop risk management strategies
M040FLOOD	Effective communication of risk, considering power relations among actors
M041FLOOD	Training, exercises and education to transfer scientific and operational knowledge to practitioners
M008MULTIPLE	Opportunities for citizens to participate in preparedness and response

CO-BENEFITS: Relevant contribution | Slight contribution

ECONOMIC	SOCIAL	ENVIRONMENTAL
Cost savings Reduced energy losses Job creation Possible reduction in prices Increased labour productivity	Reduced mortality impacts Reduced health impacts Reduced mortality from diseases Enhanced public amenity Reduced impacts on vulnerable groups Reduced number of householders, businesses forced from homes, places of work Social inclusion	Reduced mortality impacts Reduced health impacts Reduced mortality from diseases Enhanced public amenity Reduced impacts on vulnerable groups Reduced number of householders, businesses forced from homes, places of work Social inclusion



Awareness and capacity building actions in Lisbon (CML, 2019; CML, 2016)

- LISBON RESILIENCE ACTION PLAN -

MEASURES:

- M005FLOOD Learn from real-life flooding by recording and investigating events
- M069FLOOD Implement monitoring program and warning systems on drainage system
- M049FLOOD Flood forecasting and warning

CO-BENEFITS: Relevant contribution | Slight contribution

ECONOMIC	SOCIAL	ENVIRONMENTAL
<p>Cost savings Reduced energy losses Job creation Possible reduction in prices Increased property values</p>	<p>Reduced mortality impacts Reduced health impacts Reduced mortality from diseases Enhanced public amenity Reduced impacts on vulnerable groups Reduced number of householders, businesses forced from homes, places of work Social inclusion</p>	<p>Reduced water pollution Reduced land contamination Improved biodiversity and ecosystems Maintained and increased green space Reduced environmental impacts through associated awareness Increased biodiversity and ecosystem services Erosion control</p>



Learning from past events: example of flood recordings in Praça de Sete Rios (CML, 2014)

S019 – Building protections for urban electrical infrastructure, exposed to estuarine flood



DESCRIPTION:

Building protections for energy substations in areas with possible estuarine flood.

TOWS ANALYSIS:

Strengths/Opportunities Strong Lisbon engagement with existing historical data and data sharing portal, and city preparedness are used to exploit the opportunity of reinforcement of bottom-up policies and strengthen local power.	Strengths/Threats Exploit strong multi-stakeholder collaboration and consideration of critical infrastructure as a priority in the city, as well as existing protective infrastructures and ecosystems to avoid the impact of threats related to the changes in rainfall patterns and sea level rise. Similarly exploit strong preparedness concerning emergency plans and clear coordination for response and post event recovery, existing learning loops and system to provide damage and loss post-event assessment, to reduce threats related to the open data policies.
Weaknesses/Opportunities -	Weaknesses/Threats -

Typology Protective infrastructures	TOWS perspective SO, ST <table border="1" style="float: right;"> <tr><td>O</td><td>T</td></tr> <tr><td>S</td><td>SO</td><td>ST</td></tr> <tr><td>W</td><td>WO</td><td>WT</td></tr> </table>	O	T	S	SO	ST	W	WO	WT
O	T								
S	SO	ST							
W	WO	WT							
Implementation phase Planned	Timeline 3 years								
Addressed Hazards Flooding	Accounted Variables Rainfall and Sea level rise								
Responsible Body EDP Distribuição	Involved Players EDP Distribuição, Lisbon City Council								
RESCCUE Services Affected Energy									
Estimated Costs Short-term: 25.000 – 100.000 € Mid-term: 5.000 – 25.000 €									

MEASURES:

- M010FLOOD Install flood proof fencing
- M005FLOOD Learn from real-life flooding by recording and investigating events
- M013FLOOD Emergency response plans and procedures
- M001SLRISE Build riverside flood defence walls

- LISBON RESILIENCE ACTION PLAN -

CO-BENEFITS: Relevant contribution | Slight contribution

ECONOMIC	SOCIAL	ENVIRONMENTAL
<p>Cost savings Reduced energy losses Job creation Possible reduction in prices Increased labour productivity Increased economic production Increased property values</p>	<p>Reduced mortality impacts Reduced health impacts Reduced mortality from diseases Enhanced public amenity Reduced impacts on vulnerable groups Reduced number of householders, businesses forced from homes, places of work Social inclusion</p>	<p>Improved water quantity Reduced aquifer depletion Reduced water pollution Reduced land contamination Improved biodiversity and ecosystems Maintained and increased green space Reduced environmental impacts through associated awareness Increased biodiversity and ecosystem services Effective/uninterrupted water collection and security Erosion control</p>



Flooding record inside power substation (EDP-D, 2018)

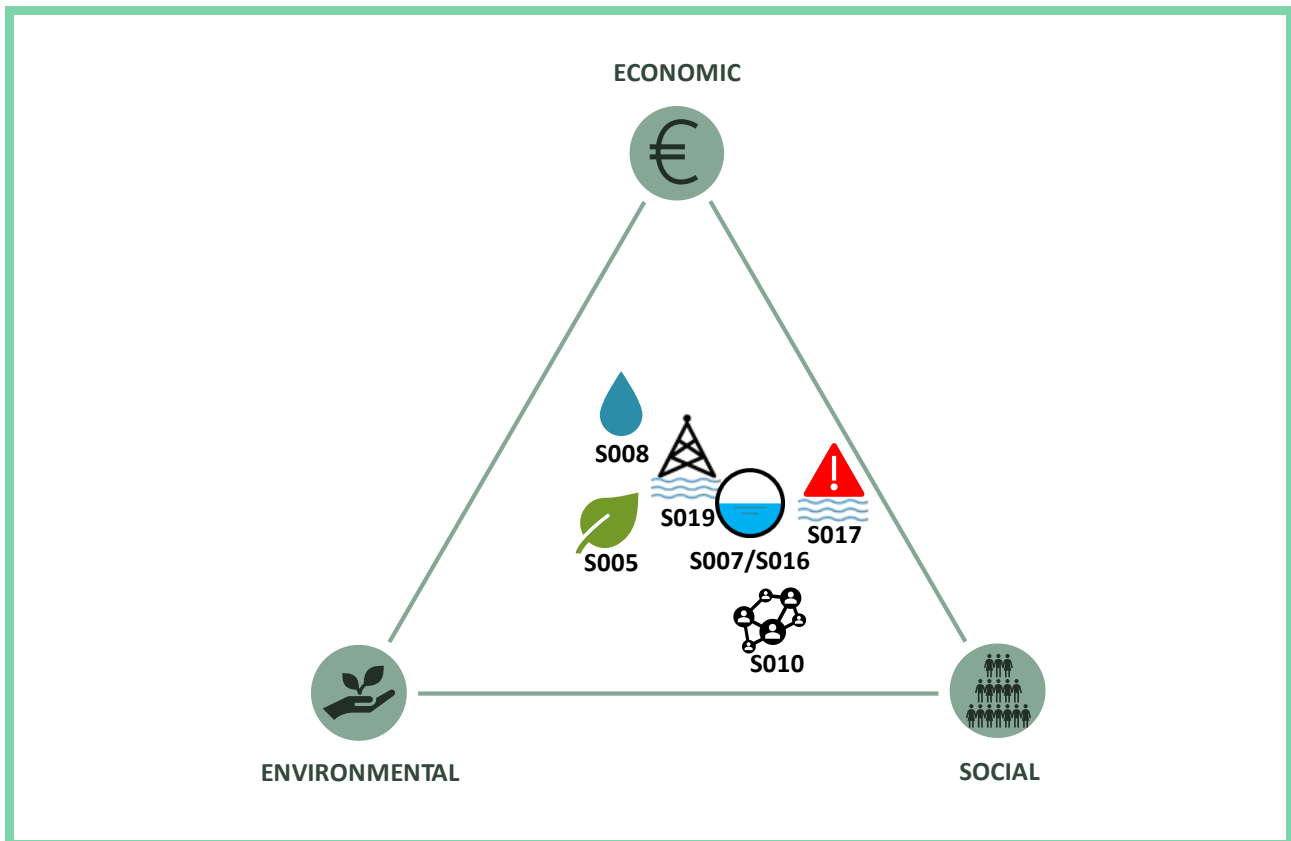


Flood protective infrastructure in a power substation (EDP-D, 2018)

CO-BENEFITS AND IMPACT ON RESILIENCE OBJECTIVES

CO-BENEFITS OF IDENTIFIED STRATEGIES

The identified strategies have several co-benefits, namely within the economic, social and environmental components. Within each component, the expected co-benefits contribute differently in each strategy. Depending on the relative contributions, the location of the strategy in the scheme below varies.



