PREPARED Risk identification and risk reduction databases

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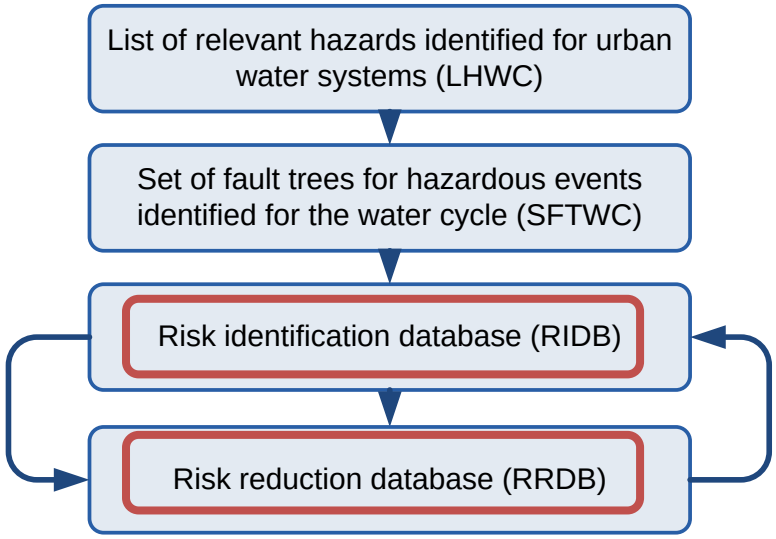
Contents

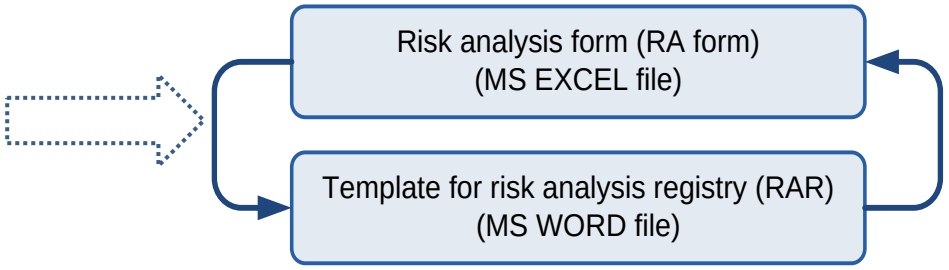
1 | Introduction

Application of WCSP framework can be facilitated by

- Setting general and common aspects in a systematic way
- Providing resources to guide and avoid repeated tasks
- PREPARED project tools and resources for WCSP

