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H2020 Project: Smart Resilience Indicators for Smart Critical Infrastructure

D5.8 - Resilience Joint Evaluation and Test Report (JET report) for the case study "SmartResilience Project: FOXTROT: Drinking water supply system"

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Resilience Joint Evaluation and Test Report (JET report) for the case study "SmartResilience Project: FOXTROT: Drinking water supply system"

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Summary / Main facts & findings

IVL Swedish Environmental Research Institute conducted three consecutive workshops with relevant stakeholders from the drinking water sector in Sweden. Researchers from IVL, led by Johan M. Sanne assessed the workshops. The workshops included a stress-test, based upon a scenario of microbial contamination of water, either raw water or distributed water, due to flooding as a consequence of heavy rain.

The stress-test was considered a good tool for self-assessment, as an input to crisis preparation. The stress-test was considered useful as a complement to current reporting formats to politicians, not at least because it visualizes resilience in different phases of the cycle. Important outcomes include the learning process as well as a list of improvement measures, including an evaluation or priority ordering.

1. Introduction

In T5.8, the water drinking system in a medium-sized town was set to a simulated stress-test, due to an assumed microbial outbreak in the raw water source. In the workshop we had experts from MSB (the Swedish Civil Contingencies Agency), the Food Agency, a municipal fire department as well as experts from several drinking water producers and/or distributors, both large and smaller. Moreover, Lars Bodsberg from SINTEF, a leading expert in resilience, and part of the Smart Resilience consortium, also contributed during the workshop. In a preceding workshop, the participants had been introduced to the scenario and they contributed to revising it to make it more relevant and worthwhile to their current concerns. The informants consented to notes taken from the workshop.

The case is designed as a worst-case scenario that threatens the functionality of the drinking water system – the threat itself is just an example of a possible and relevant threat that the organization needs to address. The focus in the report is on the consequences and the case illustrates how the organization may indicate, evaluate and improve resilience using the Smart Resilience tools and how this shows the value of the tools for the drinking water sector.

This also means that the scenario can be regarded as a proxy for "the unknown" event, the consequences a resilient SCI needs to manage. See italized text below.

The term "unknown" generally refers to the definition introduced by then U.S. Secretary of Defense Donald Rumsfeld at the Pentagon briefing of February 2002, where he stated: "Reports that say that something hasn't happened are always interesting to me, because as we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns—the ones we don't know we don't know. And if one looks throughout the history of our country and other free countries, it is the latter category that tend to be the difficult ones." (U.S. Secretary of Defense Donald Rumsfeld, 2002)

At its current stage of development, the tools cannot deal with all types of unknown, but the concept is included into the deliverable D9.3 dealing with the ISO standard 31050.

2. Assessed Critical infrastructure

2.1. General description of the assessed critical infrastructure

Drinking water is often called our most important food, also necessary for the functioning of many other infrastructures, such as healthcare. A picture of the drinking water supply cycle (including waste-water treatment) is presented in Figure 1. The water is distributed to the consumers from pressurized pipes either from a water tower or from low level water reservoirs. Water is produced in ground water or surface water plants. Half of the Swedish drinking water is produced from large surface water plants, while the majority of the 1,750 waterworks in Sweden are smaller ground water plants. Among the ground water plants, there are also plants using artificial ground water for its production, where surface water is pumped into for example an esker to increase the capacity of the aquifer

