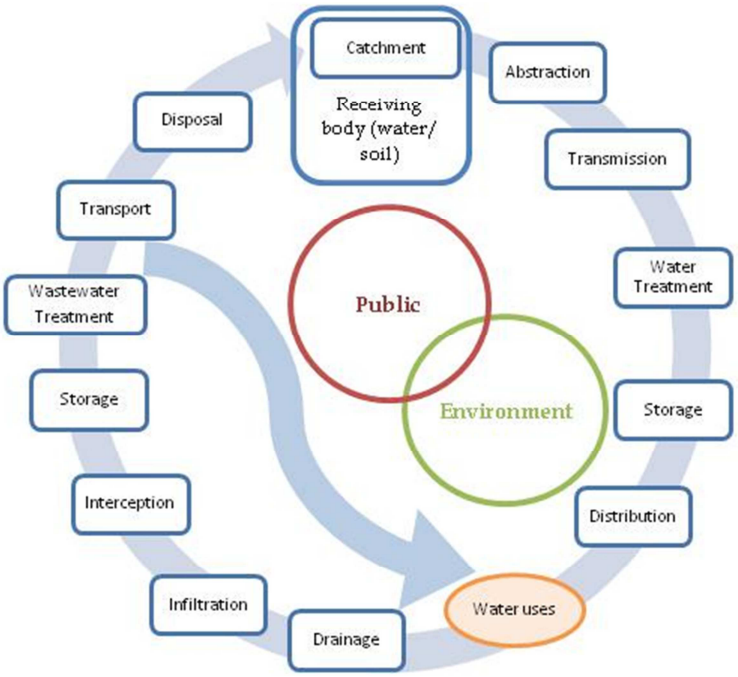
Risk identification database

Supporting document for RIDB definition of contents and data structure



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Title

Risk identification database supporting document for definition of contents and data structure

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The deliverables *D 2.2.2 Risk identification database (RIDB) contents and data structure* (PREPARED 2011.022) and *D 2.2.3 Preliminary water cycle risk identification database (RIDB)* (PREPARED 2011.023) are related. The present explanatory report "Risk identification database supporting document for definition of contents and data structure" is the supporting document to these two databases and of an additional deliverable (PREPARED 2011.024) entitled *Register of historical accidents structure.*

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PU = Public

Summary

Potential effects of climate dynamics on the urban water cycle can involve the aggravation of existing conditions as well as occurrence of new hazards or risk factors. The risks associated with expected climate changes have to be dealt with by the society in general and by the water utilities and other stakeholders in particular.

The challenges created by climate dynamics require an integrated approach for dealing with existing and expected levels of risk. In PREPARED Task 2.1.1 a WCSP framework was proposed for such an integrated approach. The application of the WCSP framework requires a number of tools to facilitate the tasks of working groups involved. One of these tasks is risk identification.

This document presents the adopted structure and contents for a risk identification database (RIDB), providing background information on the data needed for event characterization (event description, hazard, risk sources, contributing causes, existing measures to reduce risk, risk factors, typical consequence dimensions) and on data for estimating the effect of climate changes in event risk. This RIDB is intended to facilitate the task of risk identification in the WCSP. Additionally, a register of historical accidents is proposed.

The subsequent PREPARED tasks allow testing and improving of this initial proposal of the RIDB as well as feeding the databases with data from the selected case studies of the project.

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Acronyms

CC	Climate change
CSO	Combined sewer overflow
DoW	Description of work
ETA	Event tree analysis
FTA	Fault tree analysis
RIDB	Risk identification database
RRDB	Risk reduction database
RRM	Risk reduction measure
WCSP	Water cycle safety plan
WHO	World health organization

1 Introduction

1.1 Background

Climate dynamics trends impose important challenges to the urban water sector (Figure 1). Alteration of the range of operation conditions, which may result from atmosphere and sea temperature increase, variation in precipitation quantity and patterns or increase of average sea level, needs to be dealt with proactively by the different stakeholders involved in the urban water cycle.

Potential effects of climate changes on the urban water cycle involve the aggravation of existing conditions as well as occurrence of new hazards or risk factors, changing the risk of identified possible events as well as opening the possibility of occurrence of events previously not reasonably expected in each region.