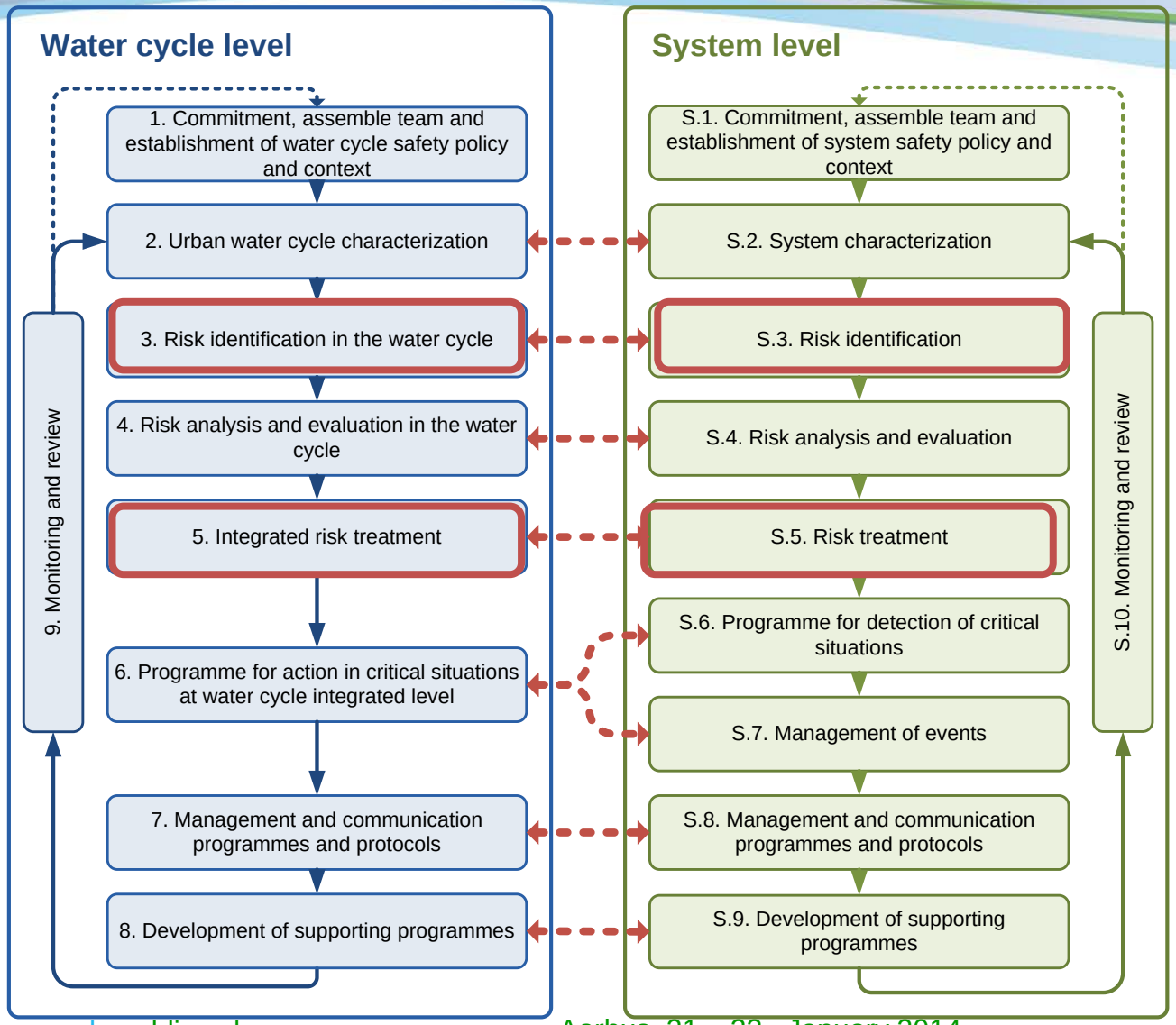


Tools developed to support the application of the WCSP framework



Form and template to support the application of the WCSP framework

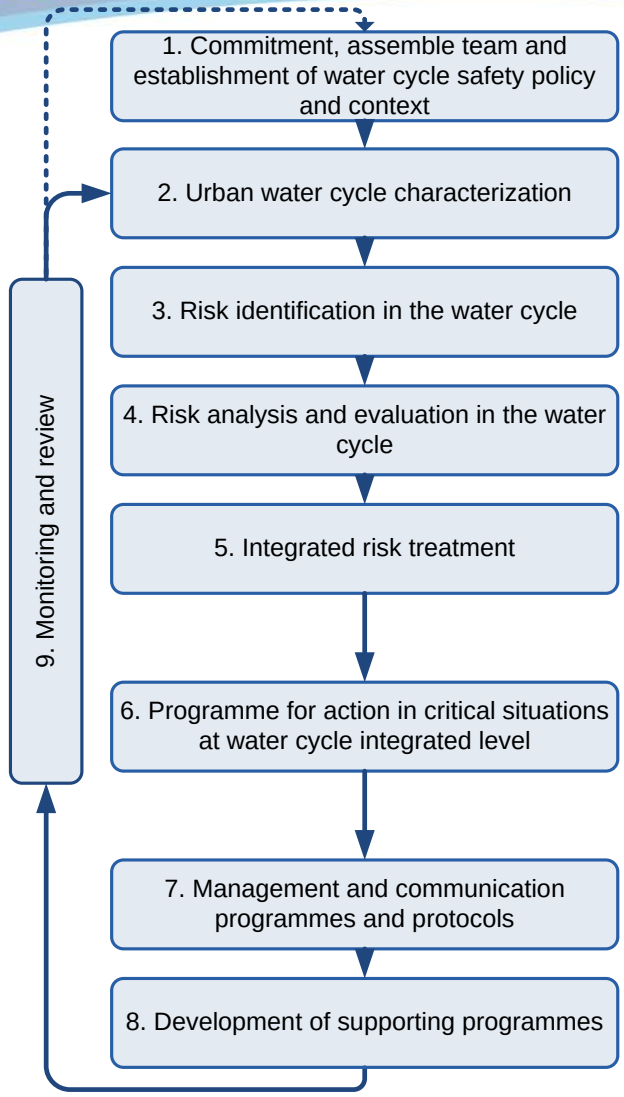
2 | Risk identification and risk reduction steps in WCSP