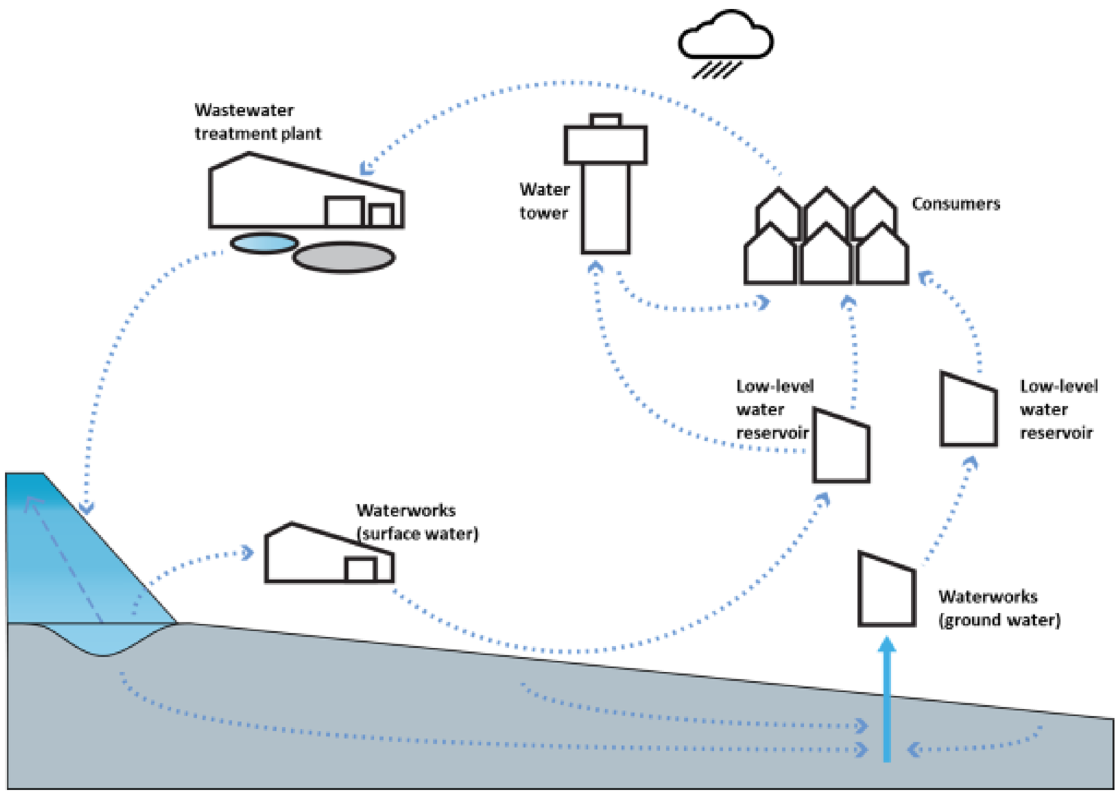


Figure 1: The drinking water supply cycle.

2.2. Smart critical infrastructure features

Currently the drinking water sector uses a number of smart technologies as listed below

Type of smart technology	*Examples*
Integrated systems	*Ø SCADA system: Supervisory control and data acquisition systems (SCADA) analyze real-time conditions, providing data for fast adjustments* *Ø Water treatment systems: can be used to supply high-quality tap water by eliminating problems such as turbidity, bacteria, and salinity. [64][JS1]* *Ø Immobilized Micro-organism Treatment System: a processing system to remove some substances (e.g. nitrogen and phosphorous) that cannot be removed by simple processes. It is used in cases when action is required* *Ø to prevent eutrophication of public waterways, or when the treated water is to be reutilized. [64]*

	Ø Membrane bioreactor system: used to remove suspended solids called "activated sludge," which multiply by a biological reaction. It also can remove bacteria and other larger microbes to produce high-quality treated water. [64] *Ø Water distribution control systems [64]*
Intelligent ICT, web based and Smart computing solutions	*Ø Smart Waste-Water Management system: can be used for reporting, monitoring and control of individual municipalities and on-ground workers through innovative web applications. Also can enable the cities to monitor waste transportation, provide MIS reports for waste collection and transportation and notify ULBs about vehicle breakdown and maintenance thereby ensuring a higher level of transparency in municipal administration. [77]* *Ø Smart Grid for Water [37*
Big/Open data producing technologies	*Ø Big Data for Dynamic Energy Management in Smart Grids [79]* *Ø Health care data: Web searches and telephone consultations to the national healthcare advisory services are currently used to indicate an outbreak of acute gastroenteritis due to microbial contamination.*
Miniaturized: Micro-Nano-Bio Systems (MNBS)	*Ø Micro-bots that remove disease-causing bacteria from water [84]: A micro-robot is a miniaturized, sophisticated machine designed to perform a specific task or tasks repeatedly and with precision.*
Micro-sensors, micro-actuators	*Ø Water sensors. e.g., for leakage status, rainfall and water level [65]* *Ø Ultrasonic sensors (water level): When the water level decrease in the tank, ultrasonic sensor detects this decreasing and sends the reading to Arduino, Arduino alarm the user that there is a decreasing in the tank. [65]* *Ø Smart Water Sensors to monitor water quality in rivers, lakes and the sea [69]* *Ø Biosensors to detect water contamination [55]* *Ø Bacteria-filled sensor for water monitoring: The sensor is filled with bacteria that produce a small measurable current as they feed and grow. When disturbed by incoming toxins and pollutants, the electric current drops, alerting researchers to the presence of unwanted contaminants. [71]*