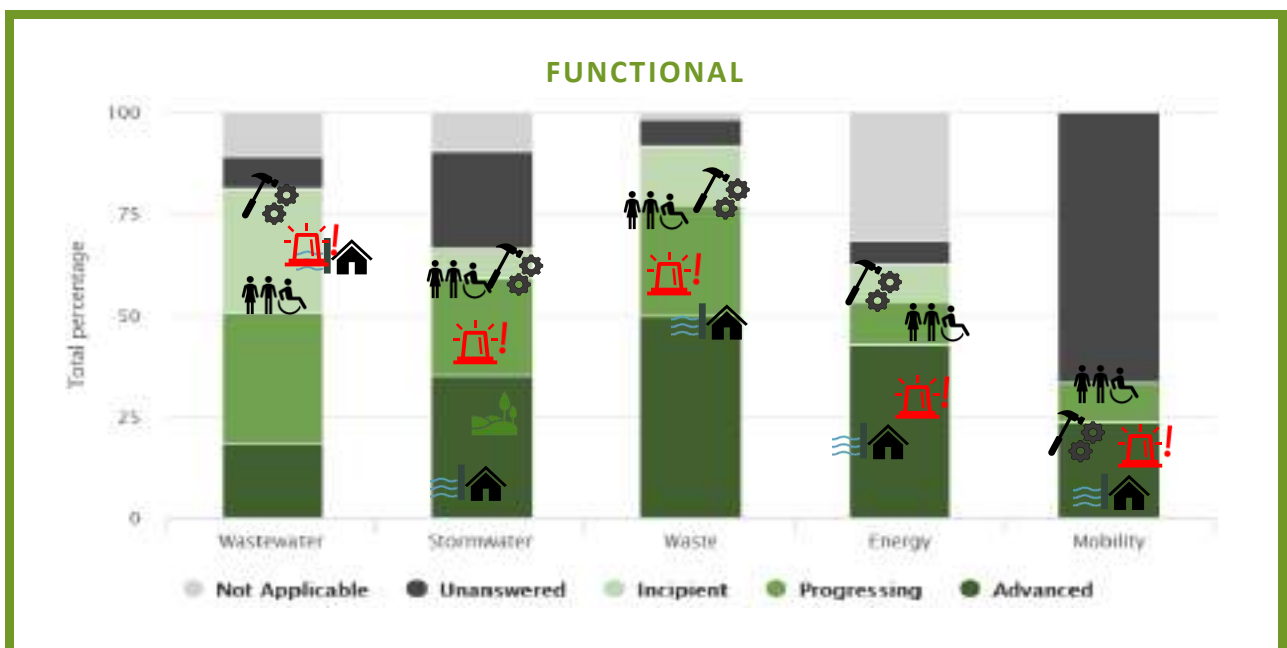
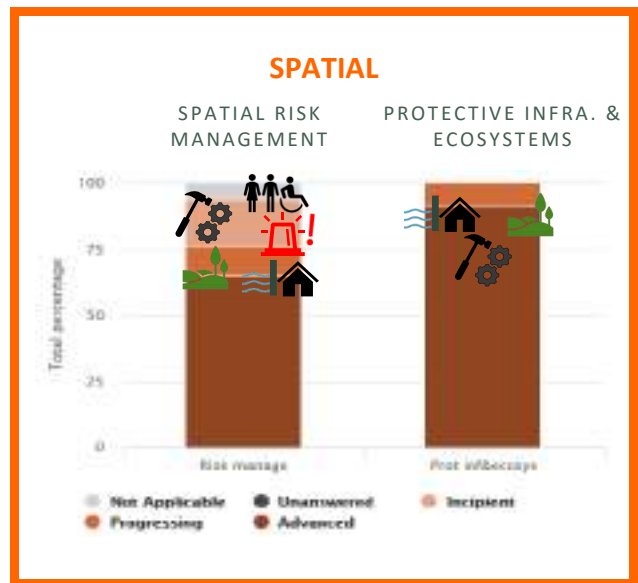
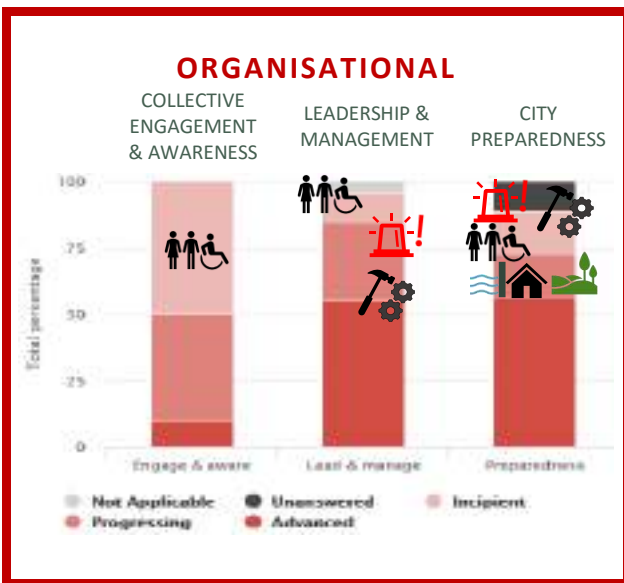
- Strategy S005 – “Adaptation of green infrastructure” is highly related with all the components, particularly within the environmental aspect.
- Strategy S007/S016 – “Promote urban rehabilitation as a tool to increase resilience: sewer systems” is more related to the social co-benefits while also contributing to the economic and environmental aspects.
- Strategy S008 – “Promote urban rehabilitation as a tool to increase resilience: facing climate change” contributes are mostly focused on the environmental aspects, contributing also for the other components.
- Strategy S010 – “Strengthening collaboration within AML, Parish’s and municipality departments” is more related to the social aspect, considering also minor contributions to the economic and environmental aspects.
- Strategy S017 – “Lisbon Drainage Monitoring and Early-Warning System” is highly related with the social aspects, contributing more within the economic aspect than within the environmental aspects.
- Strategy S019 – “Building protections for urban electrical infrastructure, exposed to estuarine flood” is highly related with all the components, namely within the social and economic aspects.

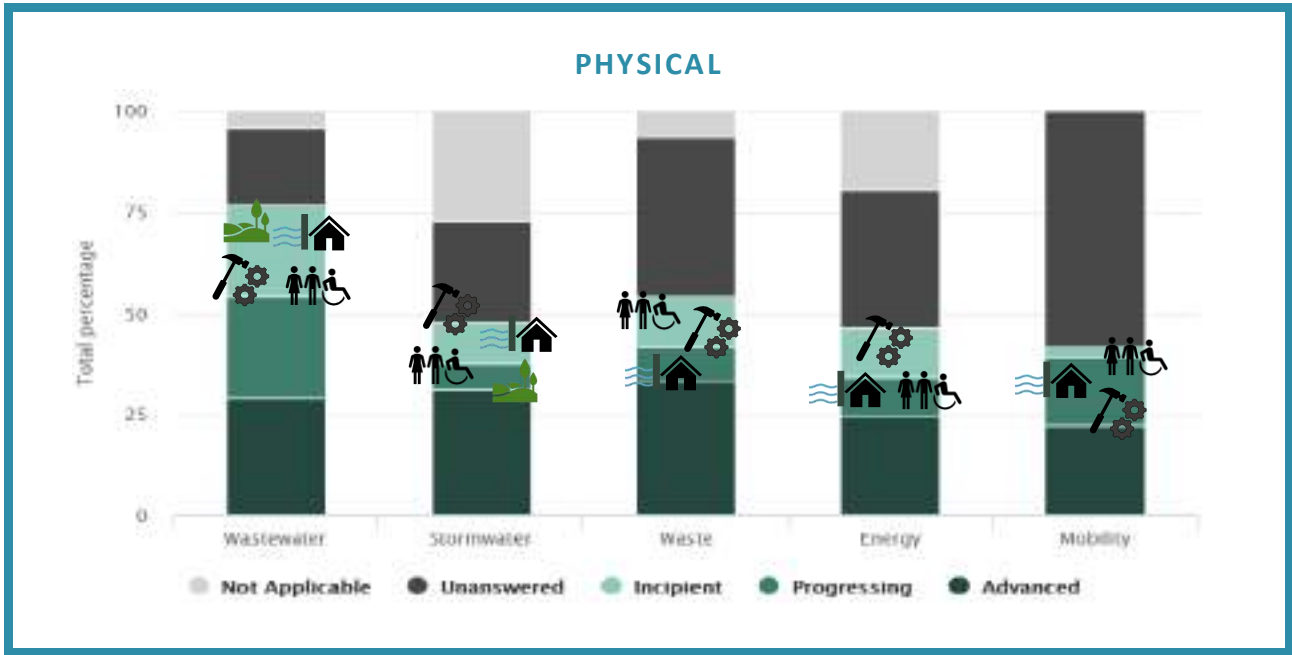
- LISBON RESILIENCE ACTION PLAN -

IMPACT OF IDENTIFIED STRATEGIES IN THE CITY'S RESILIENCE OBJECTIVES, FOR EACH RESILIENCE DIMENSION

The impact of the identified strategies in the RAF resilience objectives for Lisbon is highly significant. The identified strategies, grouped by related typology, address all the resilience dimensions and objectives as well as all services considered in this RAP.

STRATEGIES TYPOLOGY			
	CITIZENS AND STAKEHOLDRES		EARLY WARNING
	PROTECTIVE INFRASTRUCTURES		INFRASTRUCTURAL CONSTRUCTION OR REHABILITATION
			NBS AND ECOSYSTEM SERVICES






NBS AND
ECOSYSTEM
SERVICES

Strategy S005 - “Adaptation of green infrastructure” will contribute to improve organisational resilience, namely regarding the objective of city preparedness and both objectives of spatial resilience; functional resilience of the stormwater service and physical resilience, namely regarding wastewater and stormwater infrastructures.