Legend

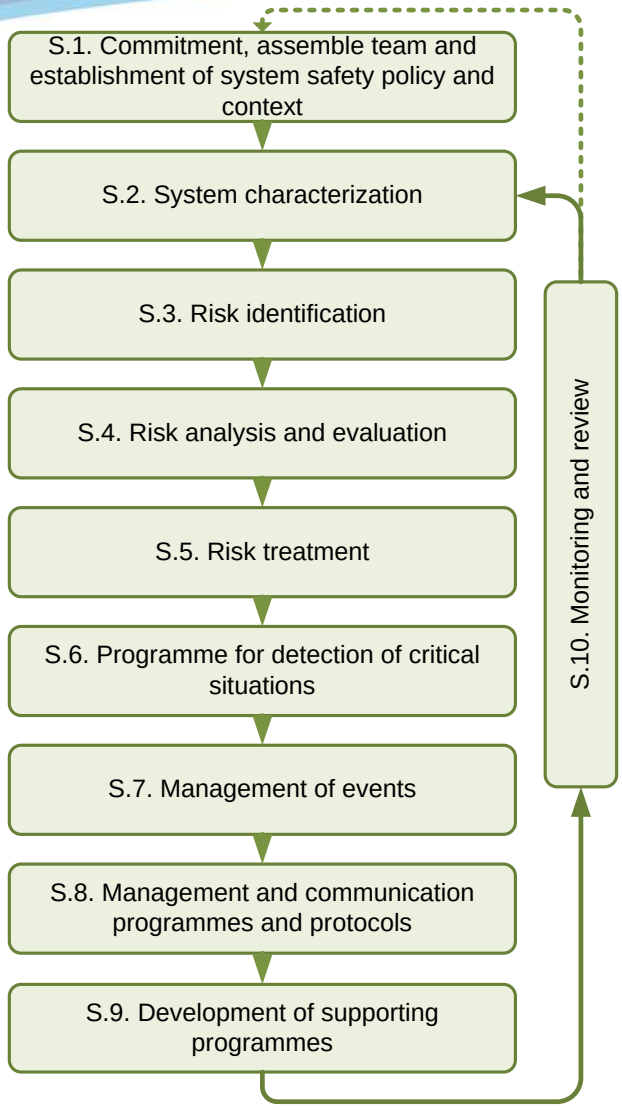
- Organisational loop
- Regular process loop
- Interaction between levels

2 | Risk identification and risk reduction steps in WCSP



Step	Key actions
1.	Identify stakeholders, assemble team and ensure commitment Establish the water cycle safety policy Establish the context
2.	Identify and describe water cycle components and interactions – Construct a water cycle flow diagram – Describe the urban water systems Identify criteria and targets for products and services
3.	**Identify relevant hazards, risk sources and risk factors** **Assess the potential effect of climate change trends** **Explore scenarios and potential events**
4.	Assess the likelihood and consequences for each event Estimate the level of risk for each event Evaluate risk for each event Compare and reassess estimated risks
5.	**Identify risk reduction measures** **Assess alternatives, prioritize and select risk reduction measures** **Assess residual risk** **Develop a risk treatment programme**

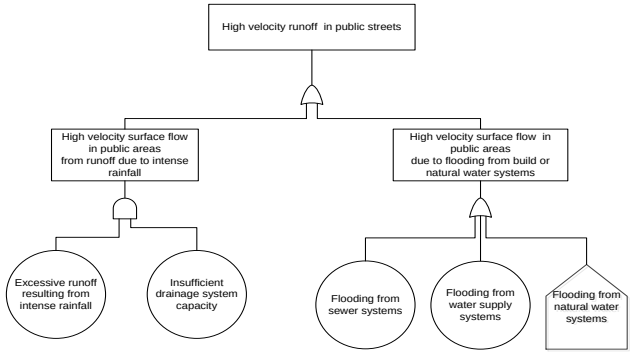
2 | Risk identification and risk reduction steps in WCSP



Step	Key actions
S.1.	▸ Identify necessary qualifications and expertise of team members and assemble team ▸ Establish the organisation safety policy ▸ **Secure management commitment and financial support** ▸ **Define roles and responsibilities of team members** ▸ Appoint a team coordinator ▸ Establish the context
S.2.	▸ **Identify and describe system components and interactions** – **Construct a system flow diagram** – **Describe the system and its subsystems** ▸ Identify criteria and targets for products and services
S.3.	▸ **Identify relevant hazards, risk sources and risk factors** ▸ **Assess potential effect of climate change trends** ▸ **Explore scenarios and potential events**
S.4.	▸ Assess the likelihood and consequences for each event ▸ Estimate the level of risk for each event ▸ Evaluate the risk for each event
S.5.	▸ Identify risk reduction measures ▸ Assess alternatives, prioritize and select risk reduction measures ▸ Assess residual risk ▸ Develop a risk treatment programme