The smartness level for drinking water in Sweden amounts to intelligence level 3 or managed (ref to D2.1). Two examples:

A) The smart grid for water is used to measure use of water and also predict future demands. This exemplifies an intelligence level 3.

B) Big data from public health web services is used to get early warning if the water treatment or the distribution network has been contaminated. This demonstrates an integration and interconnectedness level 3. This information is included in the stress-test DCL.

Moreover, two examples also show how big and smart data through connected technologies can generate as well as integrate and analyze valuable information.

1. *The first example illustrates how IT & ICT may contribute to smart critical infrastructures development. In order to detect poor raw water supply before people get ill, there is a need to develop and install continuous and real-time technologies to measure and analyze the quality. Various sensor and analysis technologies are tested and installed around the world.*

2. *The second example illustrates how "Industry 4.0" technologies may contribute to smart critical infrastructures development. Data from real-time measurement and analysis can be used to control the production autonomously but also as input into decision-support for operator decisions.*

3. Assessment Setup

3.1. Threat

A serious future threat to drinking water supply is microbial outbreaks. Heavy rain and flooding can cause sewage systems to release untreated waste-water to water protection areas and natural occurring microorganisms to be flushed into drinking water sources. Higher temperatures will increase microbial growth rates. Due to climate change more extreme weather and higher temperatures are anticipated in the future. Furthermore, a more dense population due to urbanization trends will put additional pressure on the existing waste water treatment system which may have similar effects on drinking water production.

3.2. Scenario

The scenario takes place in a medium-sized Swedish city with 10-15,000 inhabitants. In the city there is a waterworks that supplies approximately 10,000 people with drinking water. The water is taken from a surface water source and is after the purification process distributed out to the people in the city.

It has been raining for about a week. At the beginning of the week about four to five millimeters a day and the soil begins to get saturated, the rain does not decrease but increases and after seven days it has reached about 40-50 mm. Then the city is suffering from an intense rainfall, a so called 100-year rain, and for about 24 hours it rains intensively. A total of about 150 mm falls on an already saturated field. SMHI (Swedish and Meteorological and Hydrological Institute) goes out with warning class 3. The heavy rain is leading to floods. All low points in the area, such as road tunnels, are flooded and so are many basements.

One of the wastewater treatment plants have suffered loss of electricity and has lost its functionality and automatic controls. The surface water source is flooded. Even though there is no electricity the treatment plant still faces a risk of overflow because of the large amounts of water still coming in. This is an example of a cascading effect from other SCIs (electric power).

Fecal indicators are coming into the surface water with the flood. The usual treatment is precipitation in combination with chlorine treatment or UV treatment. Even diaphragm or filters can be used.

A number of waterworks pipelines have also been demolished, of which two large wires (200 wire) are completely depleted. This leads to water towers empty quickly. The plant cannot longer produce drinking water at normal capacity, with cascading effects for other SCIs such as healthcare.

3.3. Issues/elements/indicators refinement

The DCL for stress-testing in FOXTROT

Functional element 1: Internal organizational capabilities to manage a disturbance

- Ø *What is the ability to delimit disturbances to certain parts of the system?*
- Ø *What is the value of available external and internal decision support?*
- Ø *What is the ability to monitor effects and adapt in terms of managing disturbances?*

Functional element 2: Communicative and coordinative capabilities to manage a disturbance

- Ø *What are the possibilities to reach the concerned citizens and critical consumers?*
- Ø *What are the possibilities for effective and reliable communication internally and with municipal departments?*

Functional element 3: Capabilities for reliable and fast information as a means to effectively manage a disturbance