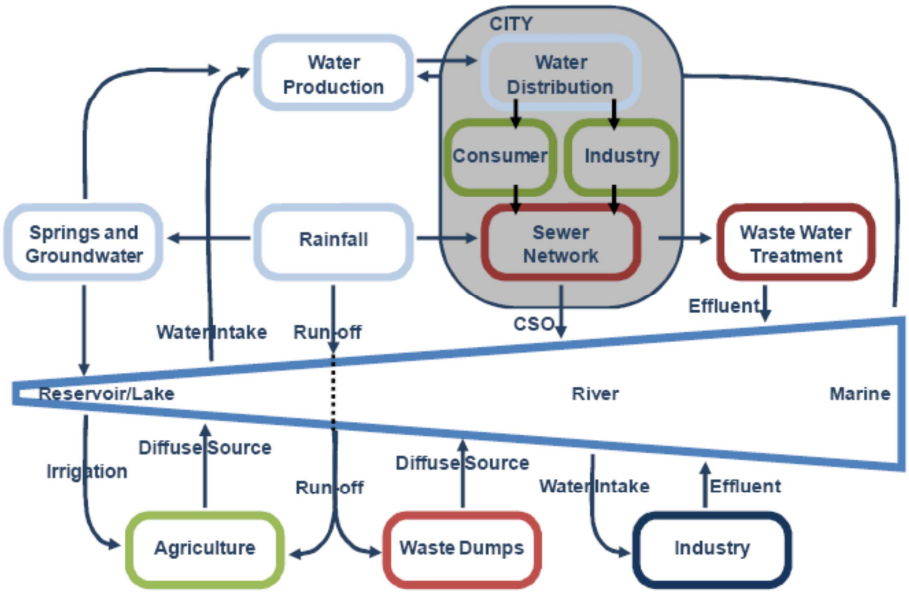

Figure 1 - Water cycle interactions and the city (Extract from PREPARED DoW)

The risks associated with expected climate changes have to be dealt with by the society in general and, in particular, by the water utilities and other stakeholders. It is recognised that these challenges require an integrated approach for dealing with existing and expected levels of risk.

Given the interactions of urban water and natural systems and the effects of climate changes affecting the entire water cycle, adaptation measures should address all water cycle components and their interactions. Therefore, a generic framework to tackle the climate change problematic is required. This framework is intended to be systematic and to incorporate uncertainties. Important steps of the framework include risk identification and opportunities in terms of alternative actions.

The main objective of the risk identification step is to identify risk sources (including hazards), risk factors and potential events, taking into account the exposure modes. Additionally, within the context of PREPARED, the effects of the expected regional climate trends (climate change impact) on risk sources, hazards, risk factors and events are especially important to help assessing potential risks. Whenever appropriate, historical data should be used to assure that information from past events is considered; useful data can derive from the case under analysis as well as events from other cases.

Climate changes can both affect probability and consequences of events that may occur in a system in the present climatic situation, and ultimately originate different events not traditionally experienced in a region. The identification of the potential events that should be considered when carrying out risk identification is a challenge to water utilities. The PREPARED risk identification database (RIDB) is intended to be a source of information to facilitate this task.

Within the proposed WCSP framework (see Deliverable D 2.2.1), two main steps deal with risk identification (Figure 2). To ensure continuity in the whole process the RIDB needs to be fully compatible with the WCSP framework. The RIDB is an essential element to support the application of the framework at the different levels. At the integrated level, the RIDB is a tool for supporting step 3. Preliminary risk identification in the water cycle; at system level, the RIDB is a tool for supporting step 5.4. Risk identification (Almeida *et al*., 2010).

At the **water cycle integrated level** issues and interactions are dealt with at a macro scale, considering not only interactions between water cycle existing components in the water systems but also with other stakeholders. This approach provides an opportunity to achieve both an overall better use of resources, if the different parties are willing to collaborate and information is shared, and improved results at the water cycle level.

Detailed processes analysis is carried out at the **system level**. Detailed analysis of specific processes or component functioning should be dealt with at systems level, unless it is found to have an important role at water cycle level.

At both levels of analysis, WCSP key actions include identification of relevant hazards, risk sources and risk factors, assessment of the potential effect of climate change trends and exploring scenarios and potential events. The PREPARED RIDB incorporates information intended to facilitate the application of these steps, especially for risk identification (Table 1).

