WCSP ► LISBON DEMO

Water Cycle Safety Plan: Lisbon case study - a way to integrate utilities

W-SMART 2017 International Workshop

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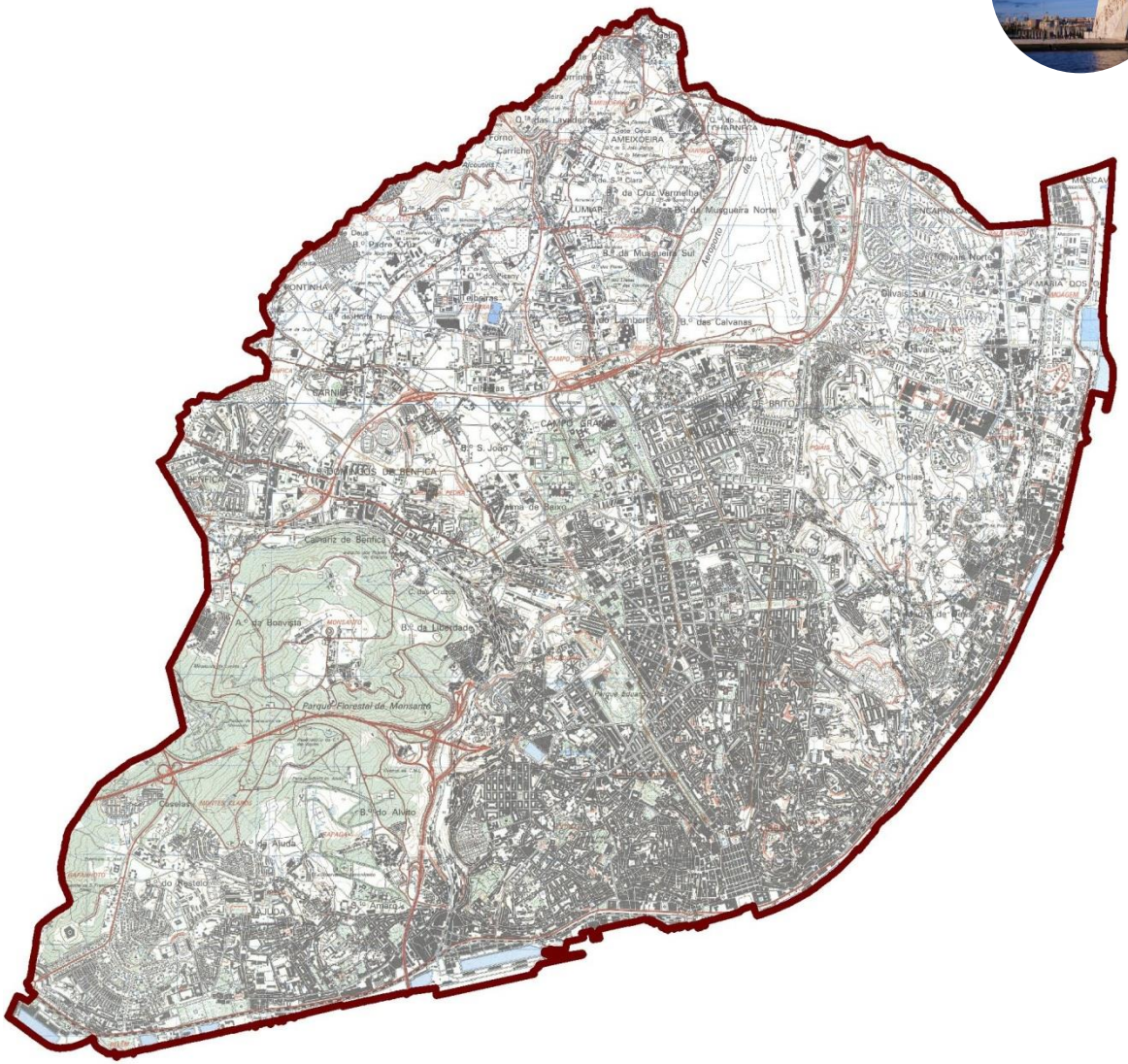
Lisbon urban area and water systems

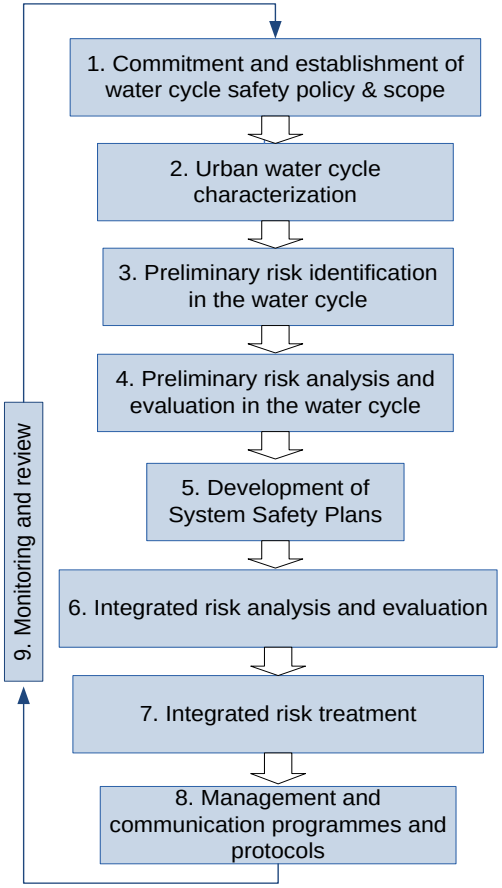


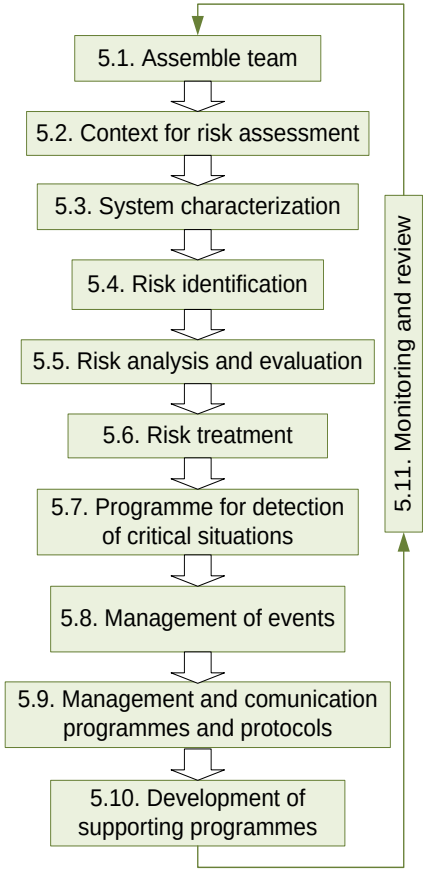
Lisbon urban area and water systems

WCSP main steps

Prepared enabling change

- Two levels of action
  - **Water cycle integrated level** – issues dealt with at a **macro scale** and **interactions** considered
  - **System level** - detailed analysis





WCSP ▶ Main components

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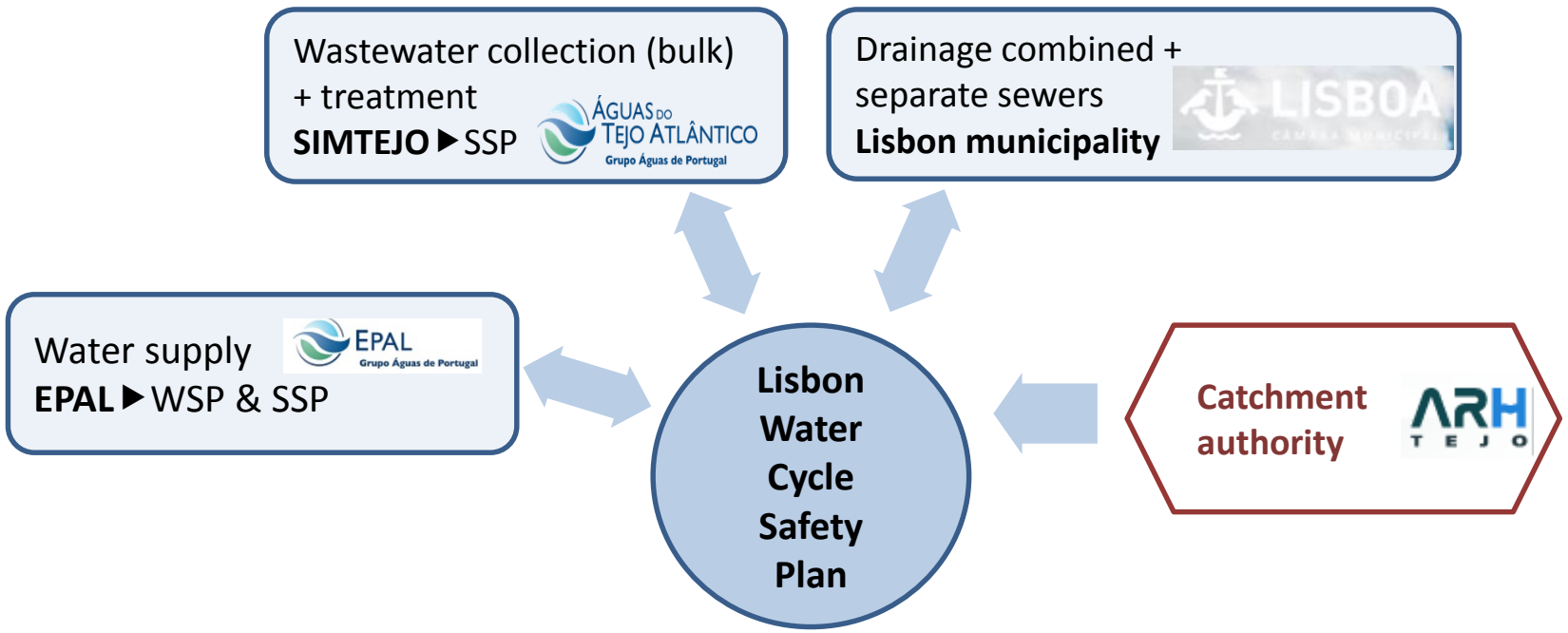
»**2012 Framework**