Scope of the RIDB

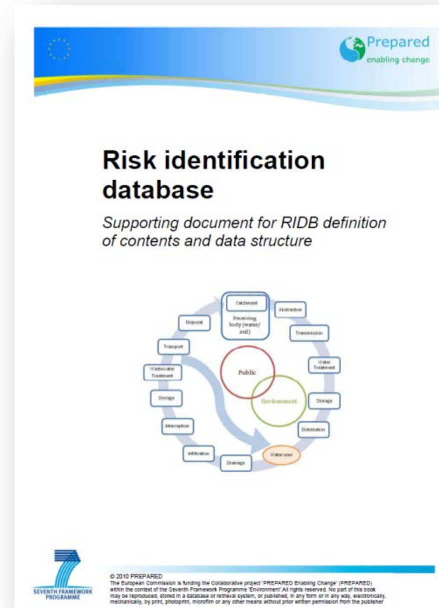
- Checklist to help the comprehensive identification of risks in each specific application (integrated or system level)
- Events listed in the database allow:
  - identification of relevant events by the users
  - starting risk identification in a systematic way
  - concentrate in application to local conditions and evaluation of areas where events are somehow likely to happen
- Database attributes allows identification of factors influencing the likelihood and consequences of event that can be relevant locally
- Set of fault trees facilitate the use of the RIDB



3 | Tool to support risk identification: the RIDB

RIDB

- The RIDB consists of five tables including
  - Event description
  - Risk sources
  - Contributing causes
  - Risk factors
  - Existing measures to reduce risk
- Around 100 events included
- Supporting document to explain the scope, structure and use of the RIDB in detail



EVENT CHARACTERISATION

Event ID	Description	Hazard	System/Subsystem where risk source occurs	System/Subsystem where exposure occurs	Consequence dimensions: Health and safety	Financial	Environmental impacts	Service continuity	Liability, compliance, reputation and image	Project development	Water cycle level: Relevance at w	System/Subsy
	Water supply system safety plan											
E0101	Presence of oxidant resistant microbial pathogens in tap water due to release of microorganisms from biofilms in the distribution systems, causing health problems to consumers	Presence of microbial pathogens in tap water	x.2.9. Distribution	x.2.10. Plumbing systems	R	R	NR	R	R	NR	-1	n.s.
E0102	Presence of oxidant resistant microbial pathogens in tap water due to growth of microorganisms in the water in distribution systems due to high temperature, causing health problems to consumers	Presence of microbial pathogens in tap water	x.2.9. Distribution	x.2.10. Plumbing systems	R	R	NR	R	R	NR	-1	n.s.
E0103	Presence of oxidant resistant microbial pathogens in tap water due to release of microorganisms from biofilms in storage tanks, causing health problems to consumers	Presence of microbial pathogens in tap water	x.2.8. Storage	x.2.10. Plumbing systems	R	R	NR	R	R	NR	-1	n.s.
E0104	Presence of oxidant resistant microbial pathogens in tap water due to growth of microorganisms in the water in storage tanks due to high temperature, causing health problems to consumers	Presence of microbial pathogens in tap water	x.2.8. Storage	x.2.10. Plumbing systems	R	R	NR	R	R	NR	-1	n.s.

CLIMATE CHANGES — CC indicators

Event ID	Increase of air P	C	Increase of temperature P	C	Increase of precipitation P	C	Decrease of P	C	Increase frequency P	C	Increase of winter P	C	Decrease of summer precipitation P	C	Changes of P	C	Increase of winter P	C
E0101	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E0102	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E0103	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E0104	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

CLIMATE CHANGES — CC direct effects and climatic region

Event ID	Increase of water P	C	Increase of sea P	C	Sea-level rise P	C	Increase of river flow P	C	Decrease of river P	C	Changes in river flow P	C	Decrease of Arctic P	C	Decrease of snow P	C	Mediterranean 1	Atlantic 2	Continental 3	climate 4	Fault tree
E0101	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
E0102	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
E0103	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
E0104	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1

3 | Tool to support risk identification: the RIDB

Structure of the RIDB: Attributes

Group	Attribute	Description
Event description	Event ID	Unique identification reference for the event
	Description	Description of the event in a structured and concise way with what occurs in the event
	Hazard	Hazard associated with the event as in a predefined list
	System/Subsystem where risk source occurs	Upper boundary of the event considering the systems and subsystems of the water cycle
	System/Subsystem where exposure occurs	Location where exposure of people or environment occurs within the event considering the systems and subsystems of the water cycle
	Consequence dimensions	Type of consequences expected from the event
	Climate change indicators	Climate change indicator and indication of the impact in the event using pre defined scale
	Climate change effects	Climate change effect and indication of the impact in the event using pre defined scale
	Climatic region	Regions where CC effects are expected