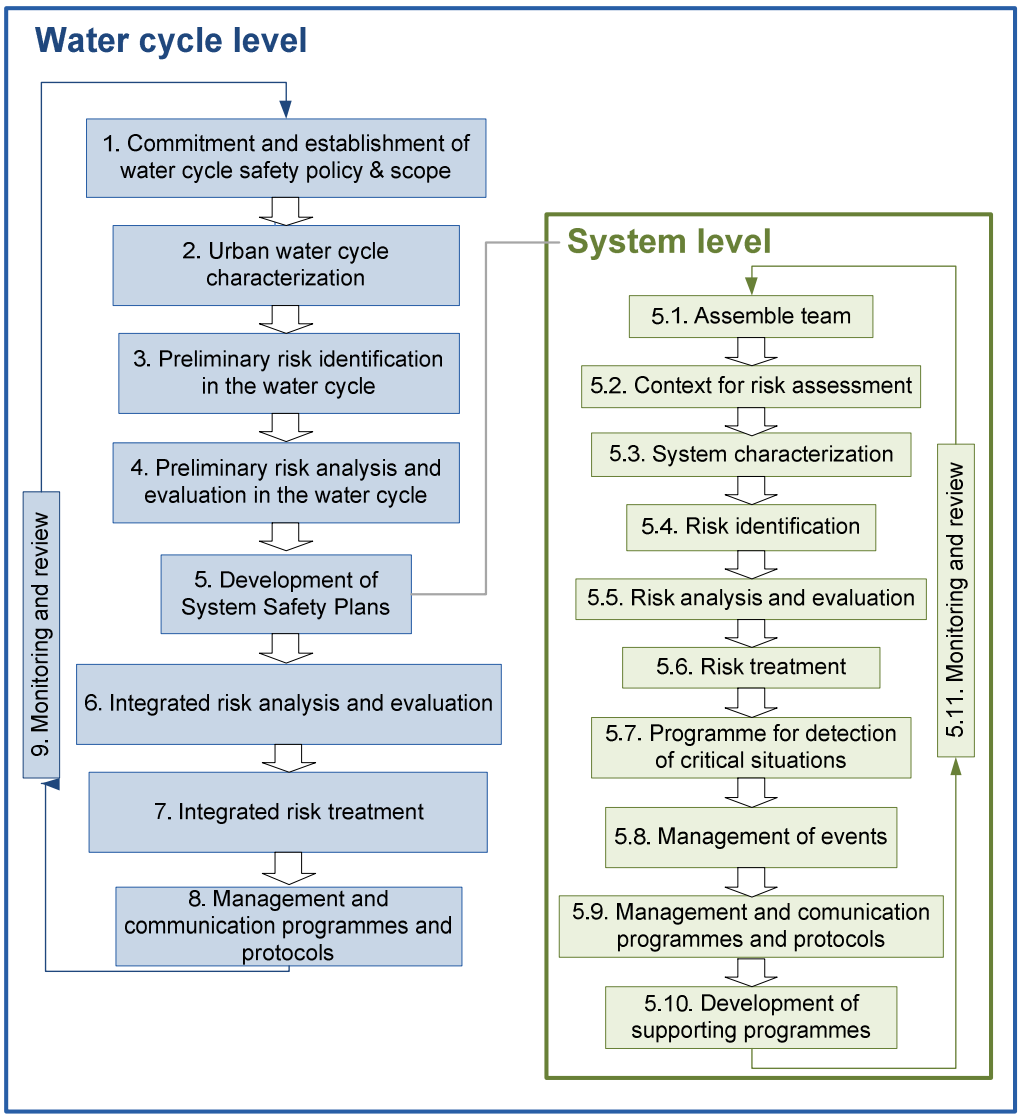

Figure 2 - WCSP framework

Table 1 – Key actions considered in WCSP risk identification steps

Integrated level: Step 3.	**Identify relevant hazards, risk sources and risk factors** **Assess the potential effect of climate change trends** **Explore scenarios and potential events**
System level: Step 5.4	Identify relevant hazards, risk sources and risk factors Assess potential effect of climate change trends Explore scenarios and potential events

The RIDB cannot substitute the comprehensive identification of risks for each application; however, the examples given allow the users to commence the process and draw their attention to some possibilities that should be investigated, when local conditions indicate that it is somehow likely to happen. Furthermore, events considered in the database are not necessarily realistic for each application and others might exist that are not included.

The events are only considered for systems in operation; accidents that might occur in other phases of the life cycle of systems and components are not included (e.g. during construction).

1.2 Scope of the WCSP and RIDB

Widening scope of safety plans implies consideration of multiple primary aims when looking at the water cycle. Therefore, the envisaged scope of the water cycle safety plans comprises the **protection of public health** but also the **public safety** and the **protection of the environment**. Different exposure modes also need to be considered.

Aspects of water quality as well as water quantity need to be addressed. Numerous examples of interaction between quality and quantity can be given such as the potential effect of water shortages in deterioration of water quality. Insufficient water supply as well as excessive water may cause safety issues (e.g. lack of water for fire fighting, flooding).

The list of potential and relevant events for the whole water cycle can be quite large; therefore, within the scope of PREPARED, the main focus is on those events that may be somehow associated with climate changes. Nevertheless, the approach can be applied for all types of events even if not climate related by those water utilities that prefer to use a broader application.

The data structure of the RIDB needs to incorporate all these aspects.

1.3 Risk identification: use case approach

A use case approach is adopted as an exercise to identify relevant hazards and events that put at risk the fulfilment of the main aims (see Almeida *et al*., 2010 for more detail). The associated questions arising are:

(i) What can go wrong at the consumers tap?
(ii) How is public health endangered during recreational uses (also to consider exposure to reclaimed water)?
(iii) How can safety of people be at risk?
(iv) Which negative impacts can result in the environment?

In a first stage of risk identification, recognition of hazards for each of the main aims is necessary, and a table containing most possibilities is an important support, even if not intended as exhaustive.

In a second stage, for each hazard, the user should list the potential events. A second table can illustrate potential events (table with relevant sequences of occurrences). The RIDB and an historical register are useful checklists to support this stage.

A further development is building cause-consequence diagrams, such as fault and event trees. For each event identified potential underlying causes should also be included to show how the hazard can arise, which are the risk sources and factors based on specific tables for selecting possibilities according to local conditions; the table for risk factors should include the effect on risk of

climate changes. Climate changes may affect the hazard or the individual causes that can lead to the occurrence of the hazard.

The historical register of events (having their events fully described, including risk sources, risk factors, etc.) can be very useful for the user in order to better understand the possible developments following a triggering occurrence.

In further steps of the WCSP, namely risk analysis and evaluation, the analyst can then proceed with assessment of the likelihood (P) and consequences (C) for each event, also indicating the deviations expected from the potential climate changes.

In this report, the contents and the structure of the databases (RIDB and historical register) to support the risk identification step, as described above, are presented. PREPARED deliverable D2.2.4 provides further details on developing these steps of the WCSP framework.