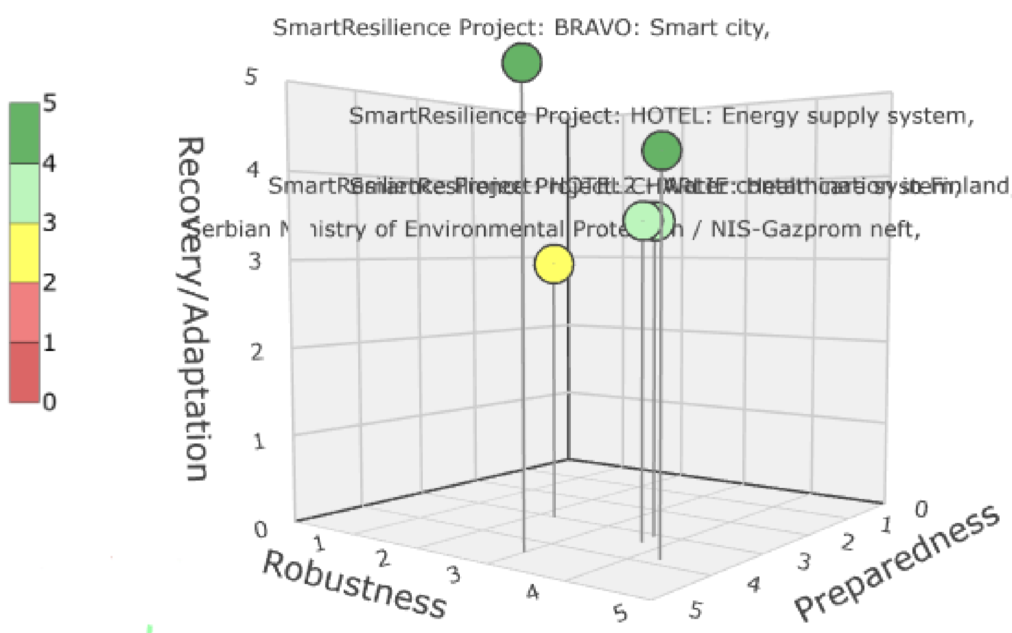
- Ø *What capabilities are there for sensors to detect and monitor disturbances?*

Ø What big data is available to detect and monitor disturbances?

3.3.1. Selection of issues/elements/indicators

The three criteria: cost, improvement and implementation time (or rather time from decision to improvement) were considered most important. It was suggested that time sometimes need to be weighed as the most important criteria. However, for major investments different sustainability criteria were also considered necessary, such as climate impact due to e.g. increased energy use. The workshop suggested that it should be possible both to aggregate and to disaggregate the various functional elements, as decision-makers sometimes wish to consider various aspects and the calculations behind them. This can be illustrated by the Smart Resilience cube, see the box below.

Functional elements can be aggregated in the SmartResilience Resilience cube, bringing all the elements under all three axes in the cube: Preparedness; Robustness; Adaptability. Functional elements can also be aggregated in an index.



The workshop discussed the data needed for the monitoring tool. It was considered essential to include tips on methodology needed, for example what standards could be used for calculating values.

3.3.2. Quality assurance

Users considered it necessary to focus not on the precise values of each functional element or indicator but on the identification of vulnerabilities and the need for improvement measures.

4. Description of the exercise method (type of event) and other practical details

4.1. Exercise method

We carried out three consecutive workshops (December 2017, February 2018 and April 2018) in which we discussed DCLs and their individual components (that is, issues, indicators and functional elements) and in between the workshops, we revised them according to the discussions. We chose workshops as the exercise method, since we could not access actual data for security reasons, and did not need to in order to fulfill the purpose of the exercise.

We organized the workshops at IVL Swedish Environmental Institute or in an adjacent location. All workshops extended for a whole day and included coffee breaks and lunch. During the workshops, we covered various topics such as:

- *Introduction to Smart Resilience and the tools to be developed*
- *Introduction to the resilience concept*
- *A discussion about resilience and its relation to similar concepts*
- *A discussion about how the project and its results can be used to fulfill objectives important to the participants or the infrastructure, in addition to and integrated with existing processes and tools for risk management/business continuity.*
- *A discussion of the scenario and the DCLs, including big data from healthcare advice centers indicating microbial outbreaks*
- *Discussions around data needed to measure indicators*
- *Discussions around how to implement the tools and how should be involved etc.*
- *Using the stress-test tool*
- *Discussion of the results and its implications for the infrastructure*

The workshops did not contain any challenges regarding logistics (other than finding suitable meeting dates), organizational, safety, security, nor privacy. We documented the workshops through written notes. All informants filled in the informed consent protocol.