WCSP ▶ Main components

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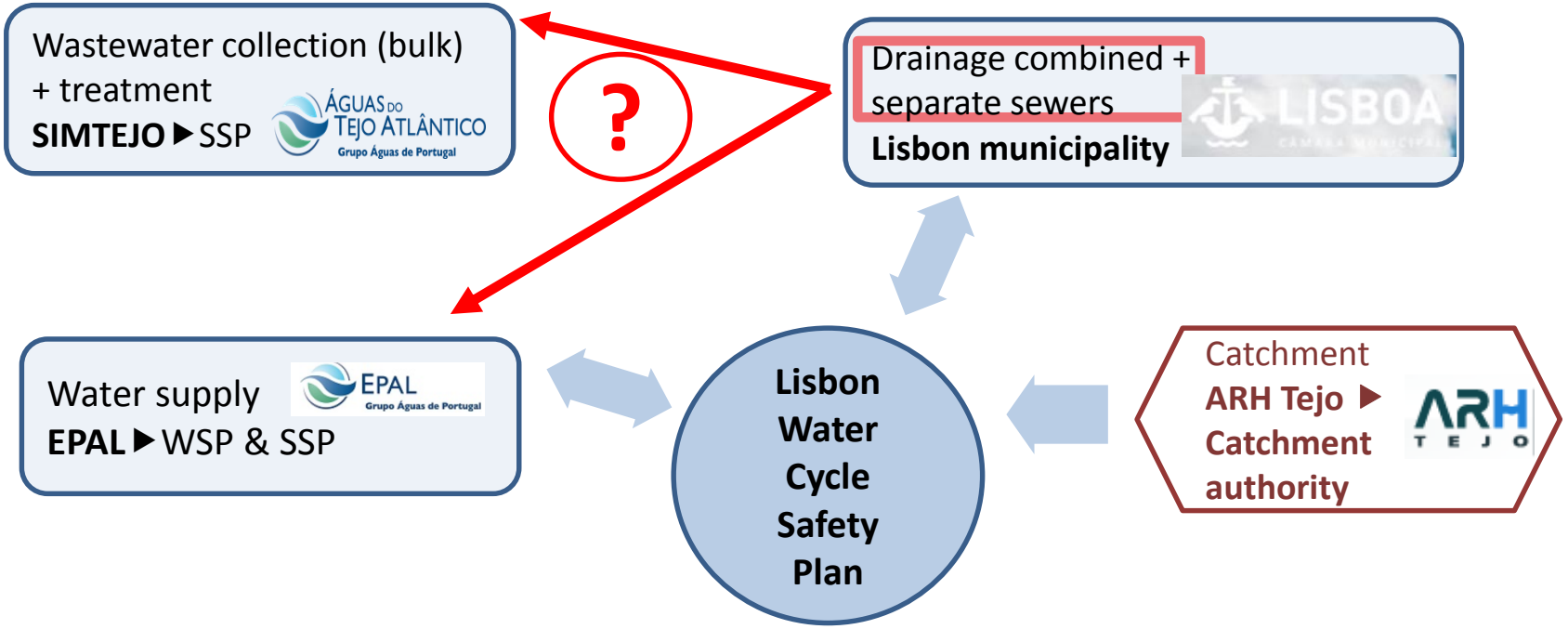
»**2017 Framework**

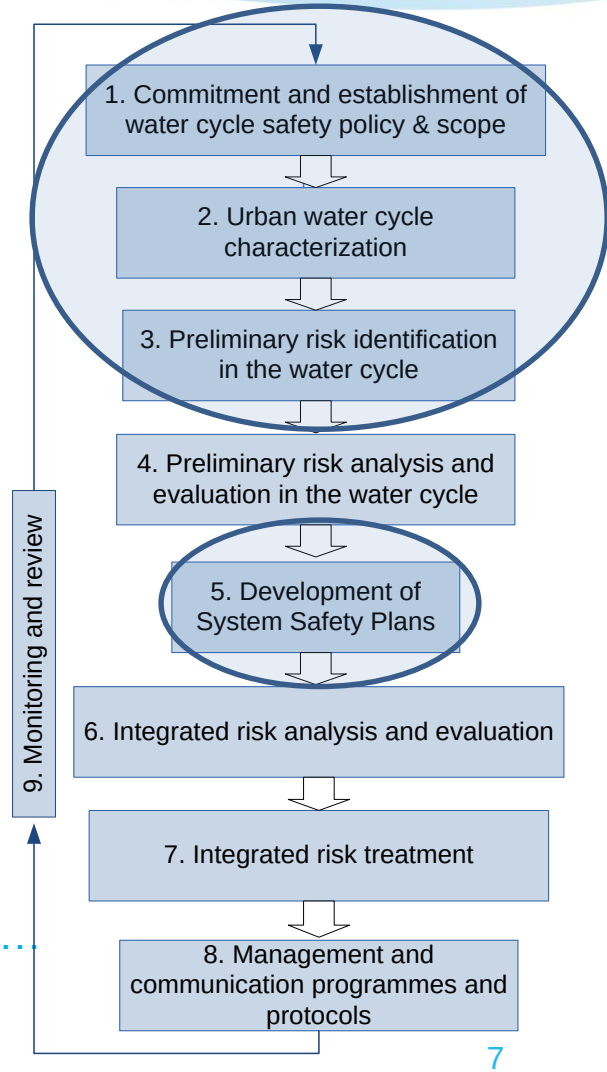


WCSP ▸ 1. Commitment and establishment of water cycle safety policy and scope

» Identified stakeholders and team

Core team	
EPAL	Utility
AdTA (SimTejo)	Utility
CMLisboa	Utility
ERSAR	Regulator
LNEC	Research partner
2nd level	
ARH	Catchment authority Lisbon and Tagus valley
ARS	Health National Authority
CML CPFD	Civil Protection and Fire Department (municipal)
3rd level	
EDP (Electrical supplier), Parish rep., Domestic customers/agents, association of consumers, APL (Port authorithy)	

» Also defined the time frame, compiled formal requirements, …



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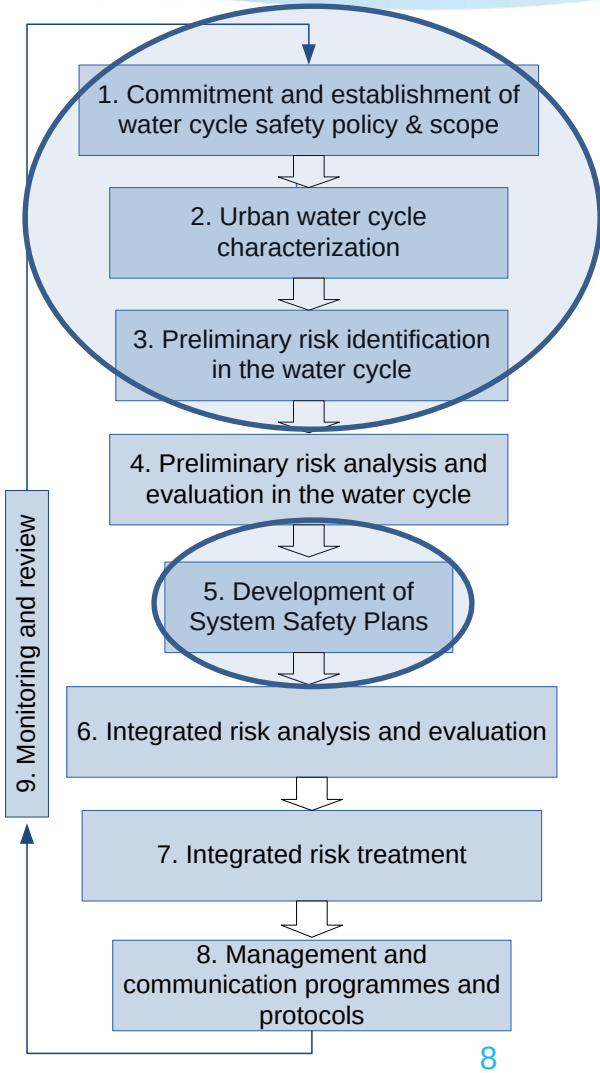
WCSP ▸ 1. Commitment and establishment of water cycle safety policy and scope

» Agreement on criteria for subsequent risk analysis

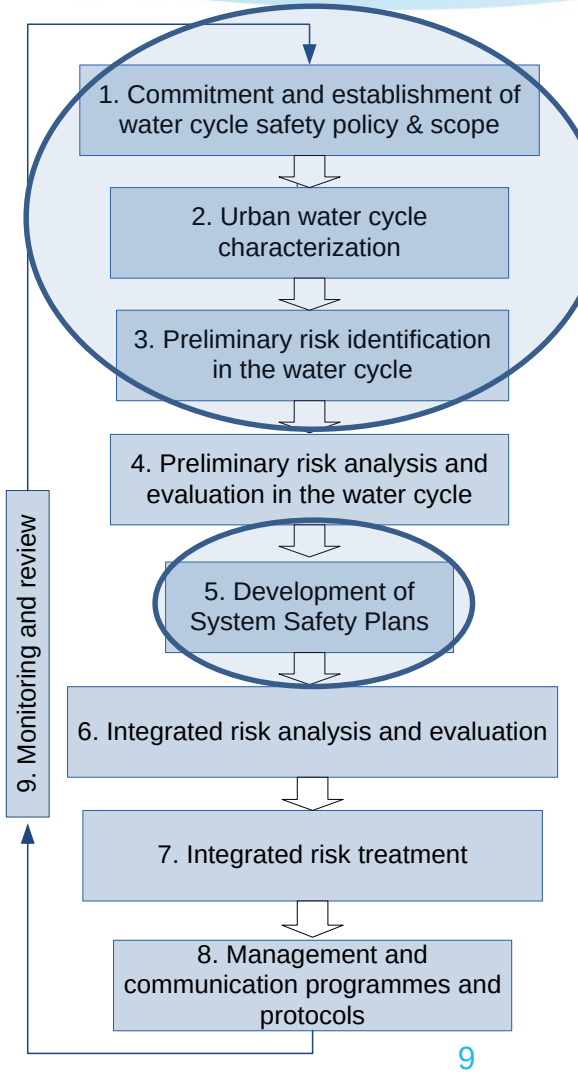
Dimension	Examples of criteria or variables useful to express relative value in each class
Health and safety (consumer, public, occupational)	▪ number and severity of injuries, number and severity of people affected by disease ▪ number of people affected permanently (mortality and disability)
Financial	▪ monetary value; should be a function of the size of utility e.g. annual operating budget (AOB)
Service continuity	▪ duration of service interruption (availability and compliance with minimum standards); differentiation of type of client affected can be used (residential, hospital, firefighting) ▪ various performance measures (e.g. client.hours.lost without supply, number of interruptions); thresholds can be associated with legal requirements ▪ various reliability measures (e.g. number of specific failures or failure modes per time unit); thresholds can be associated with legal requirements
Environmental impacts	Impact on water (surface, ground), land, air, flora, fauna. ▪ severity (e.g. expressed as expected recovery time, water quality index.time) ▪ extent (e.g. dimension of afected area, water quality index.area, volume or duration of event) ▪ vulnerability (e.g. protected areas, areas of influence for water supply abstraction)
Liability, compliance, reputation and image	▪ number of complaints; frequency of negative references to the utility in the media; frequency of lawsuits