1.4 Definitions adopted in this report

A number of definitions used in this report are defined in this section to help communication between different partners. Thus, the definitions presented in Table 2 are adopted within the present document and are intended to clarify the meaning as used by the authors. Definitions already presented in reports D 2.1.1 and D 2.4.1 are also considered and only repeated herein as appropriate.

Table 2 – Definitions adopted in the document

Expression	Definition
consequence	Outcome of an event affecting objectives. An event can lead to a range of consequences. A consequence can be certain or uncertain and can have positive or negative effects on objectives and be expressed qualitatively or quantitatively. Initial consequences can escalate through knock-on effects.
event	Occurrence or change of a particular set of circumstances. An event can be one or more occurrences, can have several causes, can consist of something not happening. An event can be referred to as an "accident" or "incident". The latter is an event without **consequences**.
exposure	Extent to which an organization or individual is subject to an **event**.
hazard	Source of potential harm. A hazard can be a **risk source**.
hazardous event	An event which can cause harm, e.g. a situation that leads to the presence or release of a hazard (Beuken, 2008). The hazardous event is part of the **event** pathway.
risk factor	Something that can have an effect on the risk level, by changing the probability or the consequences of an event. Risk factors are often causes or causal factors that can be acted upon using risk reduction measures. Typically three main categories are considered namely human factors, environmental factors and equipment/infrastructure factors.
risk source	Element which alone or in combination has the intrinsic potential to give rise to risk. A risk source can be tangible or intangible. Risk source is where the hazardous event potentially begins.

1.5 Structure of the document

The main purpose of this report is to introduce the risk identification database, by providing background information, identifying information requirements for the RIDB and proposing a database structure as well as the structure for a register for historical accidents.

In this introductory chapter, the background, the scope of the WCSP and RIDB, the steps for risk identification as a use case approach and definitions adopted in this report are presented.

In chapter 2, information requirements for the RIDB are presented, including criteria to characterise the events and data for estimating effect of climate changes in event risk. The chapter concludes with aspects to consider in organising the RIDB.

Chapter 3 presents details on the proposed RIDB structure and in chapter 4 a structure for a register of historical accidents is proposed.

2 Information requirements for the RIDB

2.1 General aspects

The main aim of the risk identification steps is to identify the events that can occur, specifying where, why and how they can happen. Comprehensive identification of these events using a systematic process is critical since if not identified at this stage relevant risks might be excluded from subsequent analysis (AS/NZS, 2005). Proper risk description should include four elements, namely, sources, events, causes and consequences (ISO 31000:2009). Information sources useful to support risk identification includes (AS/NZS, 2005):

- Expert knowledge and judgement;
- Personal and organisational experience;
- Post event reports and insurance reports;
- Reports from audits, inspections and site visits;
- Checklists;
- Historical records, incident databases and previous risk registers;
- Reports from previous risk assessments.

Several methods allowing identifying risks exist. ISO (2009b) lists and classifies different methods for this purpose, providing an indication of the applicability of the method and whether quantitative output can be provided. Within PREPARED the RIDB includes information on (not intending to be exhaustive):

- Hazards relevant to the aims of the WCSP;
- Risk sources;
- Risk factors;
- Dimensions of consequence expected;
- Typical causes;
- Typical events;
- Historical events.

The information requirements for specifying typical events, within the step of risk identification, cover two main sets of data:

- Event characterisation;
- Effect of climate changes in event risk.

The event comprises the progress from the risk sources and causes to the hazardous event, the exposure to the hazard, the accident and associated consequences.

The PREPARED project proposes a general approach but the application is focused on the effects of climate change. The selected criteria used to describe the two sets of data are presented in the following sections. This information allows the user to proceed with the risk identification steps, providing background information that can be used together with the selected approach for risk identification. If no other more complex method is adopted, the database can be used as a checklist.

The criteria should be useful to implement the WCSP framework steps. At different levels of development different detail might be required. Simple and easy to use criteria are preferred but, in specific applications, detailed analysis is recommended to take into account local conditions.

The application of the risk identification step to a specific system should be carried out using a purpose made form allowing reporting the specific events characteristics and other relevant information. The RIDB structure can be an inspiration to this form but it is not intended for that purpose. As mentioned previously, the RIDB is a checklist to help the comprehensive identification of risks in each specific application; the examples given in the database allow the users to commence the process and draw their attention to some possibilities that should be investigated, when local conditions indicate that it is somehow likely to happen. Furthermore, events considered in the database are not necessarily applicable for each application and others might exist that are not included.

2.2 Analysis units

Considering the two levels of the WCSP framework and the typical components of urban water systems, the units of analysis included are presented in Table 3. Accordingly, five sub-databases are considered in the RIDB, as many as the safety plans to be potentially developed:

1. Water cycle level or integrated level – not river basin level since the urban cycle does not necessarily coincides with a river basin;
2. Drinking water system;
3. Non-drinking water system;
4. Wastewater system incorporating combined sewer systems as adequate;
5. Stormwater systems incorporating combined sewer systems as adequate.

2.3 Data for event characterisation

2.3.1 *Relevant information*

For the purpose of describing potential events relevant attributes include:

- Event identification number;
- Event description;
- Hazard;
- Risk sources and contributing causes;
- System/Subsystem where risk source(s) occurs (as in Table 3);

- System/Subsystem where exposure occurs (as in Table 3);
- Main risk factors;
- Existing measures to reduce risk;
- Typical consequence dimensions;
- Relevance at water cycle level.