3 | Tool to support risk identification: the RIDB

Structure of the RIDB: Attributes

Group	Attribute	Description
Risk sources	Event ID	Unique identification reference for the event
	Risk source main category	Main risk source category for the event (predefined)
	Risk source secondary category	Secondary risk source category for the event (predefined)
	Risk source description	Specification of the risk source
Contributing causes	Event ID	Unique identification reference for the event
	Contributing cause main category	Main category of contributing cause (predefined)
	Contributing cause second category	Secondary contributing cause category (predefined)
	Contributing cause description	Specification of the contributing cause
Risk factors	Event ID	Unique identification reference for the event
	Risk factors	Risk factors typically associated with the event (predefined)
Existing measures to reduce risk	Event ID	Unique identification reference for the event
	Measure ID	Measures typically already in place, relevant for event risk level. Set of measures applying for each event, measure ID as in RRM Catalogue
	Measure descriptiom	Description as in RRM Catalogue

Relation with RRDB

3 | Tool to support risk identification: the RIDB

Prepared enabling change

Predefinition of attributes

- Normalization of approaches
  - Similar problems, aims and objectives of water utilities
  - Facilitates benchmarking
  - Easier to implement tools
- Example of hazards

Primary aim of WCSP	Exposure mode	Hazards
1. Protection of public health	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
	Tap water: personal hygiene and other uses (accidental ingestion, inhalation, skin contact)	▪ Presence of microbial pathogens in tap water ▪ Presence of cyanotoxins in tap water ▪ Presence of radiological contaminants in tap water
	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 flood water ▪ Presence of toxic chemicals in water bodies used for recreational activities
	Recreational or non-recreational: non-immersion	▪ Presence of microbial pathogens in water bodies used for recreational activities ▪ Presence of microbial pathogens in flood water ▪ Presence of microbial pathogens in water used for irrigation ▪ 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 have access to
2. Public safety	Socio-economic activities: public areas or private properties (injuries)	▪ Infrastructure collapses or bursts potentially causing injuries to public ▪ High velocity runoff in public streets
3. 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 ▪ Contamination of ground water by salt water intrusion ▪ Water scarcity affecting ecosystems

3 | Tool to support risk identification: the RIDB

Predefinition of attributes

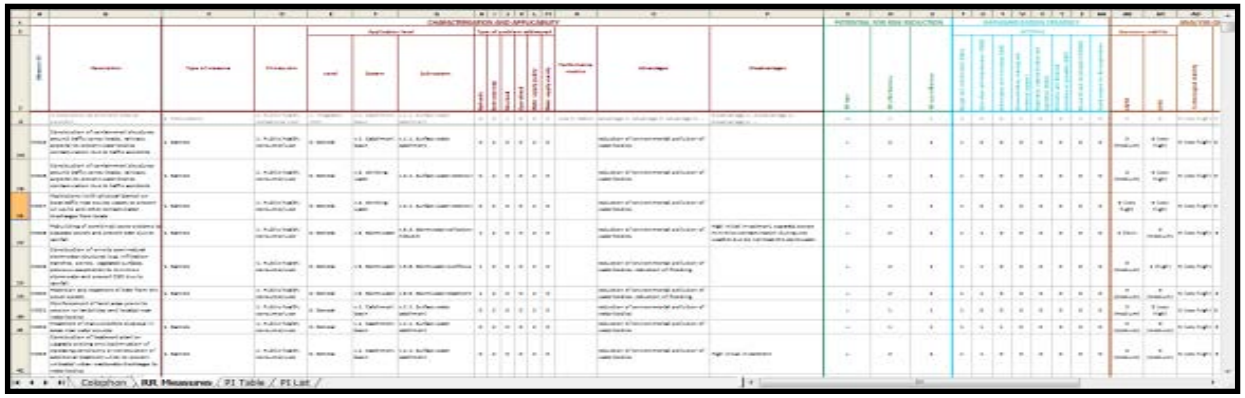
- Normalization of approaches
  - Similar problems, aims and objectives of water utilities
  - Facilitates benchmarking
  - Easier to implement tools
- Example of risk factors

Category	Risk factor
Human factors	Human reliability
	Exposure time
	Physical vulnerability
	Social vulnerability
	Behavioural factors
	…
Environmental factors	Temperature
	Precipitation intensity
	Wind intensity
	Contaminant concentration
	Nutrient concentration
	Receiving water level
	…
Equipment or infrastructure factors	Infrastructure condition
	Equipment malfunction (measurement and control)
	Equipment design
	Equipment safety features
	Infrastructure design, construction and operation
	Lack of detection systems
	Existing barriers
	Equipment failure
	Component location
	Power supply reliability
	…