WCSP ▸ 1. Commitment and establishment of water cycle safety policy and scope

» Agreement on criteria for subsequent risk analysis

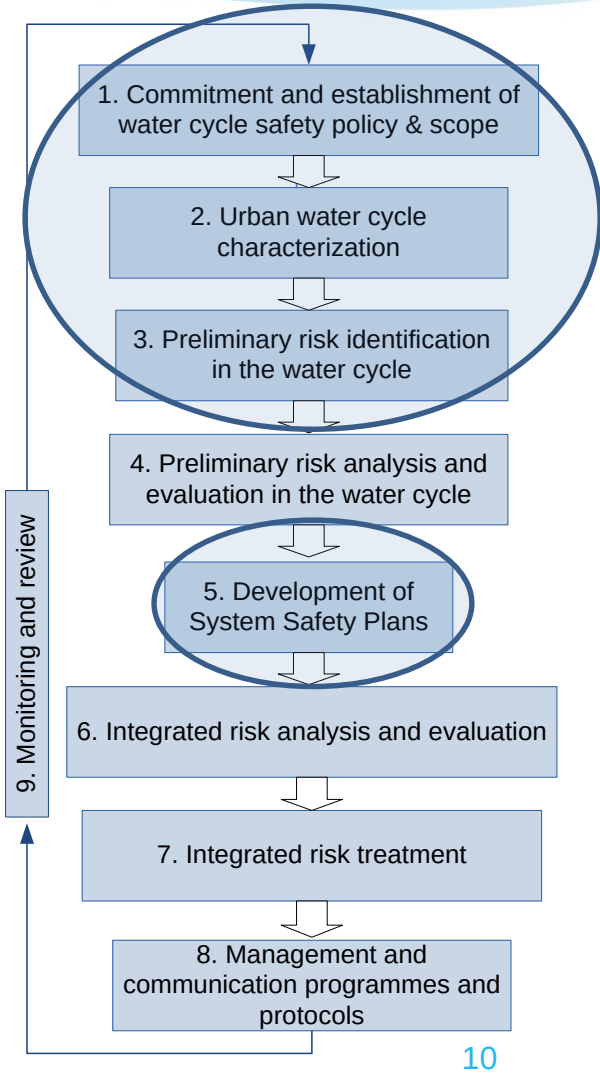
Class	Consequence level	Dimension
		Service continuity
1	Insignificant	• Interruption of water supply service* < 6 hours; Client.hours_service_loss* < 600 • Bulk water supply service loss < 10% DAF** • Wastewater untreated discharge < 5% Wastewater DWDAF** (WW DWDAF) • Flooding*** ≤ 1 property; Flooding*** area < 100 m^2
2	Low	• Interruption of water supply service 6 to 12 hours; Client.hours_service_loss 600 to 12000 • 10% DAF ≤ Bulk water supply service loss < 30% DAF • 5% WW DWDAF ≤ Wastewater untreated discharge < 10% WW DWDAF • Flooding >1 and ≤10 properties; Flooding area 100 m^2 to 1 000 m^2
3	Moderate	• Interruption of water supply service 12 to 24 hours; Client.hours_service_loss 12 000 to 24 000 • 30% DAF ≤ Bulk water supply service loss < 50% DAF • 10% WW DWDAF ≤ Wastewater untreated discharge < 50% WW DWDAF • Flooding >10 and ≤ 100 properties; Flooding area 1 000 m^2 to 10 000 m^2
4	High	• Interruption of water supply service 24 to 72 hours; Client.hours_service_loss 24 000 to 72 000 • 50% DAF ≤ Bulk water supply service loss < 70% DAF • 50% WW DWDAF ≤ Wastewater untreated discharge < 200% WW DWDAF • Flooding >100 and ≤1000 properties; Flooding area 10 000 m^2 to 1 km^2
5	Very high	• Interruption of water supply service > 72 hours; Client.hours_service_loss > 72 000 • Bulk water supply service loss > 70% DAF • Wastewater untreated discharge > 200% WW DWDAF • Flooding >1000 properties; Flooding area > 1 km^2



WCSP ▸ 1. Commitment and establishment of water cycle safety policy and scope

» Agreement on criteria for subsequent risk analysis

Classes	Likelihood	Probability (5 years)	Probability (1 year)
		Log function	Log function
1	Very rare	[0;1%[	[0; 0,2%[
2	Rare	[1 % ;5 %[	[0,2 % ;1 %[
3	Unlikely	[5 %; 10 %[	[1 %; 2 %[
4	Moderate	[10 %; 40%[	[2 %; 10%[
5	Likely	[40 %;100 %[	[10 %;100 %[

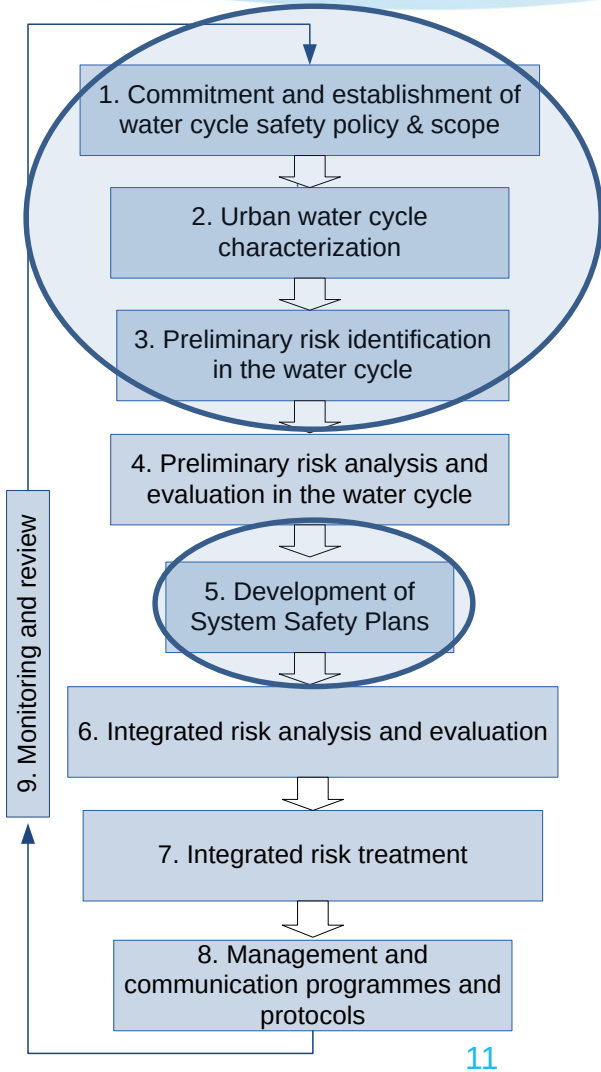


WCSP ▸ 1. Commitment and establishment of water cycle safety policy and scope

» Agreement on criteria for subsequent risk analysis

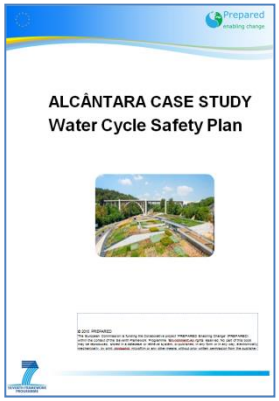
Likelihood	Consequence 1	2	3	4	5
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5

Classes	Risk level	Acceptance and tolerability level	Action for risk reduction*
1	Low	Broadly acceptable region	Not likely to be required.
2	Medium	Tolerable region	Costs and benefits are to be taken into account and opportunities to be balanced against potential adverse consequences.
3	High	Intolerable region	Risk cannot be justified

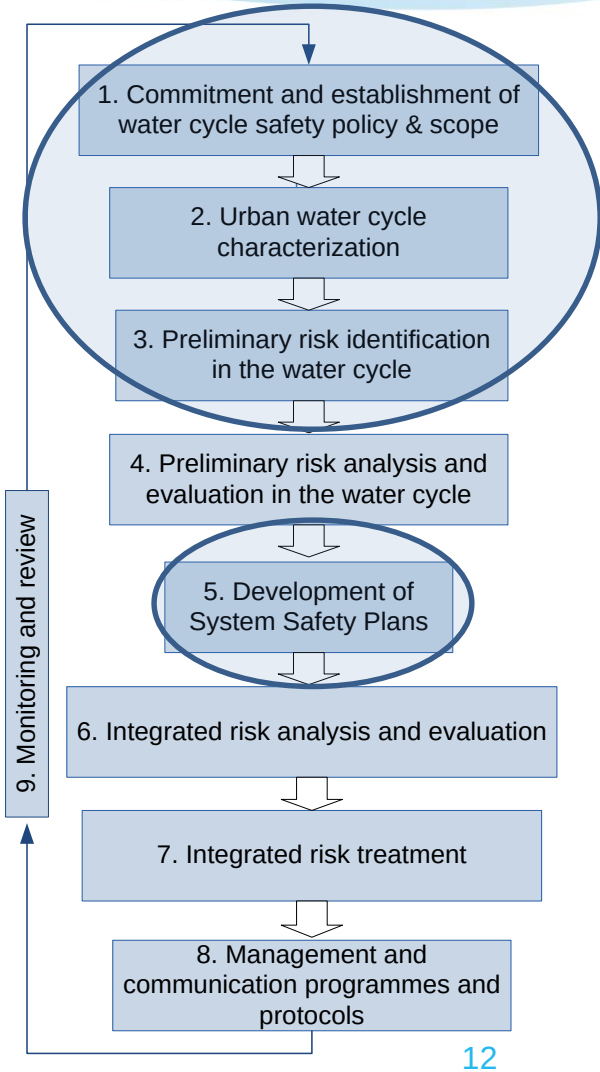


WCSP ▸ 2. Urban water cycle characterisation

- Identified water cycle components and interactions
  - Pilot area restricted to Alcântara valley (1/3 to ½ Lisbon)
  - Water cycle flow diagram under construction based on systems components
  - Common report with contributions of all core team members



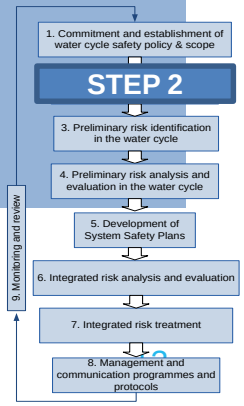
- Identification of criteria and targets for products and services being compiled
- Establishment of a GIS project as common working platform for georeferenced information



WCSP ▸ 2. Urban water cycle characterisation

Key action ▸ Identify criteria and targets for products and services

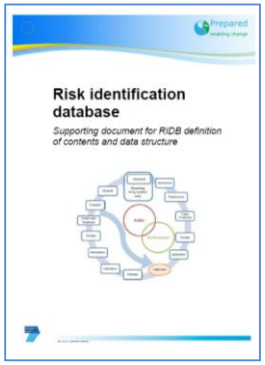
- WSP – drinking water as a product
- WCSP – products:
  - Drinking water
  - Non-drinking water
  - Water disposed at receiving water and soil
  - Reclaimed water
- WCSP – services:
  - Safeguarding public safety and health e.g. avoiding flooding or sewer collapses
  - Protecting receiving water bodies e.g. maintenance of conditions for recreational uses
- For each product or service:
  - Setting performance criteria, metrics and targets
  - Take into account regulatory standards