Table 3 – Level of analysis, system and subsystem

Level of analysis	System	Subsystem
1. Integrated	.1. Catchment basin .2. Drinking water .3. Non-drinking water .4. Wastewater .5. Stormwater .6. Receiving waters	(as below for the systems)
2. System	.1. Catchment basin	.1. Surface water catchment .2. Groundwater catchment
	.2. Drinking water	.1. Surface water reservoir .2. Groundwater reserves .3. Abstraction system .4. Groundwater recharge .5. Water treatment .6. Transmission .7. Pumping stations .8. Storage .9. Distribution .10. Plumbing systems
	.3. Non-drinking water	.1. Catchment system .2. Water treatment .3. Advanced wastewater treatment .4. Transmission .5. Pumping stations .6. Storage .7. Distribution .8. Plumbing systems
	.4. Wastewater	.1. Wastewater collection network .2. Interceptor system .3. Wastewater treatment .4. Combined sewer overflows .5. Pumping stations .6. Storage structures .7. Infiltration systems .8. Outfalls

Table 3 – Level of analysis, system and subsystem (continued)

Level of analysis	System	Subsystem
2. System	.5. Stormwater	.1. Urban catchments .2. Stormwater collection network .3. Infiltration systems .4. Source controls .5. Stormwater treatment .6. Stormwater overflows .7. Pumping stations .8. Storage structures
	.6. Receiving waters	.1. River .2. Estuary .3. Lake .4. Coastal water
3. General	(measure applicable independent of unit of analysis)	

The likelihood is not included as an attribute to characterise the event because it is strongly case dependent. Therefore, the level of risk is also not included.

2.3.2 *Description of the event*

The description of the event is a structured and concise explanation of what occurs in the event, usually including the pathway of the event, avoiding repeating information that can be included in the remaining items of this group.

2.3.3 *Hazards list*

The primary aims are protection of public health, public safety and environment. Thus, the hazards need to be defined in relation to these primary aims – a contaminant at the consumers tap is a hazard; a malfunction at the treatment plant is not yet a hazard but a risk source, a risk factor or a cause.

Different types of hazards are considered when appropriate. For instance, for protection of public health the types of hazards to evaluate are, in general, those derived from microbiological contamination, chemical contamination or radiological contamination. Options considered are presented in Table 4. In PREPARED Deliverable D2.2.4 (Guidance on water cycle RIDB hazard selection and use in the WCSP) the hazards lists are further developed including a general description of the consequence of the exposure to each hazard, as well as the potential causes and relevance of specific climate change effects.

Table 4 – Hazards list per aim and exposure mode

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
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 ▪ 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
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

The relevance of a certain hazard depends on how realistic the occurrence of e.g. a substance at concentrations that cause harm given the exposure mode. Additionally, problems that are out of the range of water utilities are not considered (e.g. presence of radiological contaminants in water bodies used for recreational activities at dangerous concentrations would be an event of national relevance).

Different hazards are grouped in Table 4 function of common pathways in the water cycle or similar impacts in public health, public safety or the environment.

2.3.4 *Risk sources and contributing causes*

Both risk sources and contributing causes are necessary to describe how the event may initiate and propagate.

For each event, a list of possibilities is provided, not intended to be exhaustive, covering the main envisaged alternatives in the different subsystems.

The main categories considered are:

- Design related
- Manufacturing or construction related
- Operation and maintenance related
- System components degradation related
- Related with water systems functional problems
- External
- Other causes

In Table 5 the risk sources and contributing causes are listed per category.

Table 5 – Risk sources and contributing causes

Category	Risk source or contributing causes
Design related	▪ Inadequate construction specifications ▪ Inadequate selection of materials ▪ Other design related causes
Manufacturing or construction related	▪ Manufacturing defects ▪ Inappropriate transport or storage of materials ▪ Deficient construction or installation ▪ Missing, inadequate or damaged corrosion protection ▪ Other manufacturing or construction related causes
Operation and maintenance related	▪ Inappropriate procedures or methods of cleaning ▪ Inappropriate maintenance procedures ▪ Inappropriate valve manoeuvre ▪ Inappropriate pipe filing procedures ▪ Mishandling or misuse of equipment, materials or others ▪ Excessive flow pressure or flow pressure fluctuations ▪ Low pressure flow in distribution network ▪ Poorly maintained water storage tanks ▪ Intermittent supply ▪ Backflow at water use devices ▪ Failure in wastewater treatment plant ▪ Incorrect dosing of water treatment chemicals ▪ Water treatment chemicals with low purity ▪ Random obstructions ▪ Other operation and maintenance related causes

Table 5 – Risk sources and contributing causes (continued)