INFRASTRUCTURAL
CONSTRUCTION
OR
REHABILITATION

Strategy S007 - “Promoting urban rehabilitation as a tool to increase resilience: sewer systems”, **Strategy S008** - “Promoting urban rehabilitation as a tool to increase resilience: facing climate change” and **Strategy S016** - “Construction of new components in drainage system” will contribute to improve the organisational resilience, namely regarding the leadership and management and the city preparedness objectives. These strategies will also contribute to improve both spatial resilience objectives and are related to all services of functional and physical dimensions.


CITIZENS AND
STAKEHOLDERS

Strategy S010 - “Strengthening collaboration within AML, Parishes and municipality departments” will contribute to improve all the objectives of the organisational dimension, the spatial risk management objective of the spatial dimension and it will also contribute to all services of functional and physical dimensions.


EARLY WARNING

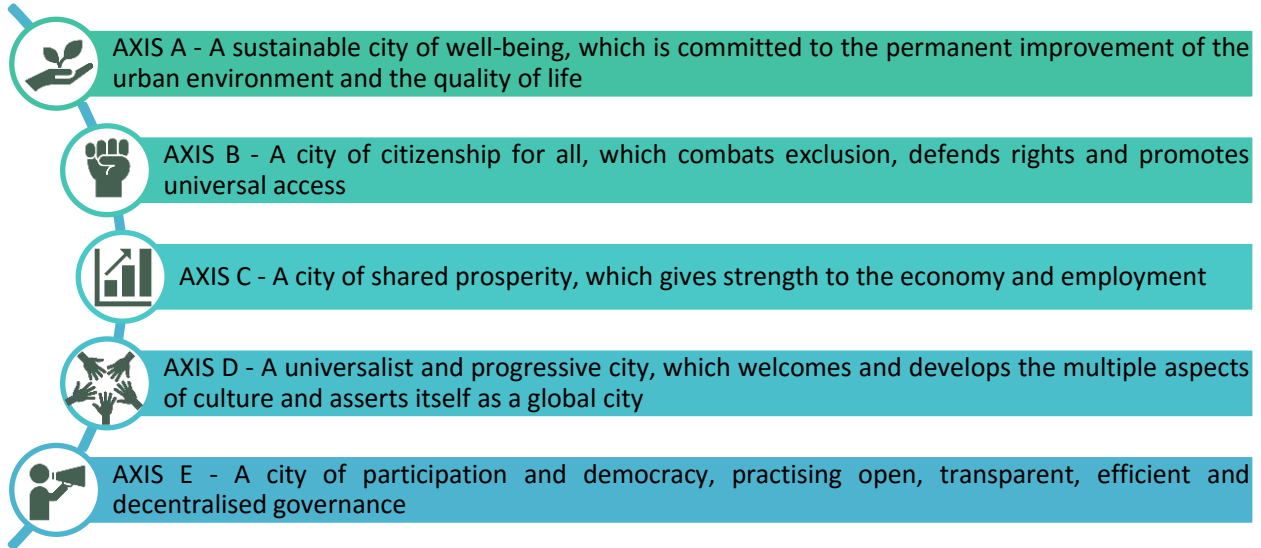
Strategy S017 - “Lisbon drainage monitoring and early-warning system” will contribute to the organisational resilience, namely regarding the objectives of leadership and management and city preparedness, to the spatial risk management objective of spatial resilience, and to all services of functional dimension.


PROTECTIVE
INFRASTRUCTURES

Strategy S019 - “Building protections for urban electrical infrastructure, exposed to estuarine flood” will contribute to improve the organisational resilience, namely regarding the objectives of leadership and management and the city preparedness. These strategies will also contribute to improve both objectives of the spatial resilience dimension and are related to all services of functional and physical dimensions.







PRIORITIZATION

The set of strategies presented is bounded by the RESCCUE Project and RAP domains, *i.e.*, the urban water services and climate-related hazards (herein focused on urban floods). These strategies were selected and defined as priority in this domain due to their alignment with several sectorial, global and territorial Municipal Master Plans, with the Municipal Main Planning Options and respective City Axis:



Naturally, there are many other domains in the city that compete with urban resilience at economic, social and environmental aspects, and although aligned with other sectorial Municipal Master Plans, these strategies might not be considered as priority in those domains. It is important to state that some of the selected strategies are already approved and budgeted, contributing to the allocation of funds to resilience. Additionally, these strategies are diverse in several aspects such as spatial and temporal scopes or addressed hazards, and the comparison between them is not feasible within the aim of setting priority strategies. For instance, S019 - “Building protections for urban electrical infrastructure, exposed to estuarine flood” is from responsibility of EDP D, a private company, and its comparison for prioritization purpose with municipal strategies is not coherent. This strategy was selected due to the high transversal dependence on the electrical energy supply service.

IMPLEMENTATION PLAN

		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	S005											
	S007/S016											
	S008											
	S010											
	S017											
	S019											

6. RAP MONITORING AND REVIEW

PROCESS

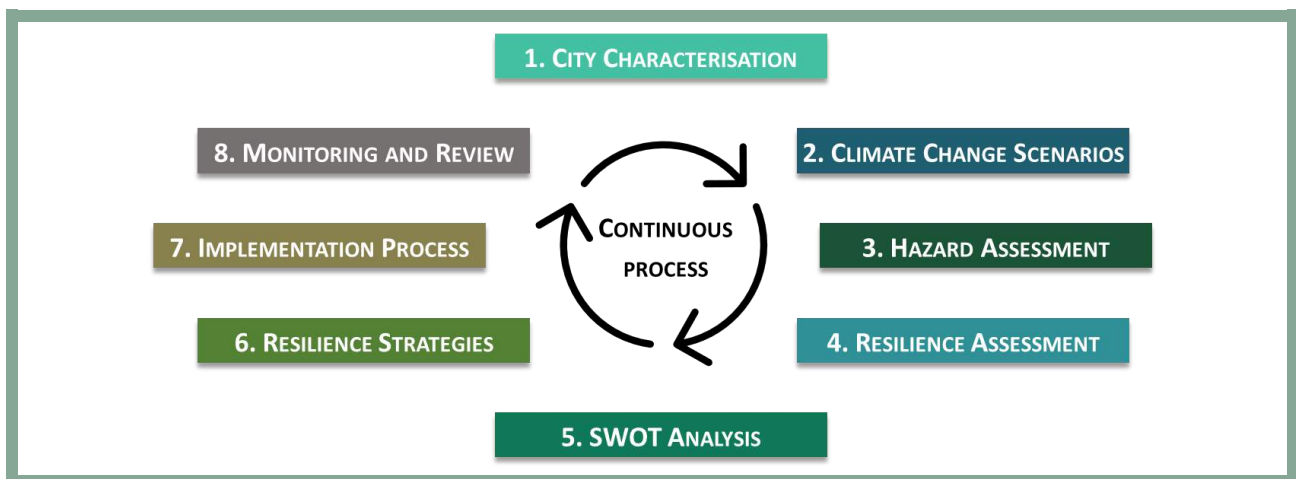
MONITORING

In order to trace the progress of the resilience strategies implementation, of resilience changes and to identify early deviations that may require corrective action, the RAP monitoring is planned as follows.

Periodicity	2 years
Responsible body	CML
Activities	Trace strategies implementation Acknowledge resilience improvements or setbacks Identify unexpected facts with impact on resilience
How	RAF APP metrics update
Dissemination	Confidential

REVIEW

To continuously ensure the city resilience considering the cities' dynamics, the RAP review is a crucial step requiring to review all the steps of the planning process, from step 1. In this plan some of the challenges identified in the SWOT are still to be addressed in the future, namely a few threats (windstorms, the socio-economics crises, contribution to new legal diplomas, concepts harmonisation and GDPR obstacles) and weaknesses (related to budget and insurance, data gaps, services resilience planning, wastewater service autonomy, services and infrastructures preparedness for CC, costs of damages in buildings, compatibility between different tools and structured georeferenced data).



- LISBON RESILIENCE ACTION PLAN -

Periodicity	10 years
Responsible body	CML
Activities	Analyse monitoring results Re-think SWOT Re-think TOWS Re-think previously identified and postponed strategies Evaluate updated knowledge on climate change Evaluate monitoring process
How	RAP update
Dissemination	Public

7. FINAL REMARKS

MAIN BENEFITS AND CHALLENGES

BENEFITS

- Current situation assessment and diagnosis and a resilience monitoring instrument focused on the water cycle and climate change.
- Partnerships strengthening within the city (bottom-up and top-down approach) and between public, private sectors and R&I Centres.
- Budget allocation to resilience-related strategies.
- Enhanced synergies and alignment between local, regional, national and international strategic plans, frameworks, networks and instruments.
- Public results to citizens – public participation reinforcement.

CHALLENGES

- Continuous engagement and involvement of key stakeholders and decision makers in the technical and scientific process.
- Integration of planning instruments from different domains.
- Collective and individual citizen participation and awareness related to a range of hazards and different disruptive events.
- Integrated and updated knowledge regarding city services and climate change related hazards (heat and cold waves, floods, windstorms, mean sea level rise and storm surges, storms, etc.).
- Funding allocation for resilience.