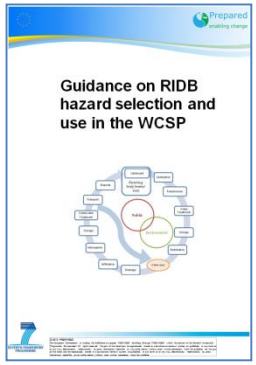


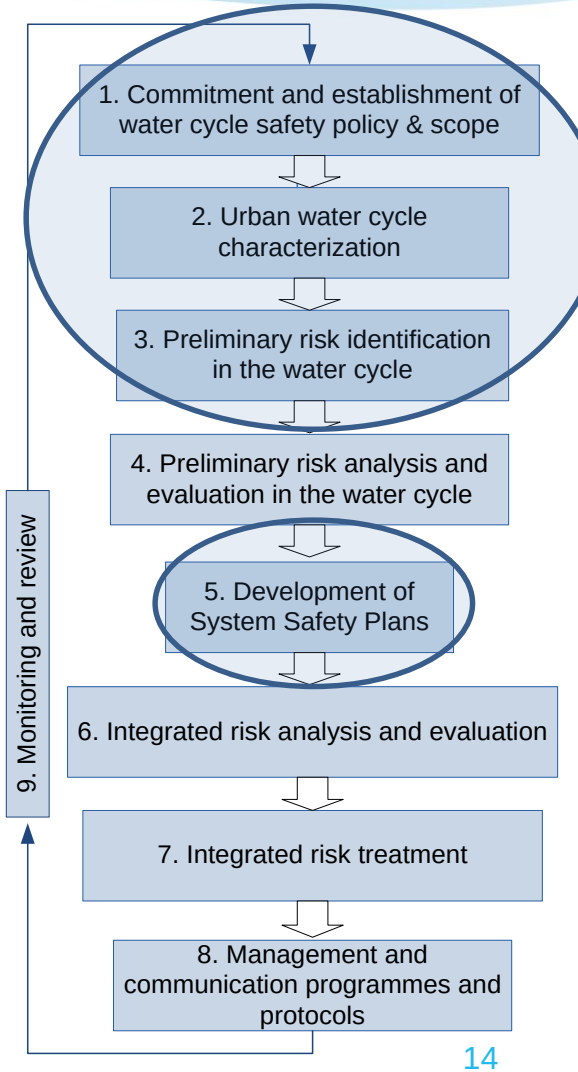
WCSP ▸ 3. Preliminary risk identification in the WC

Key actions:

- Identify relevant hazards, risk sources and risk factors (whole water cycle)
  - List of climate related hazards
  - Fault trees to assist in identification of risk sources, risk factors and events
- Description of potential events for selected scenarios (economic, CC)
  - Event characterization (including hazards, typical causes)
- Available tools:
  - Database checklist of risks (RIDB.xlsx)
  - Risk identification form to be completed for each case (RI_Form.xlsx)

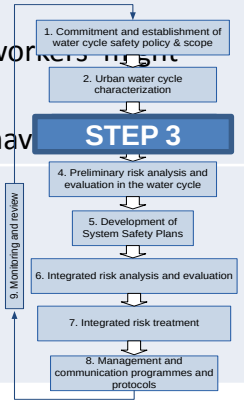






List of climate related hazards

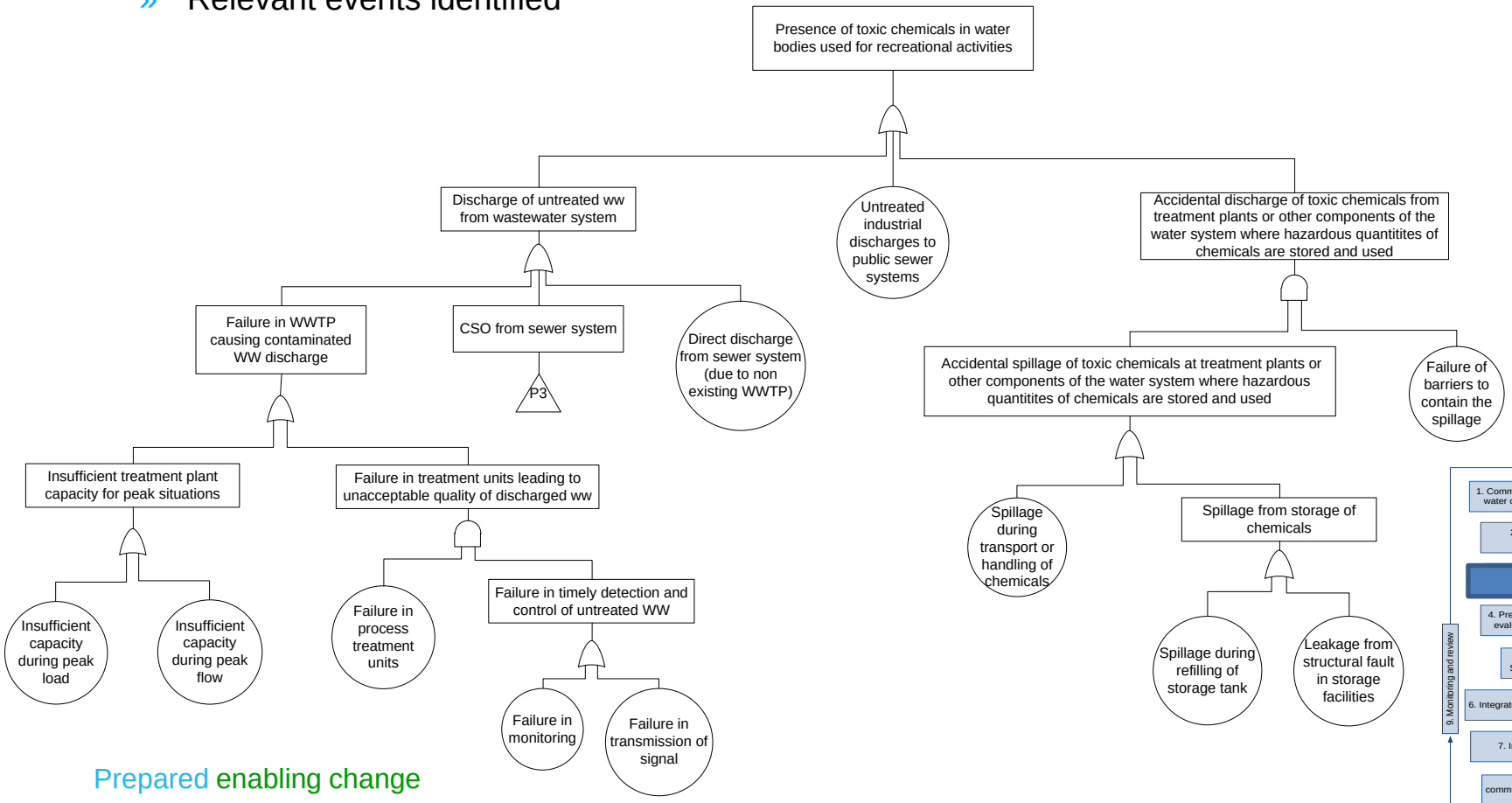
WCSP Primary aim	Exposure mode	Hazard (25 identified in total)
Protection of public health **(4 exposure modes)**	Tap water: consumption (ingestion)	▪ Presence of microbial pathogens in tap water ▪ Presence of cyanotoxins in tap water ▪ Presence of chemical contaminants in tap water ▪ Presence of radiological contaminants in tap water ▪ Extended periods without supply
	Recreational or non-recreational: immersion (accidental ingestion, inhalation, skin contact)	▪ Presence of microbial pathogens in water bodies used for recreational activities ▪ Presence of cyanobacteria and cyanotoxins in water bodies used for recreational activities ▪ Presence of microbial pathogens in flooding water ▪ Presence of toxic chemicals in water bodies used for recreational activities
Protection of public safety	Socio-economic activities: public areas or private properties (injuries)	▪ Water infrastructure collapses or bursts potentially causing injuries to public ▪ High velocity runoff in public streets ▪ High depth flooding in public areas or private properties ▪ Collapse of structures, urban equipment or trees due to effect of water ▪ Presence of toxic gases in the atmosphere of locations where public or workers might have access to ▪ Presence of toxic chemicals in locations where public or workers might hav
Protection of environment	Not detailed	▪ Discharge of organics in the water cycle or soil ▪ Discharge of nutrients (P/N) in the water cycle ▪ Discharge of heavy metals and other chemicals in the water cycle or soil ▪ Water scarcity affecting ecosystems

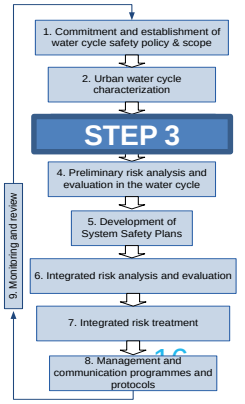


WCSP ▸ 3. Preliminary risk identification in the WC

For each hazard identified

- A fault tree was built
- Relevant events identified





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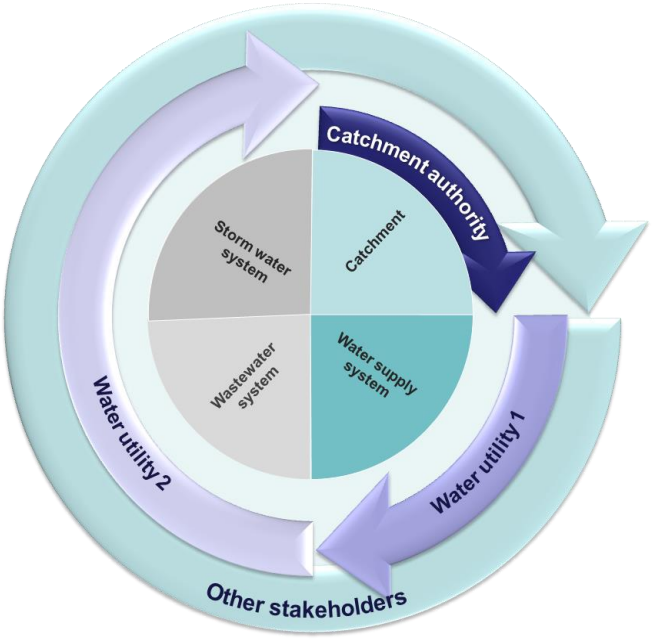
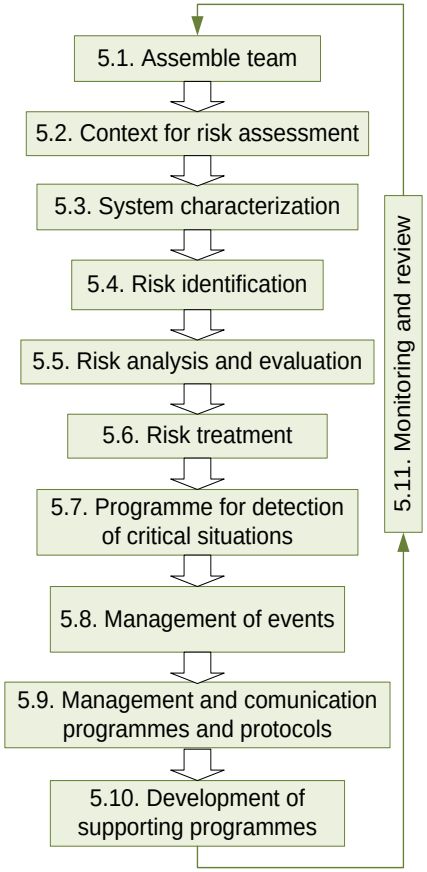
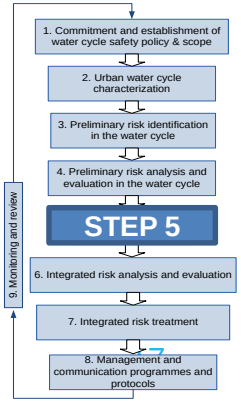
WCSP ▸ 5. Development of system safety plans (SSP)