Category	Risk source or contributing causes
System components degradation related	▪ Material wear due to flow conditions ▪ Material degradation due to aggressive atmosphere ▪ Material degradation due to aggressive water ▪ Sediments deposit ▪ Attached deposits and biofilms ▪ Poor infrastructural condition ▪ Leach of chemicals from system components ▪ Other causes related with system components degradation
Related with water systems functional problems	▪ Stormwater discharges from urban systems ▪ Untreated wastewater discharges from urban systems ▪ Exfiltration from sewers ▪ Flooding from combined sewer systems ▪ Flooding from stormwater systems contaminated with sewage ▪ Overflow from septic systems ▪ Insufficient treatment of the water to be reused ▪ Release of toxic chemicals from urban water system storage and use ▪ Release of toxic gases from urban water system storage and use ▪ Release of toxic gases from sewers ▪ Excessive extraction of groundwater reducing the ground water table ▪ Other water systems functional problems
External causes	▪ Excavation activities in the vicinity of pipes ▪ Earthquakes and soil subsidence ▪ Static or dynamic overload ▪ Water movements in the soil ▪ Aggressiveness of oil or interstitial water ▪ Root intrusion ▪ Occurrence of abnormal hydrologic phenomena ▪ Damage caused by a third-party ▪ Land slide ▪ River floods affecting urban areas ▪ Untreated wastewater discharges from industry to public sewer systems ▪ Storm water runoff from places with traffic ▪ Runoff from highway or railway accidents and spills ▪ Infiltration from graveyards ▪ Infiltration from livestock activities ▪ Storm water runoff from urban areas ▪ Runoff from cropland or pasture land ▪ Runoff from landfills leachate or from domestic waste dumping ▪ Runoff from on-site septic systems ▪ Untreated domestic wastewater discharges ▪ Untreated wastewater discharges from industrial activities ▪ Runoff from road salt use ▪ Accumulated nutrients from discharges of urban water systems ▪ Naturally occurring radioactive species in drinking-water sources ▪ Radionuclides from the medical or industrial use of radioactive materials ▪ Recreational activities in water bodies ▪ Unavailability of water at source ▪ High water losses in the transport/distribution systems ▪ Electricity or communication systems failure ▪ Other external causes

2.3.5 *Existing measures to reduce risk*

The specific events that might occur depend on the standard of work, measures already in place and their effectiveness. Thus, when describing the event, identification of the measures already in place is essential for risk identification. The measures should be referred to in accordance with the RRDB catalogue and directories (Almeida *et al.*, 2011).

2.3.6 *Main risk factors*

Risk factors, understood as something that can have an effect on the risk level, by changing the probability or the consequences of an event, are often causes or causal factors that play a role in an event. Typically three main categories are considered, namely human factors, environmental factors and equipment or infrastructure factors (Almeida *et al.*, 2010). In Table 6, examples of risk factors for each category are given. For each event can be appropriate to specify details of the risk factors playing a role.

Table 6 – Examples of relevant risk factors

Category	Risk factor
Human factors	Human reliability
	Exposure time
	Physical vulnerability
	Social vulnerability
	Behavioural factors
	Miscommunication
	Consumer sensitivity
Environmental factors	Temperature
	Precipitation intensity
	Wind intensity
	Contaminant concentration
	Nutrient concentration
	Receiving water level
	Soil type
	Seismic vulnerability
	Suspended solids in source or supply water
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
	Chemical storage
	Irrigation operational schedule
	Sediment or biofilm accumulation in water supply network

2.3.7 *Typical consequence dimensions*

Event consequences can be of different sorts, namely (Almeida *et al.*, 2010):

- Health and safety effects on consumers, public or occupational, that can be expressed as the number and severity of injuries, number and severity of people affected by disease and number of people affected permanently (mortality and disability);
- Financial impacts on the utility usually expressed on monetary value, but classes of consequences should reflect the size of utility e.g. annual operating budget (AOB);
- Service, business or functional continuity consequences expressed in terms of:
    - interruptions in the service (availability and compliance with minimum standards), which can include the differentiation of type of client affected (residential, hospital, firefighting);
    - performance measures (e.g. client.hours.lost without supply, number of interruptions) using thresholds derived from legal requirements;
    - various reliability measures (e.g. number of specific failures or failure modes per time unit), using thresholds derived from legal requirements;
- Environmental impacts on water, land, air, flora and fauna expressed in terms of severity (e.g. expected recovery time, water quality index.time), extent (e.g. dimension of afected area, water quality index, volume or duration of event) or vulnerability (e.g. protected areas, areas of influence for water supply abstraction);
- Reputation and image, e.g. expressed by the number of complaints; frequency of negative references to the utility in the media; frequency of lawsuits;
- Project development effects e.g. expressed in terms of deviations from set objectives of scope, schedule or budget.

For each event it is useful to have an indication of the typical dimensions and overall magnitude. The options to consider are relevance of the consequence dimension for the event as in Table 7.

Table 7 – Options for indicating the magnitude of consequence

Option	Description
R	Relevant
NR	Not relevant

2.3.8 *Relevance at integrated water cycle level*

Events identified at system level may be also relevant at the integrated level of analysis. Three options can be used as in Table 8.

Table 8 – Event relevance at integrated water cycle level

Option	Event relevance at integrated water cycle level
-1	Generally not relevant
0	Relevance is case dependent
1	Generally relevant

2.4 Data for estimating effect of climate changes in event risk

Climate change effect on the event can derive from modifying the likelihood of the event or the magnitude of associated consequences.

The purpose of following attributes is to provide information on the expected effects of climate changes on the probability or likelihood of the event and on the consequences.