ACKNOWLEDGEMENTS

The authors would like to thank all the RESCCUE partners, namely, the Portuguese consortium – LNEC, CML/DMPC, EDP Distribuição, AdTA, HIDRA – as well as to all other organisations that collaborated directly or indirectly, mainly through the participation on local workshops and meetings. The work developed constitute an important step-up to the resilience assessment and improvement and represent a strong effort from all the involved stakeholders to achieve a better common future for the city of Lisbon and its citizens.

REFERENCES

- Rocha, C. (2017). Estudo de avaliação da sobrelevação da maré – determinação da cartografia de inundação e vulnerabilidade da área ribeirinha de Lisboa afetada pela sobrelevação da maré como consequência da futura subida do nível médio do mar. Relatório Técnico, EMAAC – Estratégia Municipal de Adaptação às Alterações Climáticas, Câmara Municipal de Lisboa, Abril 2017, 46 p.
- Antunes, C., Mendes, S.T., Freire de Andrade C. & Taborda, R., (2013). Estudo do litoral na área de intervenção da APA, I.P. /ARH do Tejo; Cenários de evolução do nível médio do mar para 2100. Documento 1.1.6.b. Criação e Implementação de um Sistema de Monitorização no Litoral abrangido pela área de Jurisdição da ARH do Tejo.
- Canalias, M., Fontanals, I., Soler, P., Vendrell, E. (2017). Report from HAZUR® implementation in each city. D4.1 RESCCUE Project (Confidential), 2017.
- 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, 14-16 November, Lisbon, Portugal.
- Cardoso, M.A., Brito, R.S., Pereira, C., David, L., Almeida, M.C. (2020a). Resilience Assessment Framework RAF – Description and implementation. D6.4 RESCCUE project (Public), 2020.
- Cardoso, M.A., Brito, R.S., Pereira, C. (2020b). Resilience Assessment Framework Tool – RAF APP. D6.5 RESCCUE project (Public), 2020.
- CML (2015). Relatório sobre o Estado do Ordenamento do Território de Lisboa. Aprovado em Assembleia Municipal de Lisboa, em sessão extraordinária de 23 de maio de 2017.
- CML (2016a). Lisboa – A Economia em Números.
- CML (2016b). Plano Geral de Drenagem 2016 – 2030. Desenvolvido por Hidra, Lda, Engidro e Bluefocus.
- CML (2017). Estratégia Municipal De Adaptação Às Alterações Climáticas De Lisboa (EMMAC 2017). Aprovado por unanimidade e aclamação, na Reunião da Assembleia Municipal do dia 18 de julho de 2017.
- CML (2019). Municipal Plan of Forest Fire Defence, Diagnosis Book I, Lisbon City Council 2019.
- Evans, B., Djordjevic, S., Chen, A.S., Velasco, M., Russo, B., Martínez, E., Daura, E., Vela, S., Palau, A., Dominguez, J.L., De Prada, M., Almeida, M.C., Telhado, M., Morais, M., Coelho, L., Severino, M., Pimentel, N., Alves, R.L., Silva, I.C., Alberto, P., Duarte, N., Stevens, J., Goodey, P., Jennings-Howe, A., Gonzalez Gomez, A., Gabas Masip, A., Fontova Riasol, J., Vendrell, E., Fontanals, I., Fontanals, L., Canalias, M., Soler, P. Bocquentin, M., Vuillet, M., Henderson, R., (2018). Development of methodology for modelling of cascading effects and translating them into sectorial hazards. D3.3 RESCCUE project (Public), 2018.
- Evans, B., Djordjevic, S., Chen, A.S., Gibson, M., Almeida, M.C., Telhado, M., Morais, M., Silva, I.C., Duarte, N., Martínez, E., Guerrero Hidalgo, M., Ortiz, E., Russo, B., Henderson, R., Gonzalez Gomez, A., Ciudad, E.R., Sanchez, D., Domínguez, J.L. (2019). Impact assessments of multiple hazards in case study areas. D3.4 RESCCUE project (Confidential), 2019.
- Evans, B., Djordjevic, S., Chen, A.S., Webber, J., Russo, B., Forero Ortiz, E., Martinez, E., Guerrero Hidalgo, 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), 2020.
- INE (2017). Destaque do Instituto Nacional de Estatística relativo ao Rendimento e Condições de Vida.
- Martinez, 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), 2017.
- Martinez, 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), 2019.

- McClinton, P. (2015). Strategic management analysis tools: A review of the Literature. Liberty University, academia.edu. Available at: http://www.academia.edu/7055342/Strategic_Management_Analysis_Tools.
- Monjo, R., Paradinas, C., Gaitán, E., Redolat, D., Prado, C., Pórtolos, J., Torres, L., Russo, B., Velasco, M., Pouget, L., Vela, S., David, L.M., Morais, M., Ribalaygua, J. (2018). Report on extreme events prediction. D1.3 Internal RESCCUE Project document (Public), 2018.
- Pagani, G., Fournière, H., Cardoso, M.A., Brito, R.S. (2018). Report with the resilience diagnosis for each city. D6.1 RESCCUE Project (Confidential), 2018.
- Russo, B., Sunyer, D., Locatelli, L., Martínez, E., Almeida, M.C., David, L. M., Telhado, M., Morais, M., Duarte, N., Lopes, R., Barreiro, J., Simões, J., Dominguez, J.L., Sánchez, D., Pardo, M., Evans, B., Stevens, J., Goodey, P., Henderson, R. (2019). Multi-hazards assessment related to water cycle extreme events for future scenarios (Business As Usual). D2.3 RESCCUE project (Confidential), 2019.
- Russo, B., Sunyer, D., Locatelli, L., Yubero, D., Vela, S., Martínez, E., Martínez, G., Palau, A., Domínguez, G., De Prada, M., Domínguez, J.L., Pardo, M., Duarte, M., Almeida, M.C., Telhado, M., Morais, M., Coelho, L., Severino, M., Muñoz, M., Pimentel, N., Alves, R.L., Silva, I.C., Alberto, P., Duarte, N., Louro, M., Carvalho, D., Rodrigues, B., Matos, J.S., Ferreira, F., Lopes, R., Barreiro, J., Morgado, P., Evans, B., Chen, A., Djordjevic, S., Stevens, J., Goodey, P., Jennings-Howe, A., Henderson, R., (2018). Multi-hazards assessment related to water cycle extreme events for current scenario. D2.2 RESCCUE project (Confidential), 2018.
- UNISDR (2015). Disaster resilience scorecard for cities. Preliminary level assessment. United Nations Office for Disaster Reduction.
- Wehrich, H. (1982). The TOWS matrix—A tool for situational analysis, Long Range Planning, Volume 15, Issue 2, Pages 54-66, ISSN 0024-6301. Available at: [https://doi.org/10.1016/0024-6301\(82\)90120-0](https://doi.org/10.1016/0024-6301(82)90120-0).

OTHER SOURCES









RESCCUE project, www.resccue.eu

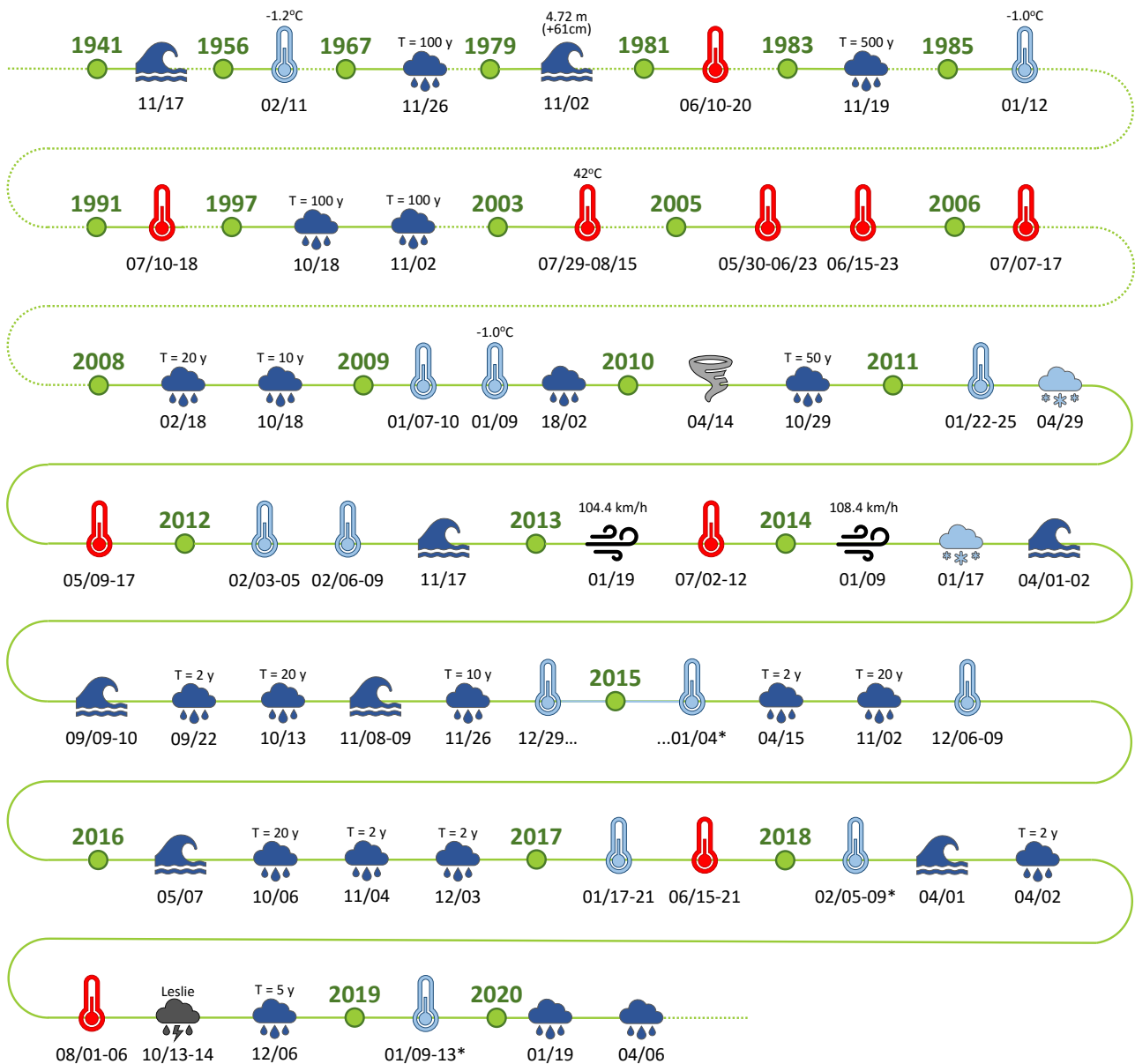
RESCCUE tool kit, www.toolkit.resccue.eu