- SSP EPAL
- SSP SIMTEJO





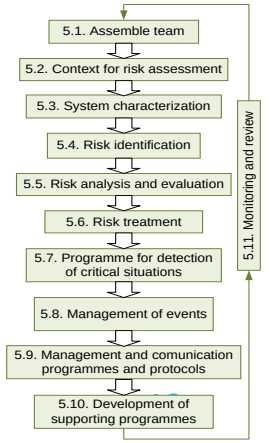


SSP EPAL ▶ Developments

EPAL SSP ▶ EPAL System level plan

- EPAL appointed a “Climate Change Team”, formed by 6 people to work in two Climate Change related projects:
  - Prepared – Enabling Change
  - Adaptaclima EPAL

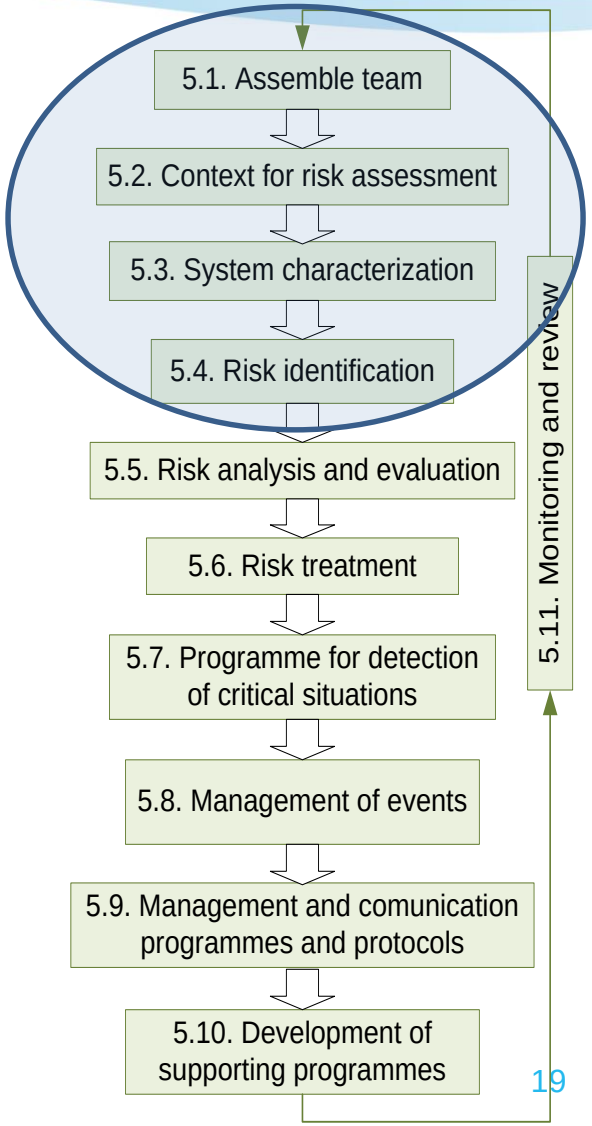
- The aim is to adapt the urban water cycle to climate change scenarios



SSP EPAL ▶ Developments

EPAL SSP ▶ EPAL System level plan

- EPAL is aware of the importance of having a water safety plan
  - **EPAL's WSP was completed in 2009**
  - A large number of hazards and risks are being addressed with different priority levels
- Climate change scenarios and its related risks encourage a new approach, taking into account the interconnections between climatic variables, water distribution and other urban water cycle utilities, aiming to protect:
  - Water supply with good quality and service continuity
  - Public health
  - People safety
  - Infrastructure integrity

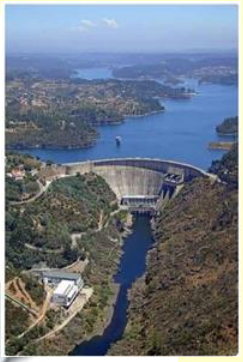


SSP EPAL ▶ Developments

EPAL has a diversified and complex System, with assets value over 800 M€, including:

- **2 Water Treatment Plants (WTP)**
- **777 km of Trunk Mains**
- **25 Chlorination Points**
- **41 Pumping Station**
- **42 Water Tanks**
- **1420 km of Distribution Mains**
- **13 Abstractions**

Castelo de Bode Dam



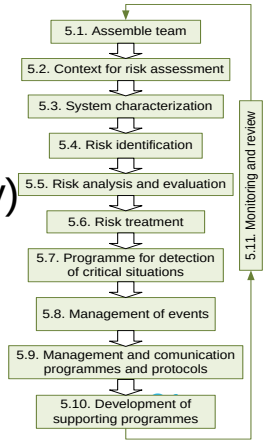
Asseiceira WTP

Tagus River Water Intake and Valada Tejo WTP

SSP EPAL ▶ Developments

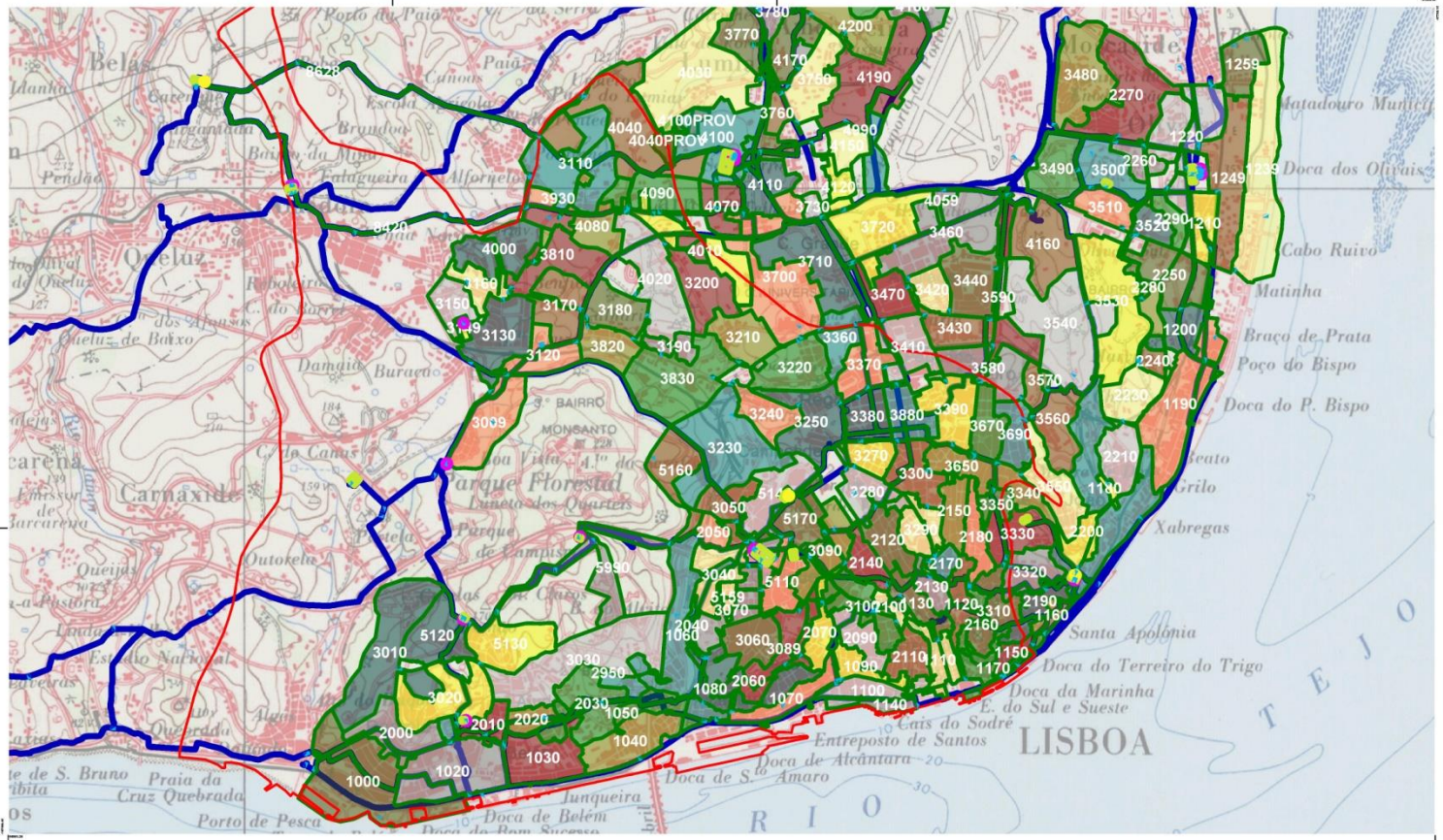
EPAL SSP ▶ EPAL System level plan

- EPAL provides drinking water to 2.6 million people (about ¼ of the Portuguese population) in **35** municipalities, including Lisbon
  - EPAL staff approximately 800 people
  - Assets with a net fixed value of more than 800 million €
- About 70 per cent of the supply comes from the Castelo do Bode Dam, owned by EDP (the Portuguese Company of Electricity).
  - Within this sub-system, water is treated at Asseiceira WTP (nominal capacity of 625,000 m^3/day)
  - Processes follow a scheme comprising mineralization coagulation/flocculation, flotation, oxidation (ozone), filtration and final disinfection (chlorine)
- The 2nd largest water source is the River Tagus
  - abstraction undertaken at Valada.
  - Water is pumped to Vale da Pedra WT (nominal capacity of 240,000 m^3/day)



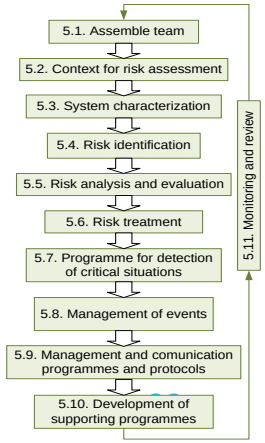
SSP EPAL ▶ Developments

Prepared enabling change



Alcântara Valley DMA's

Corresponding to the sewage and stormwater catchment (red line)