Thus, for each climate indicator or effect, as described in Ugarelli et al. (2010) and in Table 9, an indication of the impact in the event can be given using the scale in Table 10. An indication of the regions where these effects are expected is given in Table 11 (0 – not applicable; 1 - applicable).

The climate indicators are those alterations on climate variables that have direct effect on urban water systems processes, whereas the climate change direct effects are modifications in the water cycle environment that also influence system's behaviour.

Table 9 – Climate indicators and effects as identified in Ugarelli et al. (2010)

Climate indicator	Climate change direct effects
Increase of air temperature	Increase of water temperature
Increase of air temperature variability	Increase of sea temperature
Increase of precipitation annual amount	Sea-level rise
Decrease of precipitation annual amount	Increase of river flow
Increase of frequency of intense precipitation events	Decrease of river flow
Increase of winter precipitation	Changes in river flow pattern
Decrease of summer precipitation	Decrease of Arctic sea ice coverage
Changes in precipitation patterns	Decrease of snow, lake and river ice cover
Increase of winter storms	

Table 10 – Potential impact of climate change on the event

Class	Effect in technical problem
-2	Potential for severe aggravation
-1	Potential for moderate aggravation
0	No significant effect
1	Potential for moderate improvement
2	Potential for major improvement

Table 11 – Regions where the climate change indicators and direct effects are to be considered

Region ID	Region
1	Mediterranean
2	Atlantic
3	Continental
4	Cold climate

3 Proposed RIDB structure

3.1 Organising the RIDB

The first version of the risk identification database (PREPARED Deliverable D 2.2.2) is implemented in EXCEL, and consists of a set of files each to support the different safety plans considered within the urban water cycle.

Selection and organisation of the events should take into account:

- The use of the RIDB at the two levels of analysis (integrated and system's levels) and the specific systems existing within the water cycle;
- Primary aims of WCSP - protection of public health and safety and protection of the environment;
- The relation with the risk reduction measures (RRM) and RRDB structure and measures considered.

Database structure needs to be easy to understand and use when carrying out risk identification.

The list of events is initially organised by hazard, but database functions should allow queries and filters to provide purpose made views. This organisation is only to facilitate compilation of the list of events.

Only climate change related events are to be included in the database.

3.2 Data structure of the RIDB

Considering the two levels of the WCSP framework and the typical components of urban water systems five sub-databases can be considered in the RIDB, as many as the safety plans to be potentially developed:

1. Water cycle level or integrated level – not river basin level since the urban cycle does not necessarily coincides with a river basin;
2. Drinking water system;
3. Non-drinking water system;
4. Wastewater system incorporating combined sewer systems as adequate;
5. Stormwater systems incorporating combined sewer systems as adequate;

Each RIDB sub-database (EXCEL files) contains six tables: a table with the description of the events (Event description), a table with the risk sources per event (Risk sources), a table with the contributing causes per event (Contributing causes), a table with the risk factors per event (Risk factors), a table with existing measures to reduce the risk per event (Existing measures to red. risk) and a table containing the options for each attribute in the tables (Options). The common attribute in the different tables is the EVENT ID, and several entries can exist for the same event except for the table with the event description. The options follow the description presented in chapter 2. The attributes of the tables are presented in Table 12. This basic structure of a sub-database is presented in the PREPARED deliverable D 2.2.2.

Table 12 – Attributes for the RIDB tables

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, usually including the pathway of the event, avoiding repeating information that can be included in the remaining items of this group
	Hazard	Hazard associated with the event as in the list defined in Table 4 and D 2.2.4
	System/Subsystem where risk source occurs	Upper boundary of the event considering the systems and subsystems of the water cycle and Table 3
	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 and Table 3
	Consequence dimensions	Type of consequences expected from the event
	Climate change indicators	Climate change indicator , as in Table 9; indication of the impact in the event using scale in Table 10
	Climate change effects	Climate change effect, as in Table 9; indication of the impact in the event using the scale in Table 10
	Climatic region	Regions where CC effects are expected as in Table 11 (0 – not applicable; 1 - applicable)
Risk sources	Event ID	Unique identification reference for the event; several entries for the same Event ID possible
	Risk source main category	Main risk source category for the event as in Table 5
	Risk source secondary category	Secondary risk source category for the event as in Table 5
	Risk source description	Specification of the risk source
Contributing causes	Event ID	Unique identification reference for the event; several entries for the same Event ID possible
	Contributing cause main category	Main category of contributing cause as in Table 5
	Contributing cause second category	Secondary contributing cause category as in Table 5
	Contributing cause description	Specification of the contributing cause
Risk factors	Event ID	Unique identification reference for the event; several entries for the same Event ID possible
	Risk factors	Risk factors typically associated with the event as in Table 6
Existing measures to reduce risk	Event ID	Unique identification reference for the event; several entries for the same Event ID possible
	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 description	Description as in RRM Catalogue

4 Proposed register of historical accidents structure

4.1 Purpose

Sources of information for the risk identification step include data on past events in similar systems. Therefore, one alternative for identifying the events is a register of historical accidents related to the water cycle systems as defined in the project.

Similar databases exist for other areas. For instance, the comprehensive energy-related severe accident database (ENSAD) proves to be a good example of such a structure of data, in this case limited to the class of events with higher consequence (Burgherr and Hirschberg, 2008).