ANNEX

- LISBON RESILIENCE ACTION PLAN -

REGISTER OF EXTREME WEATHER-RELATED EVENTS IN LISBON

EVENT TYPOLOGY		
 HOT WEATHER / HEAT WAVES	 COLD WEATHER / COLD WAVES	 STRONG WIND / WIND GUST
 TORNADO	 MARITIME AGITATION / STORM SURGE	 FLOODING DUE TO RAINFALL
 HAILSTORM	 STORM	

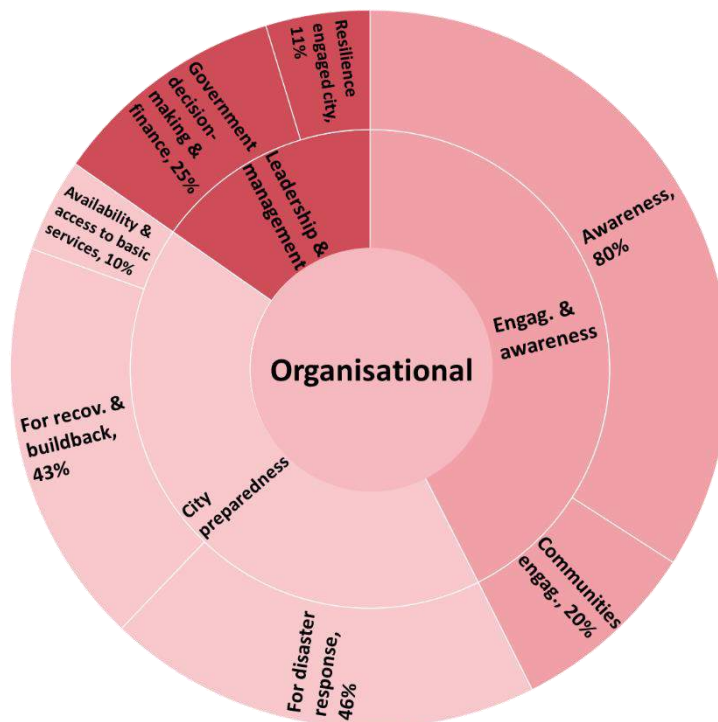


*Activation of the Contingency Plan for the Homeless due to cold weather although the values observed do not meet the criteria

OVERALL RAF CITY TESTING BY DIMENSION

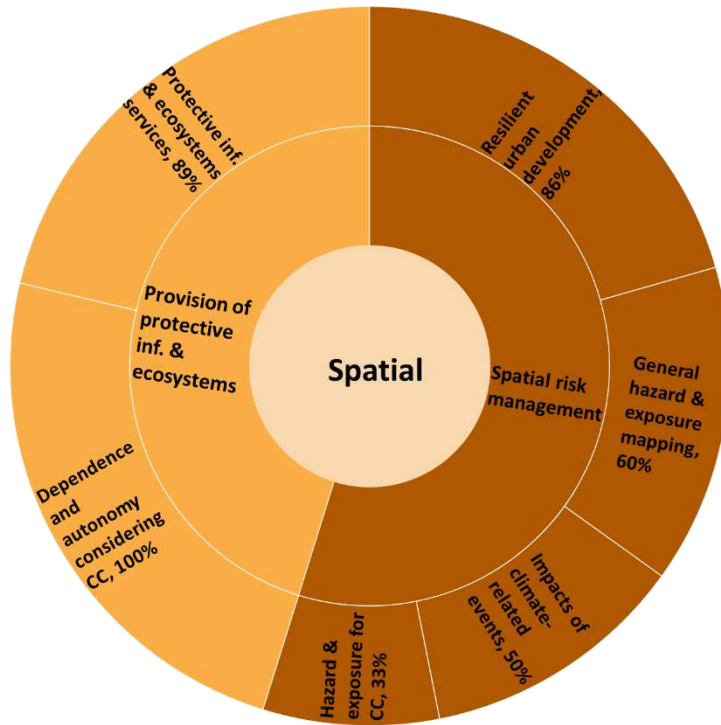


a) % of advanced metrics

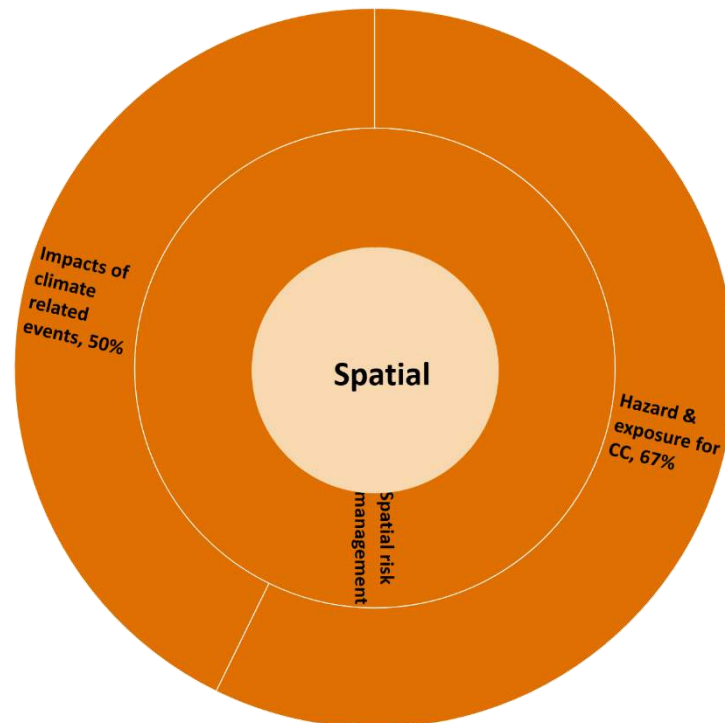


b) % of incipient metrics

Figure A 1 - Overall of city testing | organisational dimension: development level