SSP EPAL ▶ Developments

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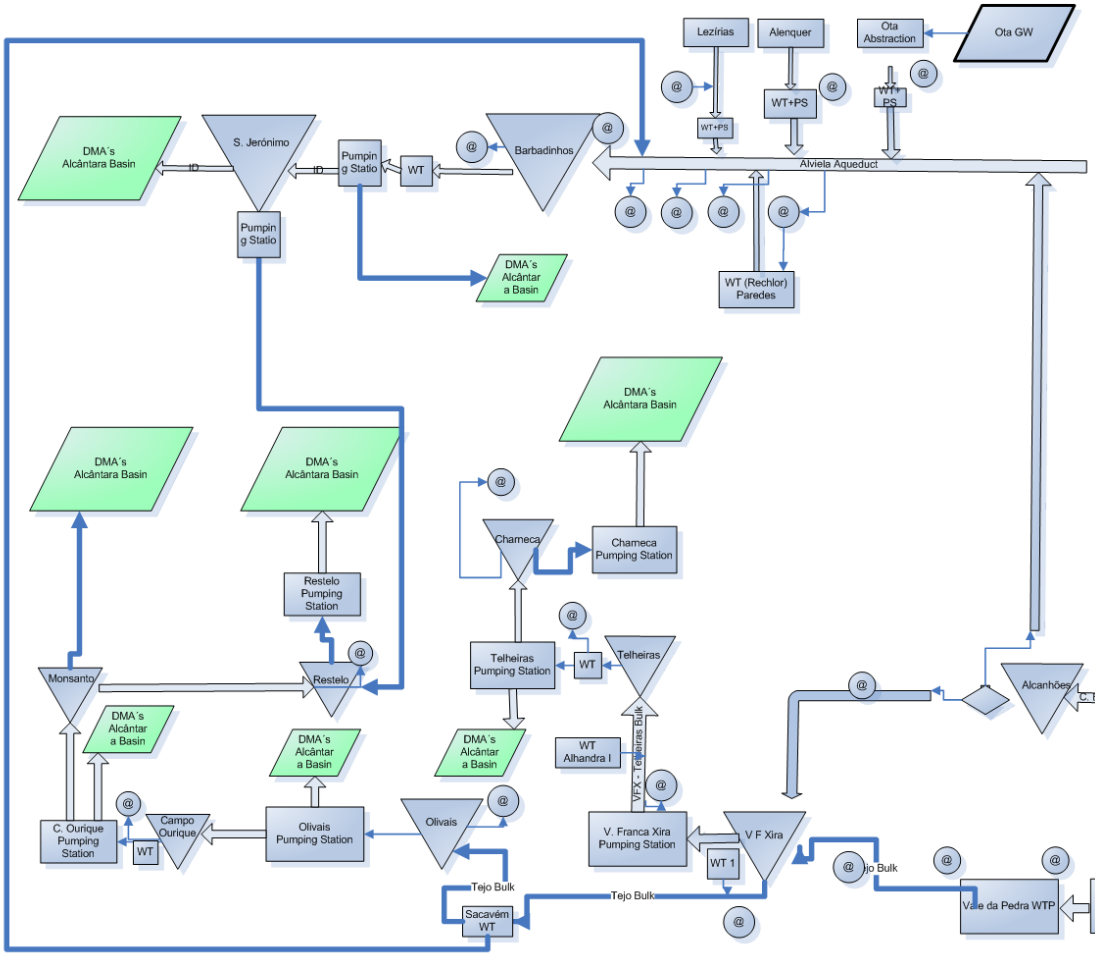
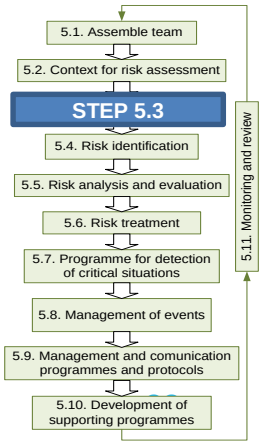
Water supply system to Alcântara Valley

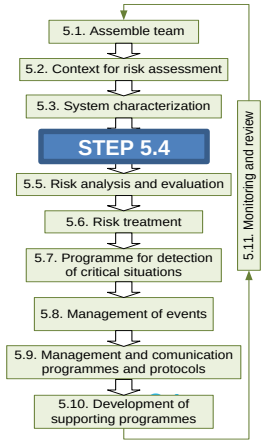




SSP EPAL ▶ Developments

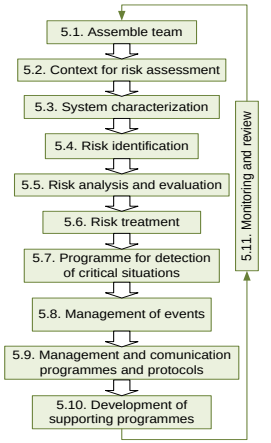
EPAL SSP ▶ EPAL System level plan

- Using the Risk Identification Database
  - EPAL is using the tool (RI Form) to:
    - Describe hazardous events, its consequence dimensions and CC relationships
    - Identify:
      - Risk sources, contributing causes, risk factors and measures to reduce the risk
  - This work sets the context to the next stage - Risk Reduction Database



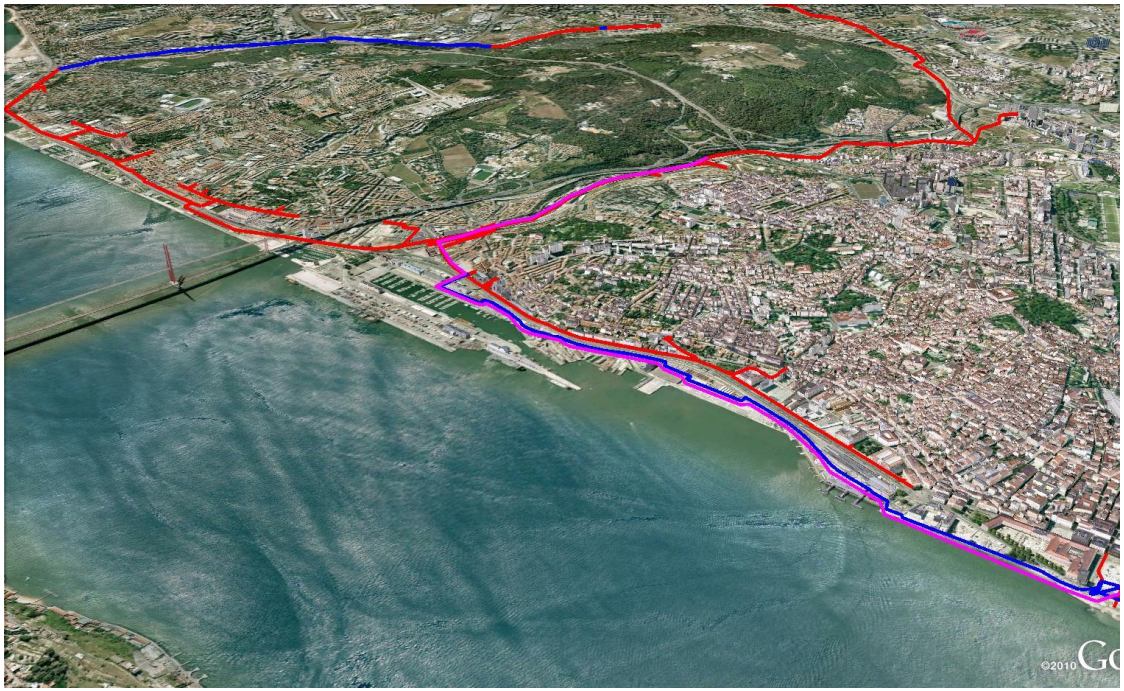
EPAL SSP ▶ Major opportunities, benefits and difficulties

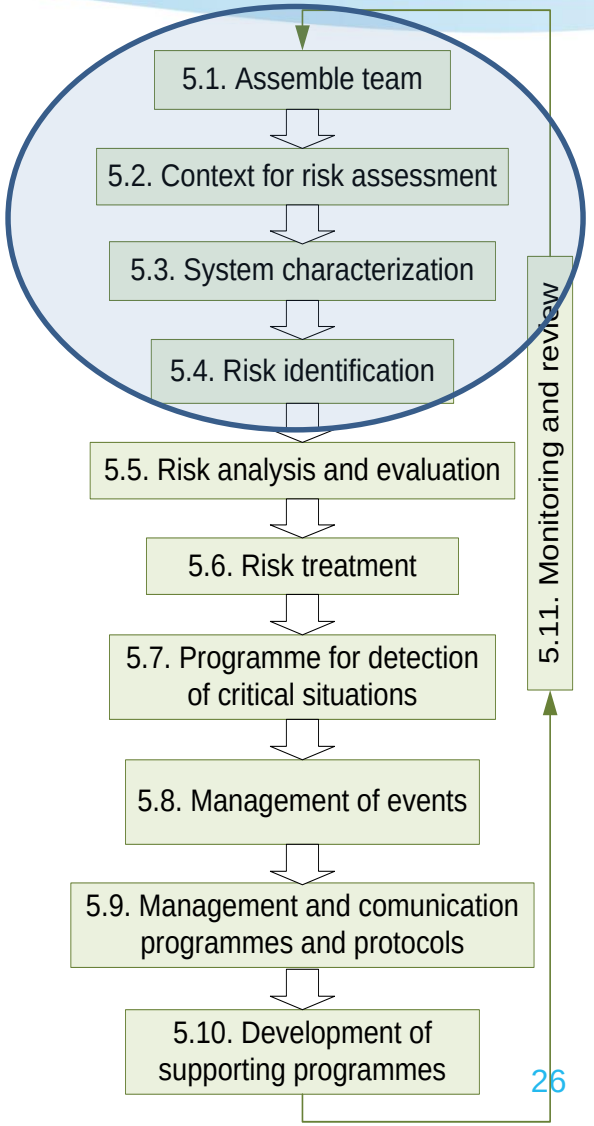
- This work is an opportunity for a new approach on EPAL WSP, with a new methodology for risk assessment
- It is also a learning opportunity
- An increasing awareness on climate change related risks, system's interconnections and needs for a specific adaptation policy
- An opportunity to meet other relevant stakeholders to discuss common issues
- Some difficulties arising from the need to use the new approach and software limitations for supporting development



SSP SIMTEJO ▶ Developments

SIMTEJO SSP ▶ WW System level plan

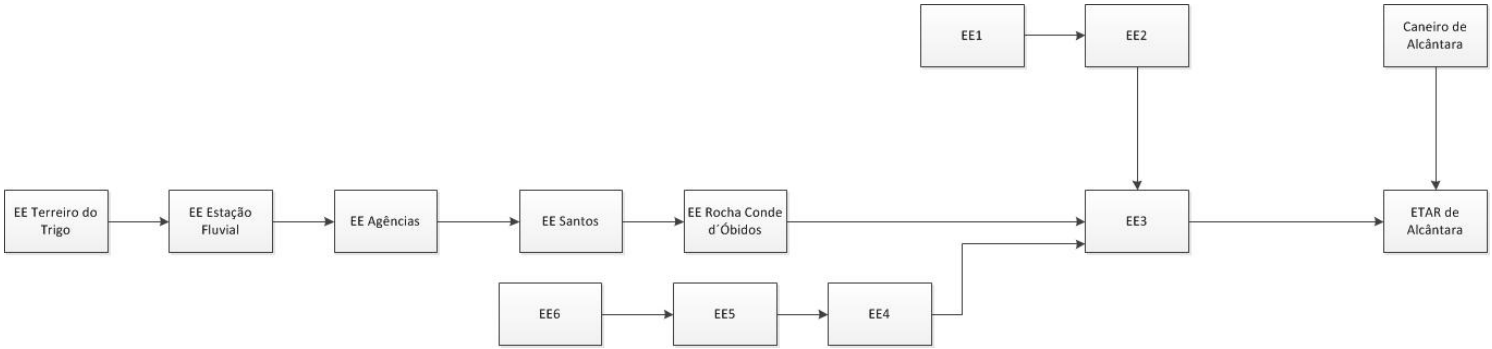


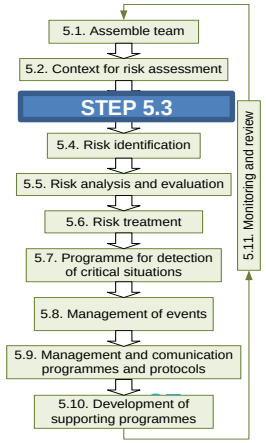


SSP SIMTEJO ▶ Developments

SIMTEJO SSP ▶ AdTA System level plan

- Biggest AdTA Subsystem (ca. 756.000 inhab.eq)
- Lisbon + Amadora + Oeiras Municipalities
- Secondary + disinfection treatment (3.3 m^3/s) + wet weather advanced primary treatment (3.3 m^3/s)
- 11 pumping stations + 26 km sewage network
- Treated flow: 130,000 -140,000 m^3/day (dry weather)