4.2. Stakeholders involved in the exercise

In the workshops we had experts from MSB (the Swedish Civil Contingencies Agency), the Food Agency, a municipal fire department as well as experts from several drinking water producers and/or distributors, both large and smaller. The experts had been suggested by the Swedish Water and Wastewater association, as representative for the industry at large and selected by IVL as reflective persons. We also had an expert from the partner Sintef present during the workshops (Lars Bodsberg) and once an expert from RISE (involved in the IMPROVER) project.

4.3. Planning of the exercise

The participants were provided with material in advance that explained the overall purpose of the workshop and what we wanted from the participants. We also provided a description of the scenario, quality criteria for the indicators, including specific questions for different participants and a description of the schedule for each part of the workshop and the purpose of them.

4.4. Informed consent

All the participants signed the informed consent at the workshops.

5. Results

5.1. Main results

The tool is suitable for evaluating an event and to prepare for the future, answering questions such as: what happened, what did we do and then find improvement areas. It might also be used for training, and as part of crisis preparation. One could design fictitious crisis scenarios as a way to stress-test the internal organization with regard to its resilience towards various threats. E.g. one could analyze how to organize a suitable response organization as a means to accomplish the water emergency supply plan. For these purposes, it is important to find the right focus, i.e. to find improvement potential and to identify concrete measures. For example, one could consider moving pumps upstream to minimize risks for bacterial contamination of the raw water intake.

The stress-test was considered a good tool for self-assessment, as an input to crisis preparation. It was considered a good complement to e.g. the Sustainability Index, for which a lot of data is provided but without specific feedback on the own organization (the Sustainability Index is primarily a bench-mark exercise). The stress-test was considered useful as a complement to current reporting formats to politicians, not at least because it visualizes resilience in different phases of the cycle.

5.2. Other information

It was very useful to have recurrent workshops with the same participants, making it possible to successively refine the indicators and the DCLs in iterative cooperation.
In the workshops, we discussed how the different values (0 to 5) for the indicators should be set and what would be the various measures for each value. It could be problematic according to public law to strive for more than good (that is 3) as that would require more than justified charges. Sometimes however, good today is not necessarily good in a long-term perspective, so higher values today could be justified concerning the need to prepare for foreseen challenges due to climate change or foreseen legislation on wastewater treatment for pharmaceuticals.

6. Recommendations

The stakeholders concluded that resilience was useful as an umbrella concept encompassing several aspects of risk and vulnerability. They concluded that the stress-test could be made a useful tool, in addition to other means of assessing these aspects.

The resilience assessment is suitable for regularly ”taking the temperature” on a chosen organizational level. Following up own development over time (trending) and analyze the status, comparing with others (benchmarking), providing overview of strengths and weaknesses and point at improvement needs, making any gaps visible (lack of relevant indicators).

The assessment provides a method to identify long term risks. It can also be used as a tool for contemporary analysis. Can also be used to identify new threats where the user needs to identify vulnerability and consequences. E.g. - Benchmark against others and/or evaluation of own organization.

The tool can be used when perspectives change e.g. regularly, once a year, every third year, when something in the organization changes, when there is a new threat or phenomenon. It can be used in relation to various assignments such as e.g. risk analysis, business continuity planning, budget process, climate adaptation.

It can be applied at different levels. It can be on a strategic level in the municipal organization, or on a strategic level in the water works. It should foremost be actors within the organization, E.g. Water work personnel, Wastewater manager, Risk manager etc. To conduct risk assessment, you may need the following information: Data, steering and/ or guiding documents regarding municipal planning, strategic plans, guidelines etc.

7. Conclusions and lessons learned

The Smart Resilience tools can be used to support assignments and processes internal to the waterworks or on a higher level. They can be used to identify, visualize and evaluate resilience within the waterworks as support to maintenance and investment planning, risk analysis, and business continuity. They can also be used on an overall municipal/regional level for assignments such as climate adaptation and city planning and/or emergency and business continuity planning, planning for civil defense and as support to business intelligence.