4 | Tool to support risk treatment: RRDB

Scope of the RRDB

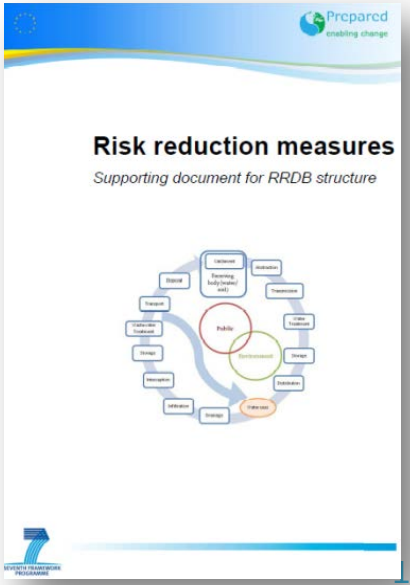
- Tool to support the risk treatment at integrated and at system level within the WCSP
- Identification and selection of appropriate risk reduction measures (RRM)
- Gives a first idea of potential for risk reduction



4 | Tool to support risk treatment: RRDB

RRDB

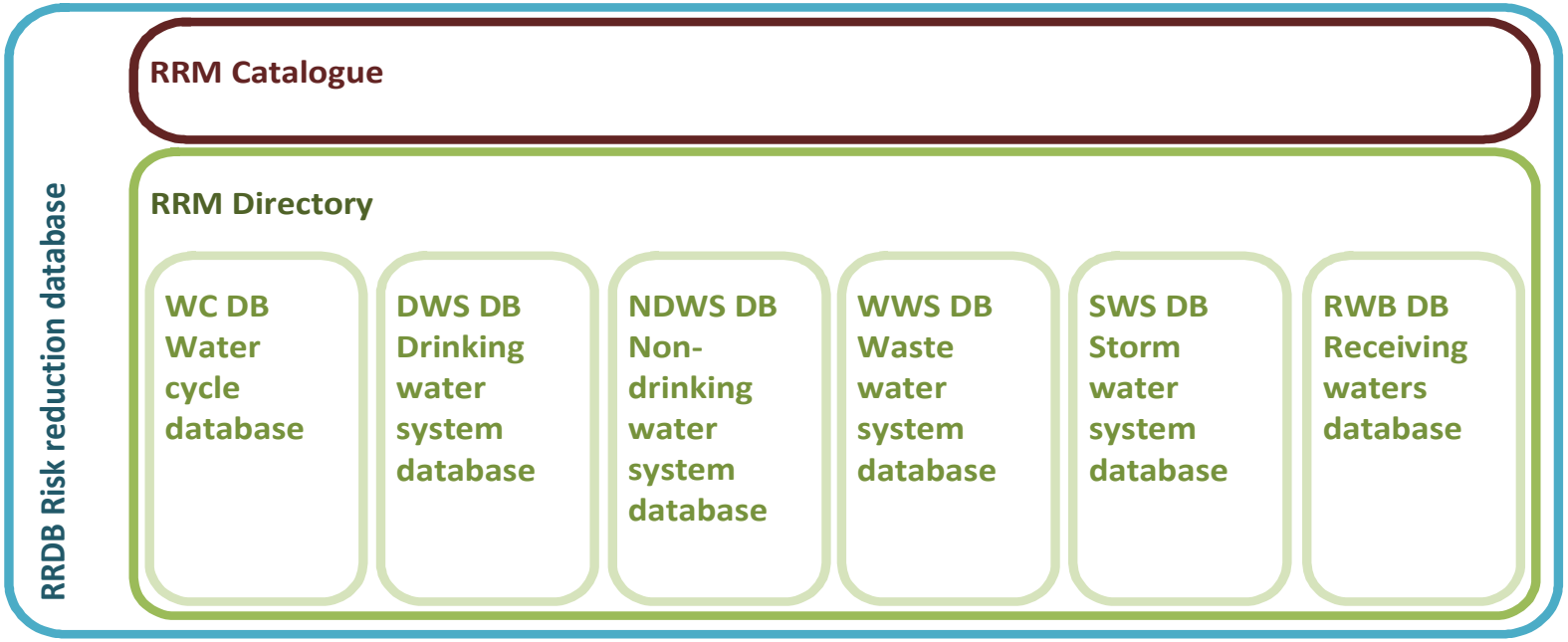
- The RRDB consists of different excel sheets which are all ready available
- Around 180 measures included
- Supporting document to explain the scope, structure and use of the RRDB in detail available



4 | Tool to support risk treatment: RRDB

Structure of the RRDB

- RRM catalogue: comprehensive list of measures
- RRM directory: consists of six sub-databases with condensed sets of measures for the integrated level and the 5 water systems



4 | Tool to support risk treatment: RRDB

Content of the RRM catalogue

- RRM catalogue includes 4 groups of attributes to give information about each **measure**
- Those parts are:
  1. Characterization and applicability
  2. Potential for risk reduction
  3. Implementation strategy
  4. Analysis of viability