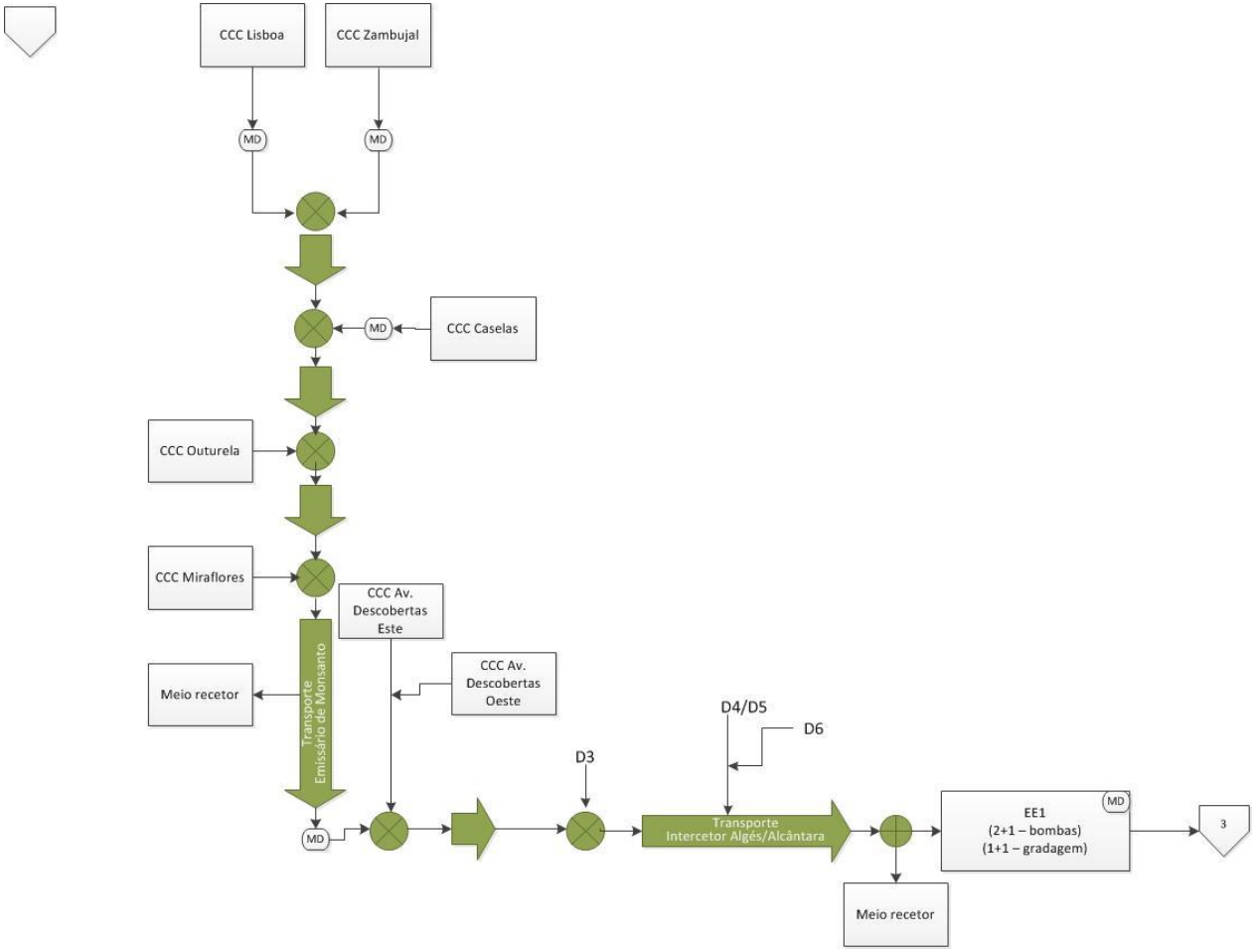


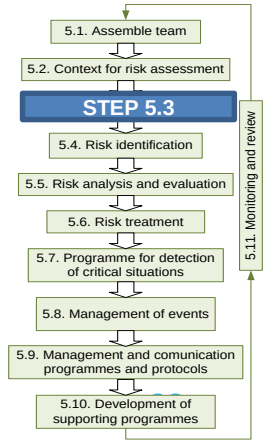


SSP SIMTEJO ▶ Developments

Prepared enabling change

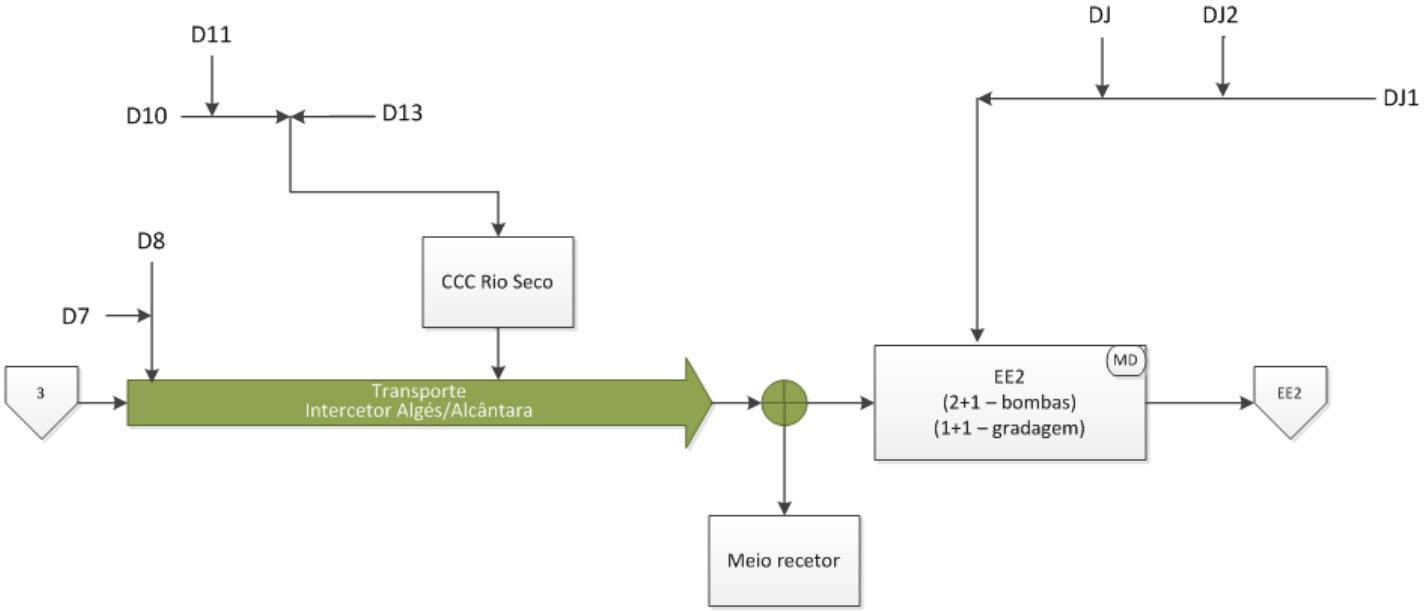
SIMTEJO SSP ▶ AdTA System level plan

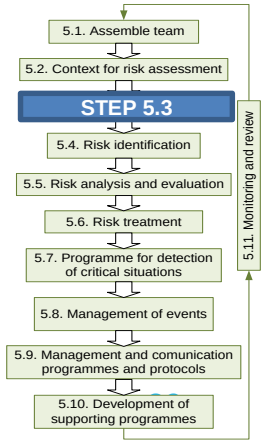




SSP SIMTEJO ▶ Developments

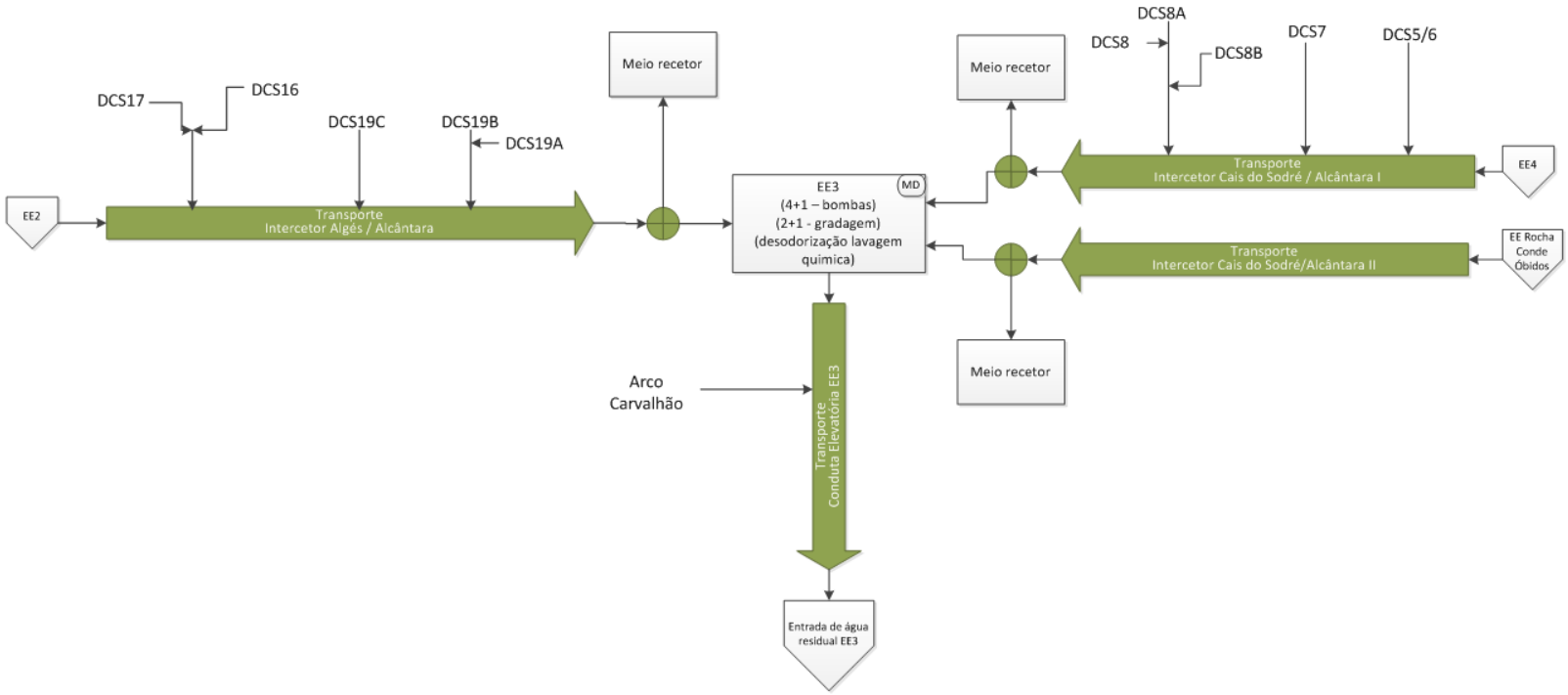
SIMTEJO SSP ▶ AdTA System level plan

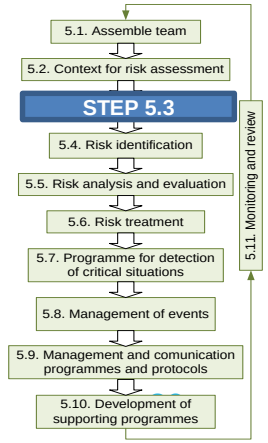




SSP SIMTEJO ▶ Developments

SIMTEJO SSP ▶ AdTA System level plan

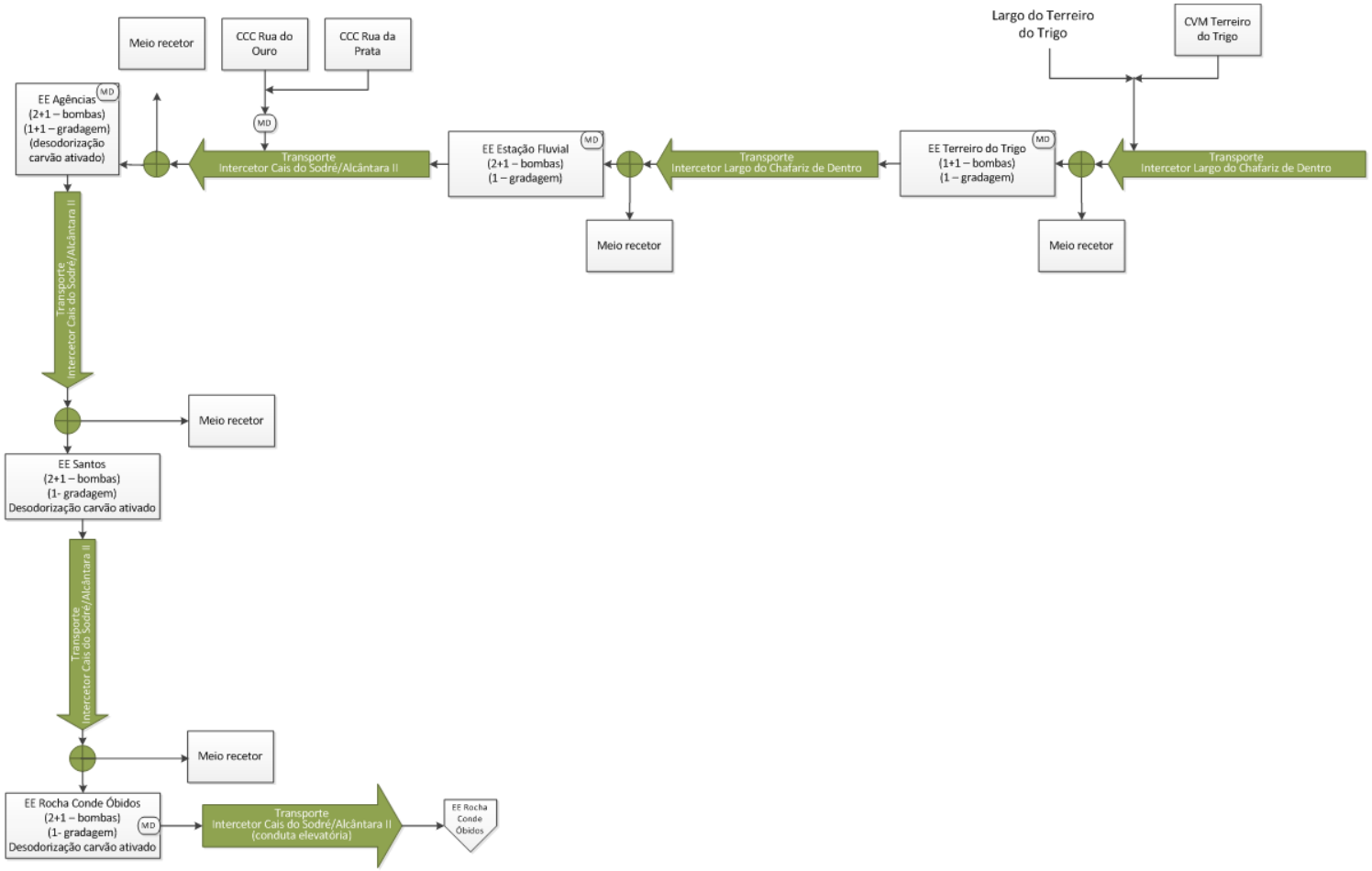


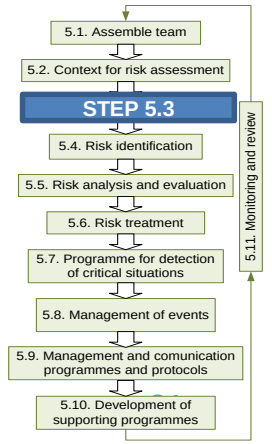


SSP SIMTEJO ▶ Developments

Prepared enabling change

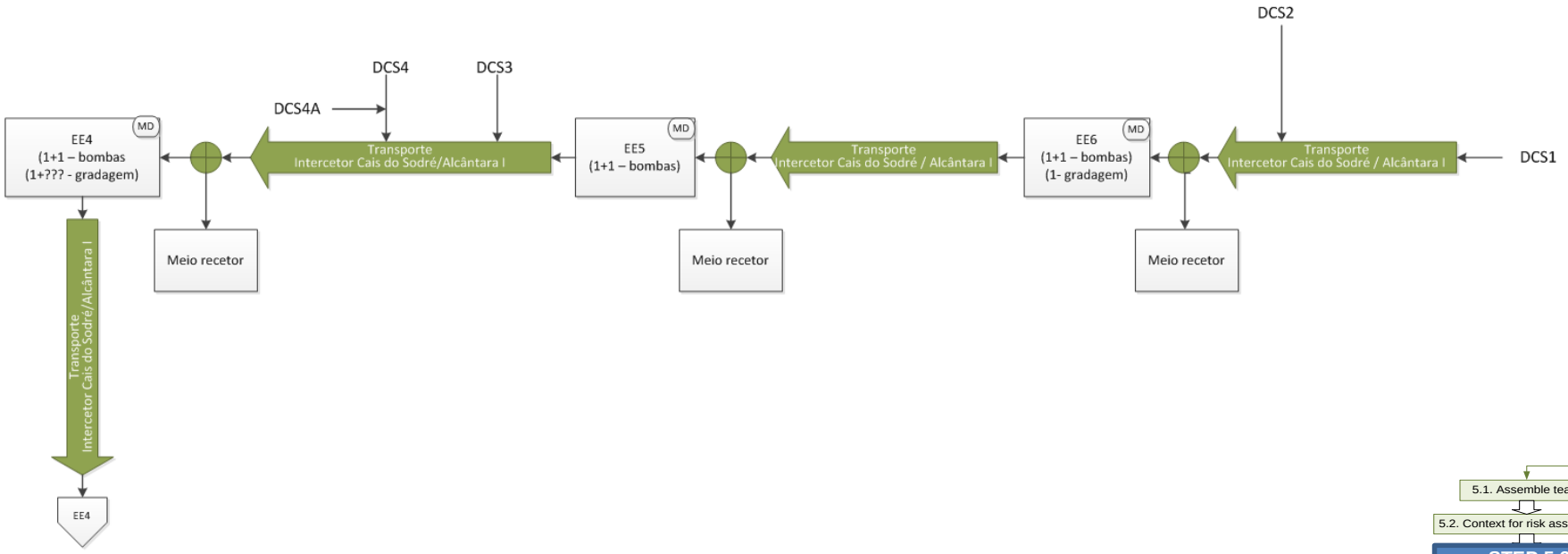
SIMTEJO SSP ▶ AdTA System level plan

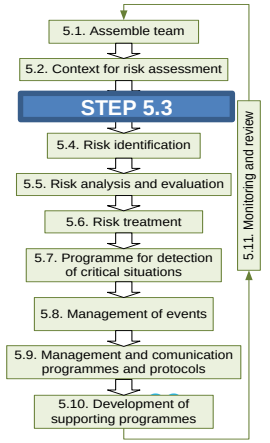




SSP SIMTEJO ▶ Developments

SIMTEJO SSP ▶ AdTA System level plan



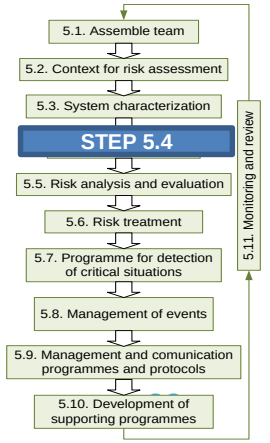