ANNEXES

1	RiL Drinking Water Production;ID-290 (Drinking water contamination)
2	Stress test;ID-288 (Drinking water contamination)

RESILIENCE ASSESSMENT REPORT FORM

The template is proposed in the EU funded project: SmartResilience (the Grant Agreement No. 700621)
see more: http://smartresilience.eu-vri.eu/

Scenario name & ID:	**Drinking water contamination; ID-17**
DCL name & ID:	**FOXTROT stress test; ID-84**
Assessment name & ID:	**Stress test; ID-288**
Date:	**22.04.2018**

Executive summary of the exercise:

Historical data/ situational reporting of the similar events (real or simulated):

Main objectives and challenges of the exercise:

Description of the conducted exercise:

Main findings after the exercise:

Part A: Basic info

I. Resilience assessment/stress-test team member's information: Requestor		
I.1 Requestor's initials & last name:	I.2 Requestor's organization:	I.3 Requestor's position:
I.4 Requestor's phone number:	I.5 Requestor's email address:	
II. Resilience assessment/stress-test team member's information: Resilience Assessment Exercise (RAE) Manager		
II.1 RAE Manager's initials & last name:	II.2 RAE Manager's organization:	II.3 RAE Manager's position:

II.4 RAE Manager's phone number:	II.5 RAE Manager's email address:	
III. Resilience assessment/stress-test team member's information: Executive Team		
III.1 Main Analyst's initial & last name:	III.2 Main Analyst's organization:	III.3 Main Analyst's position:
III.4 Liaison Officer/Security Liaison Officer's initials & last name (if applicable):	III.5 Liaison Officer/ Security Liaison Officer's organization (if applicable):	III.6 Liaison Officer/ Security Liaison Officer's position (if applicable):
III.7 Resilience Tool Operator's initials & last name (if applicable):	III.8 Resilience Tool Operator's organization (if applicable):	III.9 Resilience Tool Operator's position (if applicable):
IV. Resilience assessment/stress-test team member's information: Team Members		
IV.1 Infrastructure Specialist's initials & last name (if applicable):	IV.2 Infrastructure Specialist's organization (if applicable):	IV.3 Infrastructure Specialist's position (if applicable):
IV.4 Other Experts' initials & last name (if applicable):	IV.5 Safety & Security/ Rescue Specialists' initials & last name (if applicable):	IV.6 IT/SCADA/data specialists' initials & last name (if applicable):

V. Scenario information (to be completed by the Resilience Assessment Exercise Manager)	
V.1 Scenario name: Drinking water contamination	V.2 Scenario description: The scenario takes place in a medium-sized Swedish city with 10-15,000 inhabitants. In the city there is a waterworks that supplies approximately 10,000 people with drinking water. The water is taken from a surface/ground water source and is after the purification process distributed out to the people in the city. It has been raining for about a week. At the beginning of the week about four to five millimeters a day and the soil begins to get saturated, the rain does not decrease but increases and after seven days it has reached about 40-50 mm. Then the city is suffering from an intense rainfall, a so called 100-year rain, and for about 24 hours it rains intensively. A total of about 150 mm falls on an already saturated field. SMHI (Swedish and Meteorological and Hydrological Institute) goes out with warning class 3. .The heavy rain is leading to floods. All low points in the area, such as road tunnels, are flooded and so are many basements.
V.3 Type(s) of (smart) critical infrastructure involved:	☐ All/any infrastructures ☐ Financial Systems ☐ Energy Supply Systems ☐ Health Care Systems ☐ Transportation System ☐ Industrial Production Systems ☑ Water Supply Systems ☐ ICT Systems ☐ Other SCIs
V.4 Particular substructures (parts of infrastructures) involved in the exercise:	

V.5 Provide details on the smartness level of the selected infrastructure:		
V.7 Other CI(s) possibly affected:		
V.8 Type(s) of threats:	☐ All/any threats ☐ Terrorist attack ☐ Cyber attack ☐ Natural threats ☐ Social Unrest ☐ New Technology Accident ☐ Cascading Effects ☑ Other Threats	
Other (description/details):		
V.9 Task Nr.:	V.7 Case Study "identifier" and name: SmartResilience Project: FOXTROT: Drinking water supply system	
VI. EXCERCISE INFORMATION (to be completed by Resilience Assessment Exercise Manager)		
VI.1 Start date, time:	VI.2 End date, time:	VI.3 Event place/venue:
VI.4 Type event (cf. FEMA 2013):	☐ Seminar ☐ Workshop ☐ Table-top ☐ Game ☐ Drill ☐ Functional Exercise ☐ Full-Scale Exercise ☐ Other (describe)	
Other (description/details):		