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF
1		CHARACTERISATION AND APPLICABILITY														POTENTIAL FOR RISK REDUCTION			IMPLEMENTATION STRATEGY								ANALYSIS OF VIABILITY					
2				Application level			Type of problem addressed												ACTIONS								Economic viability					
3	Measure ID	Description	Type of measure	Level	System	Sub-system	Hydraulic	Environmental	Structural	Operational	Water supply quality	Water supply scarcity	Performance metrics	Advantages	Disadvantages	RR type	RR effectiveness	RR cost efficiency	Design and construction (D&C)	Operation and maintenance (O&M)	Information and education (I&E)	Documentation, training and technical support	Regulation, standardisation and legislation (RS&L)	Economic and financial incentives or penalties (E&I)	Research and development (R&D)	Social support to the populations	CAPEX	OPEX	Technological viability	Functional viability	Environmental viability	Social acceptance

Content of the RRM catalogue: attributes of RRM table

Group	Attribute	Description
Characterisation and applicability	Measure ID	Unique identification reference for the measure
	Description	Summary description of the measure
	Type of measure	Type of measure to reduce risk
	Primary aims	Contribution to primary aims of WCSP
	Application level	Subdivided: level of analysis, system and subsystem when applicable
	Technical problem	Type of technical problem addressed (six possibilities can apply)
	Performance metrics	Indicators or indexes for performance assessment (detailed in PI table)
	Advantages	Main advantages
	Disadvantages	Main disadvantages
Potential for risk reduction	RRM type	Type of risk reduction potentially achieved with the measure
	RR effectiveness	Risk reduction effectiveness
	RR cost efficiency	Overall risk reduction cost efficiency
Implementation strategy	Actions	Actions to consider for implementation of measure (six types of actions)
Analysis of viability	Economic viability	Relative magnitude of CAPEX and OPEX
	Technologic viability	Availability of technology
	Functional viability	Added requirements in operation and maintenance, ease of use
	Environmental viability	Balance between environmental benefits and negative impacts
	Social acceptance	Evaluation of expected social acceptance

4 | Tool to support risk treatment: RRDB

Content of the RRM directories

- 6 RRM directories relate the possible events (from RIDB) with the set of measures that can be considered for risk treatment step.
- Each directory is divided per subsystems having 2 sheets per subsystem:

1. RRM for each event

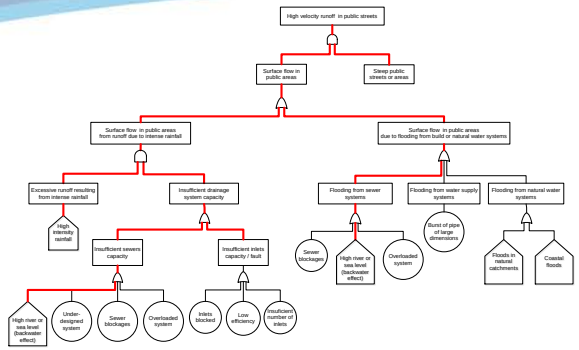
Attribute	Description
Object of analysis	Indication, as appropriate, of system, subsystem or component
Event ID	Event identification number as in RIDB
Event description	Event description as in RIDB
Measure ID	Measure ID as in RRM Catalogue
Measure description	Measure description as in RRM Catalogue
Typical priority	Implementation priority for the measure applied to that event in a typical situation
Potential reduction in consequence dimensions	Typical reduction in consequences associated with the event expected when implementing this measure. Expression in the dimensions of health and safety, financial, environmental impacts, functional, service and business continuity, reputation and image or project development.

Example: Wastewater subsystems

Wastewater system DB	Wastewater collection network
	Interceptor system
	Wastewater treatment
	Combined sewer overflows
	Pumping stations
	Storage structures
	Infiltration systems
	Outfalls