SSP SIMTEJO ▶ Developments

SIMTEJO SSP ▶ AdTA System level plan

- Sea level rise
- Rain profile
- Water shortage – treated water reuse

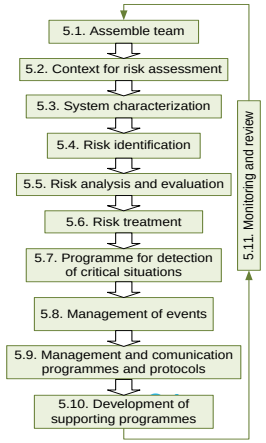
» Actual step SimTejo: Risk Identification Database



Prepared enabling change

AdTA SSP ▶ Major opportunities and benefits

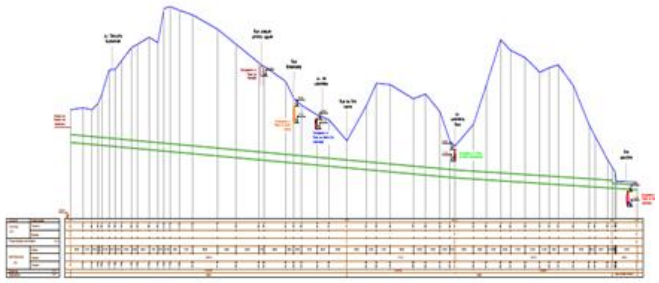
- New, integrated approach
- Scenarios testing with a common standard
- Think and think again...
- Development of a management tool
- Support of operation and investment options
- The methodology can later be used in other subsystems
- Participation of the overall entities involved (WCSP)



SSP SIMTEJO ▶ Developments

AdTA SSP ▶ Connection with Lisbon Municipality

» Flood control system (municipal) design in compliance with te WW system (inc. Alcântara) – under construction



Diameter: 6 m
Length: 5 km
T100
Diversion
Storage