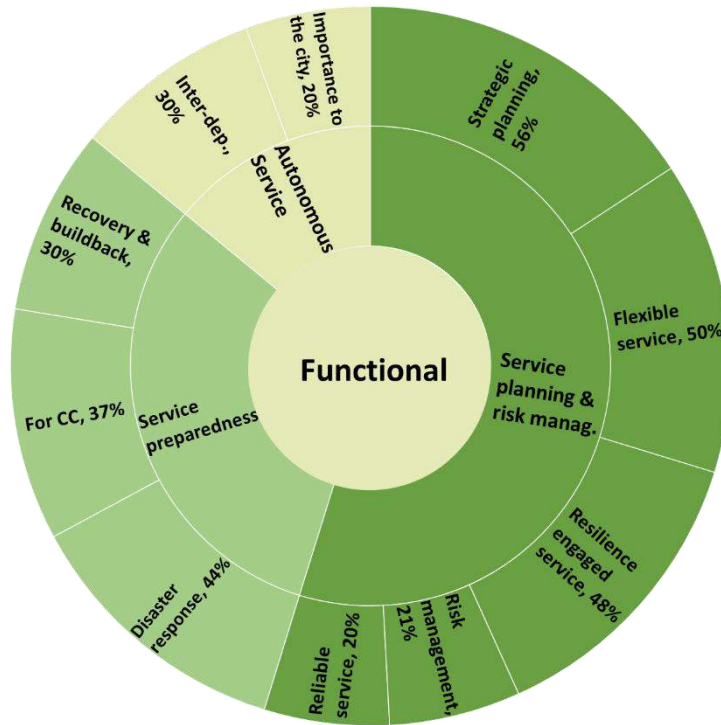


a) % of advanced metrics

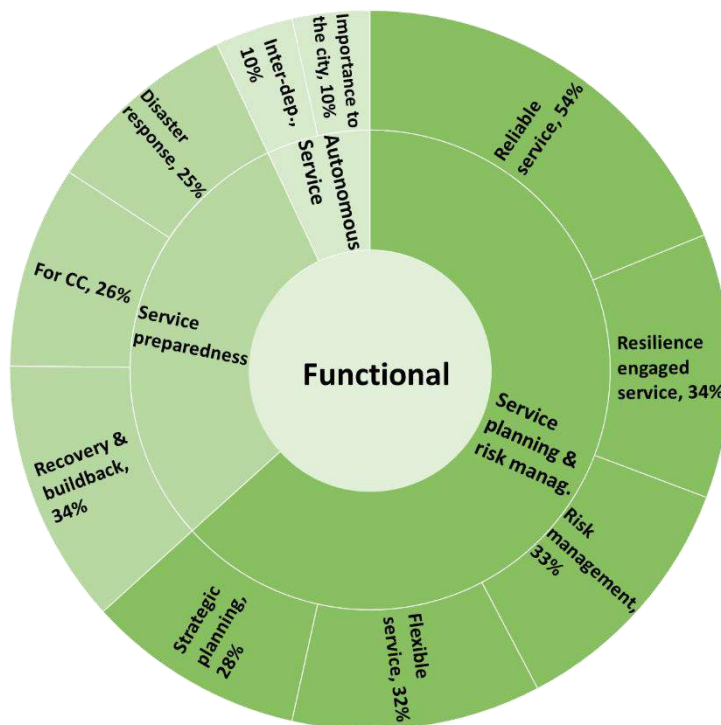


b) % of incipient metrics

Figure A 2 - Overall of city testing | spatial dimension: development level

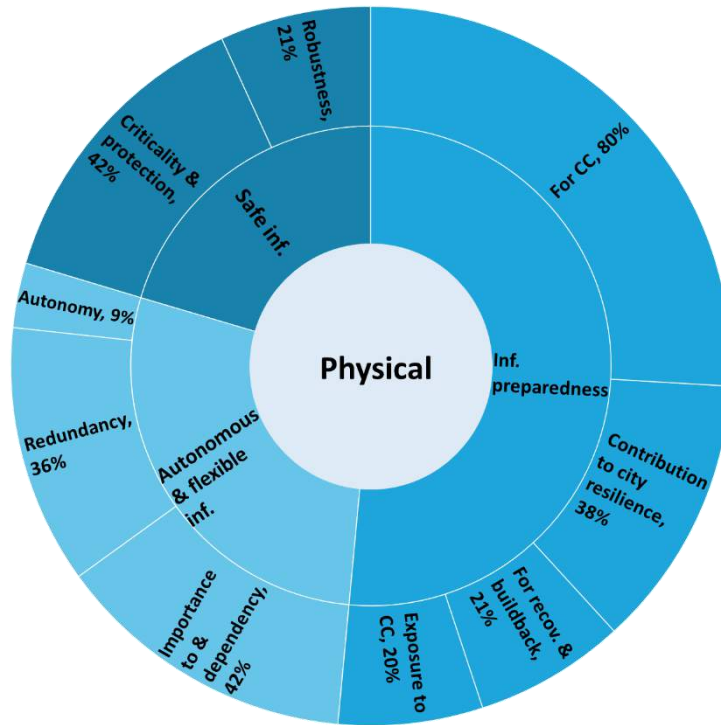


a) % of advanced metrics

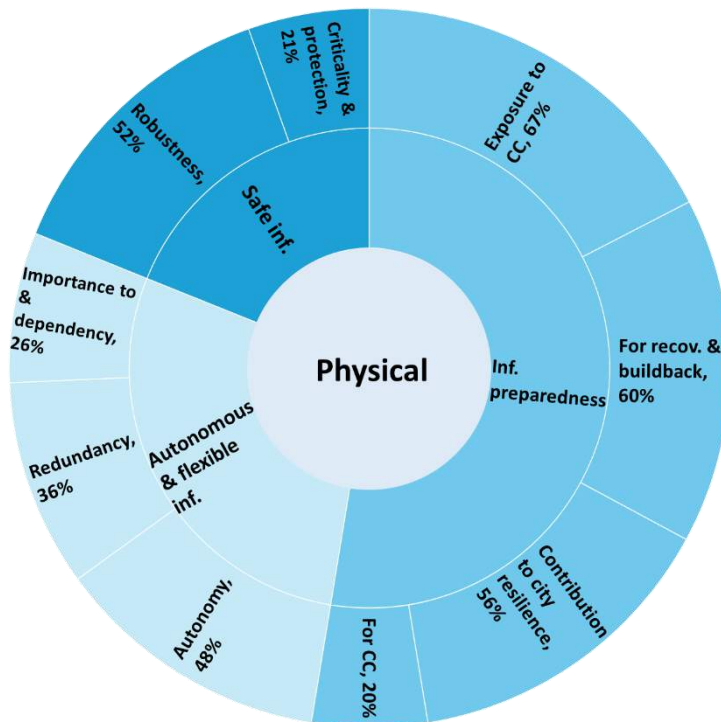


b) % of incipient metrics

Figure A 3 - Overall of city testing | functional dimension: development level



a) % of advanced metrics

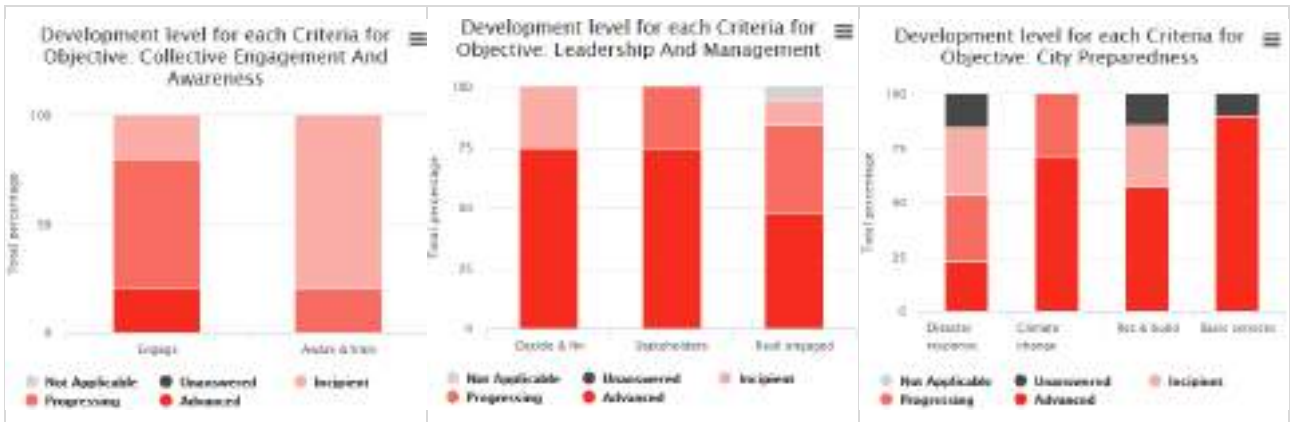


b) % of incipient metrics

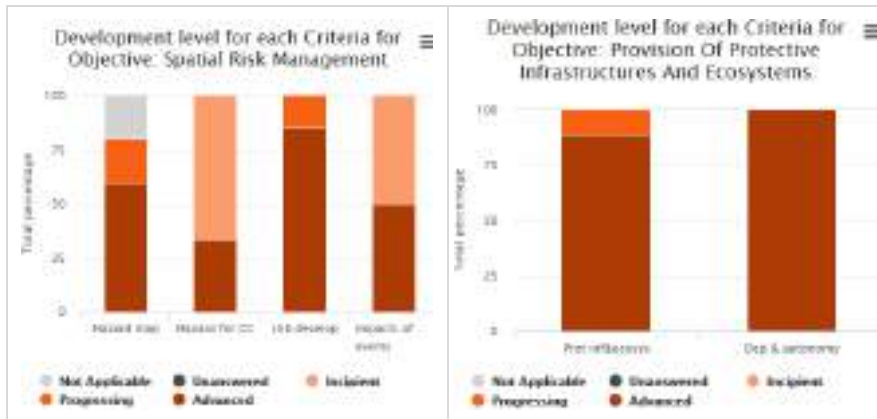
Figure A 4 - Overall of city testing | physical dimension: development level