Database structure to compile list of events or accidents includes the detailed description and relevant fields similar to those used in RIDB. Additional information includes local information.

To avoid populating the register with larger number of events having low levels of consequences associated, only consequence classes of 3, 4 and 5 are to be considered, independent of the consequence dimension.

Populating the register can be carried out from literature review and with contributions from the partners. An example of an accident to include is the one in Walkerton, Canada, in May 2000 (Hrudey and Hrudey 2004).

4.2 Data structure of the register of historical accidents

The proposed register of historical accidents contains six tables: a table with the description of the events (Event description), a table with the risk sources per event (Risk sources), a table with the contributing causes per event (Contributing causes), a table with the risk factors per event (Risk factors), a table with existing measures to reduce the risk per event (Existing measures to red. risk) and a table containing the options for each attribute in the tables (Options). The attributes of the tables are presented in Table 13.

This is a first proposal to be upgraded with contributions from project partners.

The consequences need to be expressed using dimensions and classes defined by metrics. The definition of this scale is to be defined in coordination with partners considering available information in subsequent tasks of the WA2.

Table 13 – Attributes for the register of historical accidents tables

Group	Attribute	Description
Event description	Event ID	Unique identification reference for the event
	Event date	Date and time interval (yy/mm/dd hh:mm)
	Country	Selection from a list
	Location coordinat.	M and P coordinates
	Location details	Town/region, system, subsystem
	System/Subsystem where risk source occurred	Upper boundary of the event considering the systems and subsystems of the water cycle and Table 3
	System/Subsystem where exposure occurred	Location where exposure of people or environment occurs within the event considering the systems and subsystems of the water cycle and Table 3
	Description	Text description including the pathway of the event, avoiding repeating information included in other items
	Type of accident	Selection from a set list
	Hazard	Hazard associated with the event as in the list defined in Table 4 and D 2.2.4
	Consequences in different dimensions	Magnitude of consequences of the event in different dimensions using the consequence class as in table of consequences
	Relevance at WC level	Indication of number of system units involved
	Reference	Bibliographic sources
Consequences	Event ID	Unique identification reference for the event; several entries for the same Event ID are possible
	Conseq. dimension	Consequence dimension associated with the event
	Metric	Specification of the consequence with the metric selected from the consequence scale and appropriate units (immediate and within following year)
	Specific description	Details for the event and consequence dimension
	Consequence class	As defined in the consequence scale
Risk sources	Event ID	Unique identification reference for the event; several entries for the same Event ID are possible
	Risk source main category	Main risk source category for the event as in Table 5 or others
	Risk source secondary category	Secondary risk source category for the event as in Table 5 or others
	Specific description	Details for the event
Contributing causes	Event ID	Unique identification reference for the event; several entries for the same Event ID are possible
	Contributing cause main category	Main contributing cause category for the event as in Table 5 or others
	Contributing cause second category	Secondary contributing cause category for the event as in Table 5 or others
	Specific description	Details for the event

Table 13 – Attributes for the register of historical accidents tables (Continued)

Group	Attribute	Description
Risk factors	Event ID	Unique identification reference for the event; several entries for the same Event ID are possible
	Risk factors	Risk factors associated with the event as in Table 6 or others
	Specific description	Details for the event
Existing measures to reduce risk	Event ID	Unique identification reference for the event; several entries for the same Event ID possible
	Existing measures	Measures that were in place, relevant for risk level of the event. For each event, the set of measures is included using the measure ID from the RRM Catalogue.
	Specific description	Details for the specific local conditions
Measures taken after the event	Event ID	Unique identification reference for the event; several entries for the same Event ID possible
	Measures	Measures that were implemented after the event. For each event, the set of measures is included using the measure ID from the RRM Catalogue.
	Specific description	Details for the specific local conditions
Climate change influence	Event ID	Unique identification reference for the event; several entries for the same Event ID possible
	CC indicators	Indicators that may influence this type of event
	CC effects	Effects that may influence this type of event
	Climatic region	Indication of the region where event occurred

5 Methodology for events identification and characterisation

Sources of information for the risk identification step include data on past events in similar systems. Therefore, one alternative for identifying the events is a register of historical accidents related to the water cycle systems as defined in the project, described in chapter 4.

To avoid populating the RIDB with larger number of events having low levels of consequences associated, only consequence classes of 3, 4 and 5 are to be considered, independent of the consequence dimension.

The methodology to identify and select events to populate the database is as follows:

- systematisation of events using tools such as fault tree analysis (FTA) and event tree analysis (ETA). This work allows to compile a first list, to be verified in subsequent steps of the project, and is incorporated in PREPARED deliverable D 2.2.3;
- collection of events reported in the literature to be verified in subsequent steps of the project;
- identification of events to be included in the register of historical accidents related to the water cycle systems as defined in the project and adapted to the RIDB;
- possible identification of additional events when developing other project packages (WP 2.2, WA4, WA5);
- identification of additional events, or validation of those included in the database, during application of the WCSP framework to cities (Eindhoven, Lisbon, Oslo and Simferopol), together with suggestions from other project partners.

Following this methodology, a final set of events will be compiled and incorporated in PREPARED deliverable D 2.2.5.

6 References

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