2. Recommended action for each event

5 | Examples



From RIDB: Event description

Event ID	Detailed description	Hazard	System/Subsystem where risk source occurs	Component where risk source occurs	System/Subsystem where exposure occurs	Consequence dimensions						CC indicators																								CC direct effects																							
						Health and safety	Financial	Environmental impacts	Service continuity	Liability, compliance,	Project developmen	Increase of air		Increase of		Increase of		Decrease of		Increase frequenc		Increase of winter		precipita		Decrease of		Changes of		Increase of winter		storms		Increase of water		Increase of sea		Sea-level rise		Increase of river		Decrease of river		Changes in river		Decrease of Arctic		Decrease of snow,	
												P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C
E1305.06	High depth flooding in public areas or private properties in **Alcântara (Docas, R. Fradesso da Silveira, R. Cozinha Económica, R. Vieira da Silva, R. 1 de Maio)** due to intense rainfall (RP = 100 years) and to insufficient sewers capacity resulting from insufficient inlets capacity/fault, causing injuries to public, damages to property, disturbances in services and activities	High depth flooding in public areas or private properties	Alcântara catchment	combined/storm sewers	Public areas	R	R	NR	R	R	R	0	0	0	0	-2	-2	2	2	-2	-2	-2	-2	0	0	-1	-1	-2	-2	0	0	0	0	-1	-1	-1	-1	1	1	0	0	0	0	0	0
E1703.00	Discharge of organics in the water cycle or soil due to discharge of untreated WW from wastewater system caused by failure in **Alcântara WWTP** for Insufficient treatment plant capacity during peak flow causing damages to the environment	Discharge of organics in the water cycle	Alcântara WWTP	Alcântara WWTP	Tagus estuary	R	NR	R	R	R		0	0	0	0	-2	-2	2	2	-2	-2	-2	-2	1	1	-1	-1	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E1707.00	Discharge of organics in the water cycle due to discharge of untreated WW due to failure in Alcântara WWTP caused by flooding in the plant Discharge of organics in the water cycle due to contaminated untreated CSO	Discharge of organics in the water cycle	Alcântara WWTP	Alcântara WWTP	Tagus estuary	R	NR	R	R	R		0	0	0	0	-2	-2	2	2	-2	-2	-2	-2	1	1	-1	-1	-2	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

5 | Examples

From RIDB: RRM

Event ID	Measure ID	Measure short description	Measure description	Actions	Measure status
E1703.00	M030	Construction of wastewater treatment plant or upgrade existing one (optimization of operating conditions or construction of additional treatment units) to prevent untreated urban wastewater discharges to water bodies		Plant with wet weather treatment line (2x Dry Weather peak flow)	Implemented
E1703.00	M155	Treatment of CSO, including physico-chemical processes (e.g. conventional tanks allowing settling of solids, vortex separators, screens) and hydraulic performance		Advanced primary treatment line for excess water during rainfall	Implemented
E1703.00	M156	Real time control system to improved regulation and usage of available system capacities (storage, transport and treatment)			Implemented
E1703.00	M133	Construction of green roofs			Implemented
E1703.00	M137	Inline/offline storage within the drainage network, such as oversized pipes, deep shafts, attenuation tanks, geocellular systems			Not planned

5 | Examples

From RIDB: Risk sources, contributing causes, risk factors

Event ID	Risk source main category	Risk source second category (when applicable)	Risk source description
E1706.00	External	Occurrence of abnormal metereologic phenomena	High intensity rainfall
E1705.05	External	Occurrence of abnormal metereologic phenomena	High intensity rainfall
E1705.06	External	Occurrence of abnormal metereologic phenomena	High intensity rainfall
E1705.11	External	Occurrence of abnormal metereologic phenomena	High intensity rainfall
E1705.12	External	Occurrence of abnormal metereologic phenomena	High intensity rainfall

Event ID	Contributing cause main category	Contributing cause second category	Contributing cause description
E1707.00	Operation and maintenance related	Failure in wastewater treatment plant	Failure due to excessive flow (over plant capacity)
E1707.00	Operation and maintenance related	Equipment failure	Plant mechanical overload
E1707.00	System components degradation related	Sediments deposit	Excessive debris transport due to rain
E1707.00	Related with water systems functional problems	Flooding from combined sewer systems	Combined sewer systems
E1706.00	Design related	Other design related causes	Failure due to excessive flow (over plant capacity)
E1706.00	Operation and maintenance related	Inappropriate procedures or methods of cleaning	Potential insufficient debris cleanning
E1706.00	Operation and maintenance related	Inappropriate valve manoeuvre	Potential valve failure due to excessive manouvres
E1706.00	Operation and maintenance related	Failure in wastewater treatment plant	Failure due to excessive flow (over plant capacity)

Event ID	Risk factor	Risk factor description
E0506	Human physical vulnerability	Sensitive consumers
E0506	Precipitation intensity	Decrease of precipitation/drought
E0507	Human physical vulnerability	Sensitive consumers
E0507	Human physical vulnerability	High intensity precipitation

6 | Final remarks

- Both databases were developed, tested and complemented in PREPARED, during demonstration activities of the WCSP framework
- In both cases, a form or registry should be used for each specific case, to record the application to the situation under analysis.
- The databases are compatible in terms of contents and structure.
- To complement the databases, guidance documents for application of the risk identification and risk treatment steps and supporting documents for use of the databases are also results from the PREPARED project
- Acknowledgements are due to all demo participants for the collaboration in the testing and complement of the databases

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