LISBON RESILIENCE ASSESSMENT FROM RAF BY CRITERIA

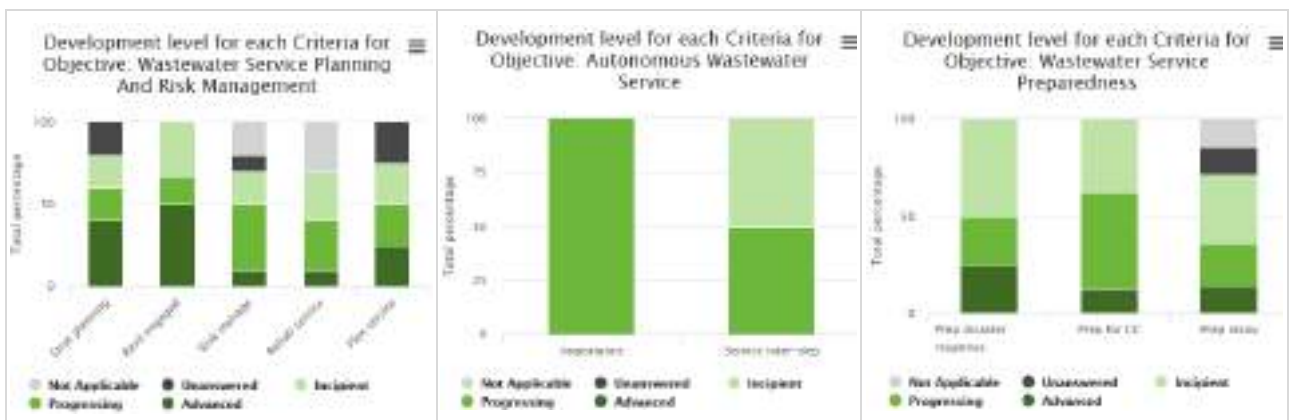
Organisational



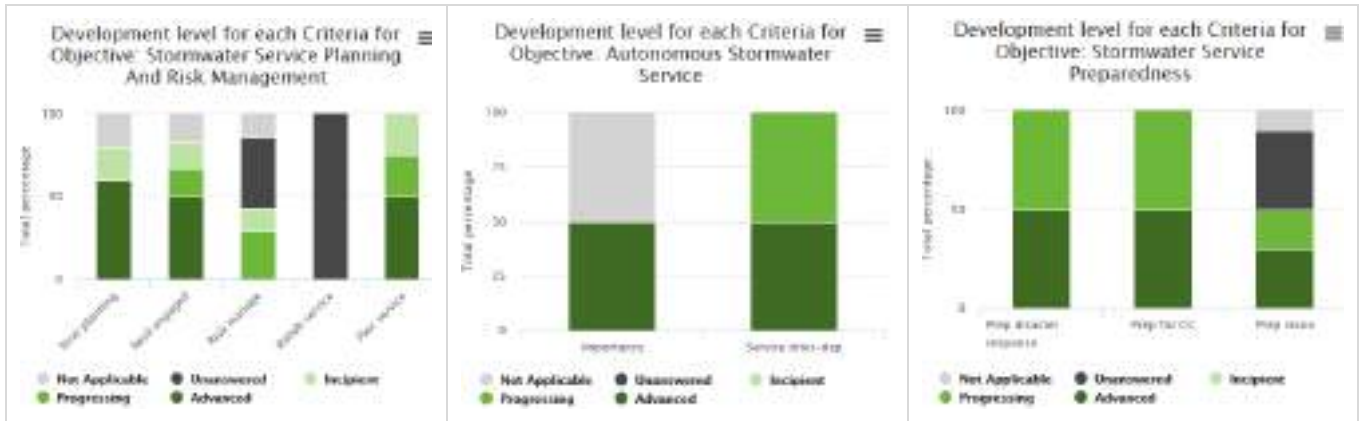
Spatial



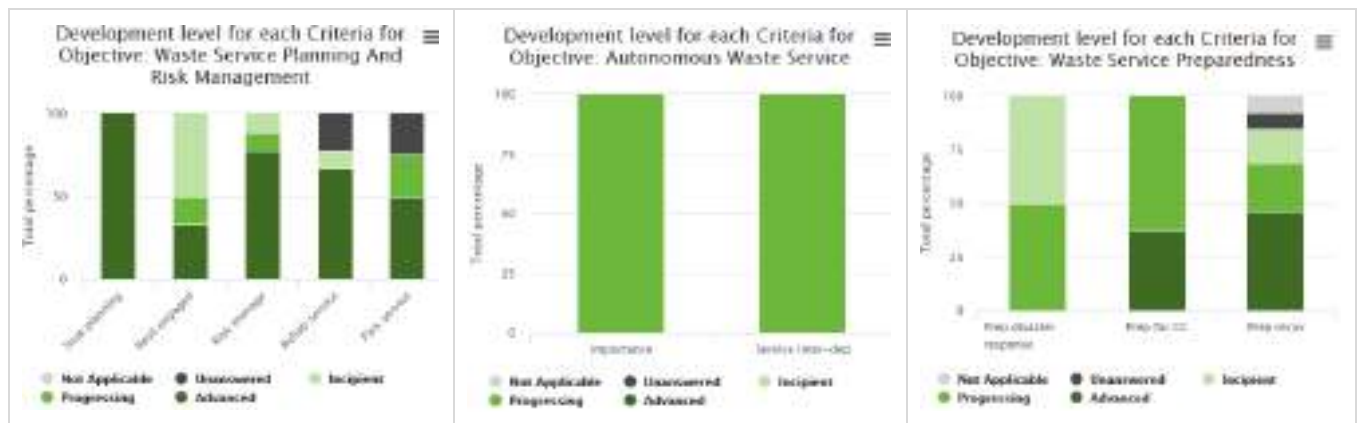
Functional - Wastewater



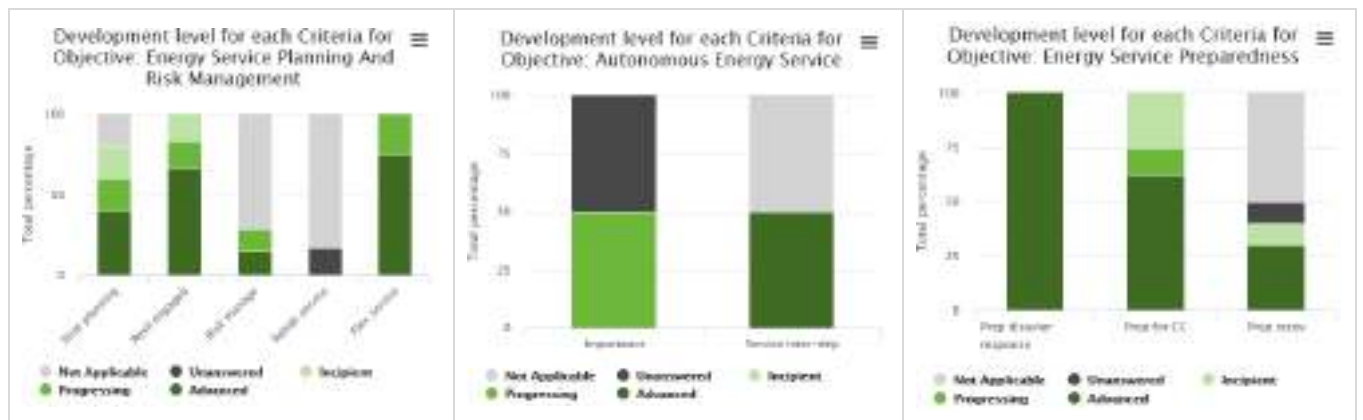
Functional - Stormwater



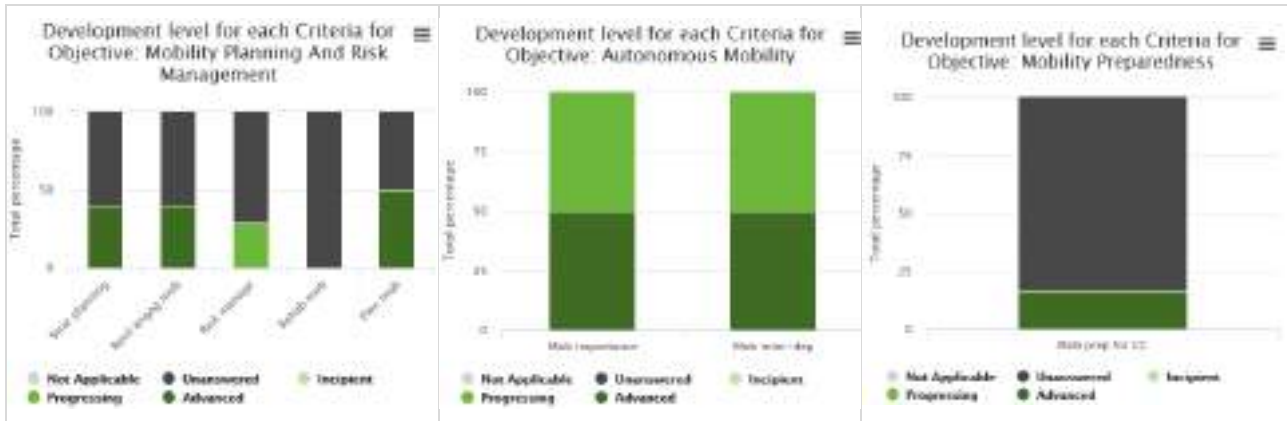
Functional - Waste



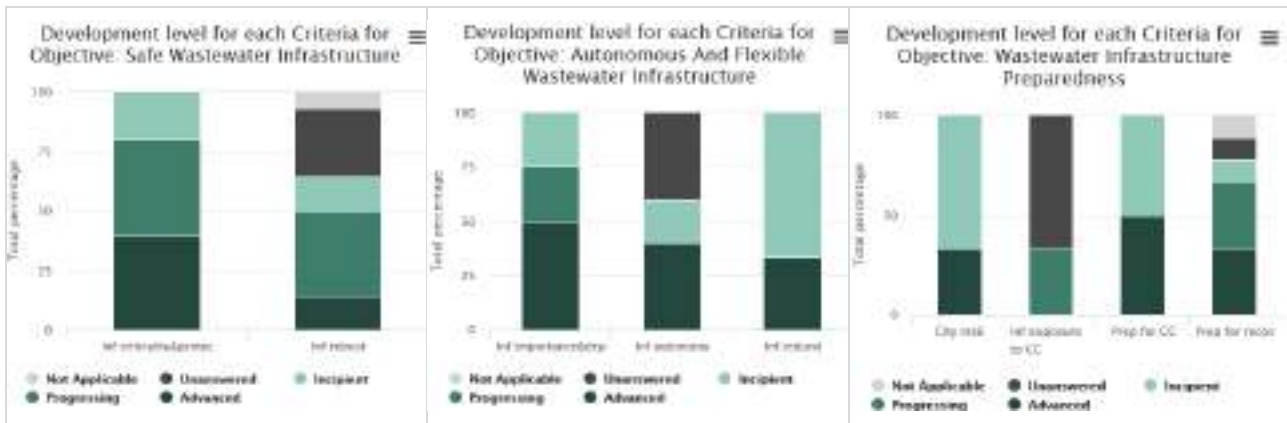
Functional - Energy



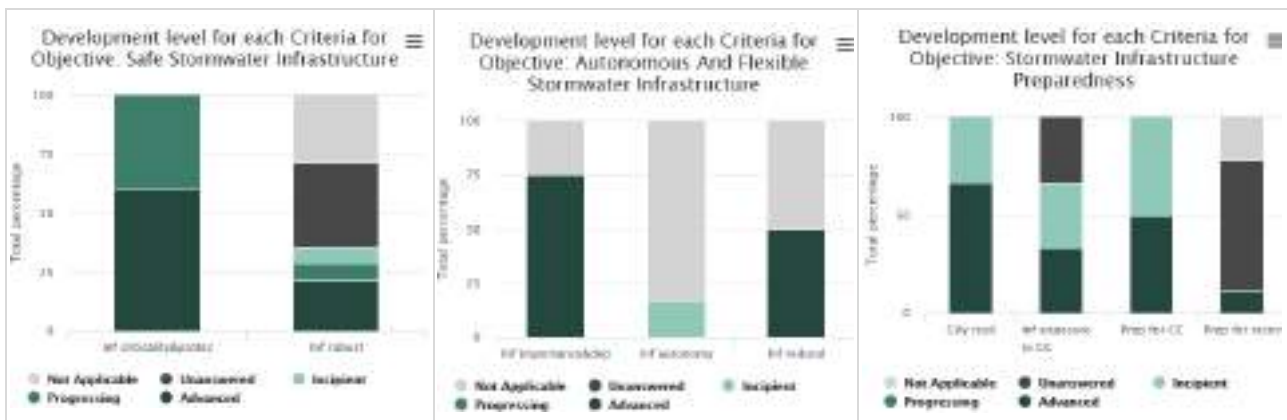
Functional - Mobility



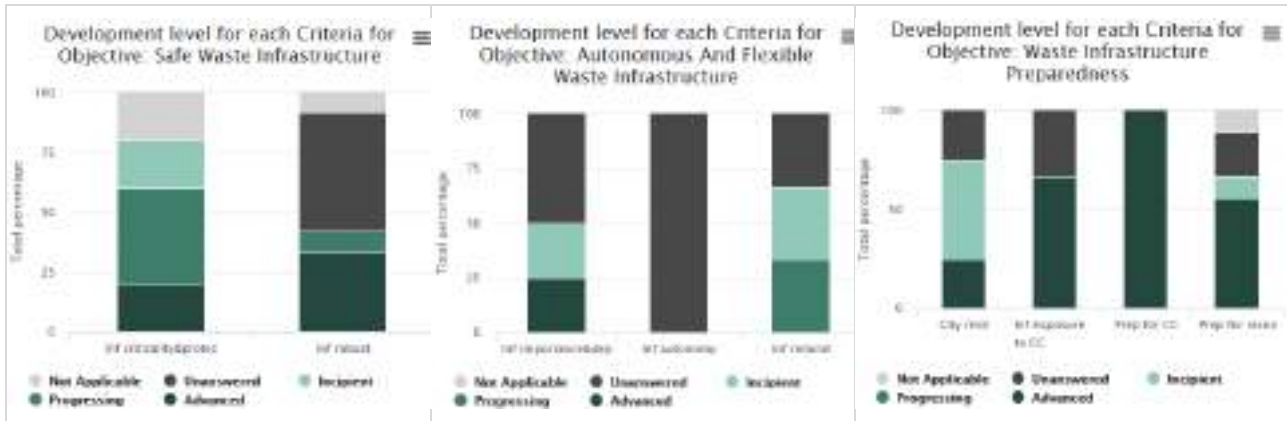
Physical - Wastewater



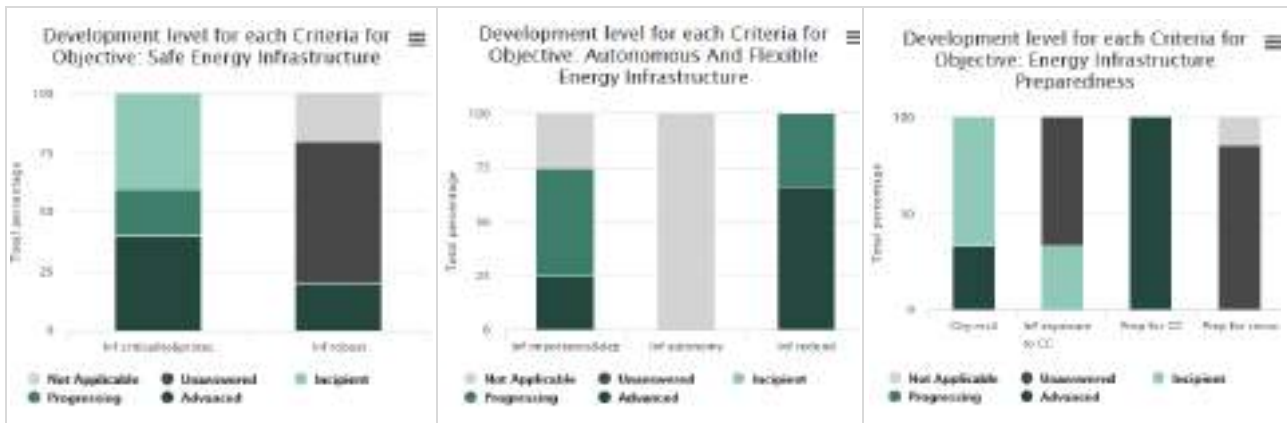
Physical - Stormwater



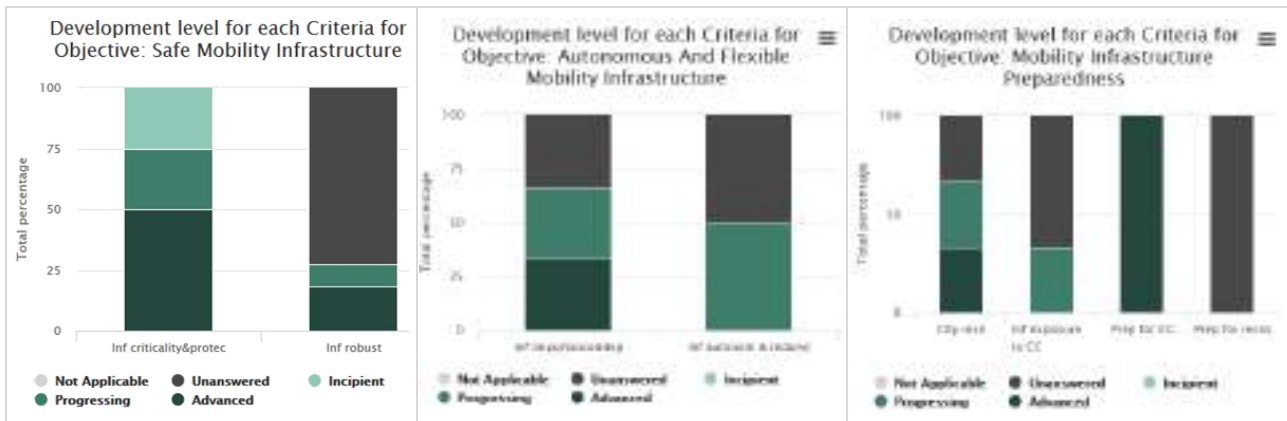
Physical - Waste



Physical - Energy



Physical - Mobility





LISBON RESILIENCE ACTION PLAN - 2020-2030

Lisbon Municipality

July 2020



RESILIENCE TO COPE WITH CLIMATE CHANGE IN URBAN AREAS



This Project has received funding from European Commission by means of Horizon 2020, The EU Framework Programme for Research and innovation, under Grant Agreement no. 700134