Part B: Resilience Assessment Setup

VII. SmartResilience analysis setup (to be completed by the Exercise coordinator)	
VII.1 Type of resilience analysis:	☐ resilience level assessment (RL) ☑ stress-text / functionality assessment (FL) ☐ other (describe)
VII.2 Other (description/ details):	
VII.3 Dynamic Check-List (DCL) ID: 84	VII.4 DCL name: FOXTROT stress test

VII.5 Elements and indicators for Functionality Level assessment (FL)* with theirs IDs: * - alternatively attach the full list as Appendix	Element, indicator (at given points in scenario time) **Functionality** 1. FE Organizational; ID-3471 1.1. What is the ability to stop or reduce operations in case of a disturbance?; ID-3070 1.2. What is the value of of available external decision support?; ID-3079 1.3. What is the ability to monitor effects and adapt?; ID-3087 2. FE Communicative; ID-3472 2.1. How fast can the organization repair equipment in unplanned situations?; ID-3094 2.2. What is the ability to communicate status externally?; ID-3072 2.3. What are the possibilities to reach the concerned citizens and organization; ID-3470 3. FE Microbial; ID-3473 3.1. Number of microorganisms?; ID-1946 3.2. Time to identify contaminated raw water; ID-3474
VII.6 Functionality parameters:	Downtime (minutes, days, etc.):
	Recovery time (minutes, days, etc.):
	Recovery rate (% over time):
	Improvement/adaptation/transformation (%):

Part C: Resilience Assessment Results

VIII. Functionality level assessment/stress-test results		
VIII.1 Resilience level assessment/stress-test performance date: 22.04.2018	VIII.2 Location:	
VIII.3 Functionality Level assessment / stress-test results:	See: Annex 1: Functionality Level assessment results for Stress test	
VIII.4 Evaluation of Functionality Level assessment /stress-test results:		
VIII.5 Evaluation of the results compared to minimum / critical level of functionality / Stress-test limits:	Downtime (minutes, days, etc.):	Is it equal/ above threshold:
	Recovery time (minutes, days, etc.):	Is it equal/ above threshold:
	Recovery rate (% over time):	Is it equal/ above threshold:
	Improvement/adaptation/transformation (%):	Is it equal/ above threshold:
VIII.6 Preventative/ protective/ corrective measures to be implemented:		
VIII.7 MCDM results:	N/A	

VIII.8 Selected alternative:	
VIII.9 Other relevant information:	
VIII.10 Approved by (name, affiliation):	VIII.11 Date:

VIII.12 List of attachments:

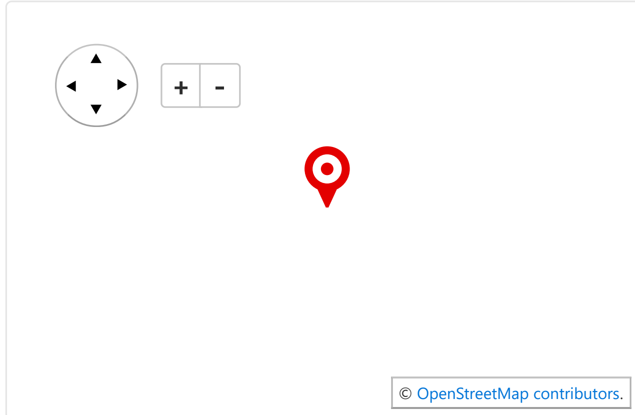
File Name	Download	Delete
No records to display.		

IX. Feedback from the resilience assessment exercise
IX.1 Issues/ suggestion methodologies:
IX.2 Issues / suggestions tools:
IX.3 Resilience of the SCI in the DCL based test compared another resilience or risk assessment method:
IX.4 New indicators which have been derived from the dataset:
IX.5 Other suggestions/general feedback:

Dynamic Checklist Assessment Results

Assessment Basic Information

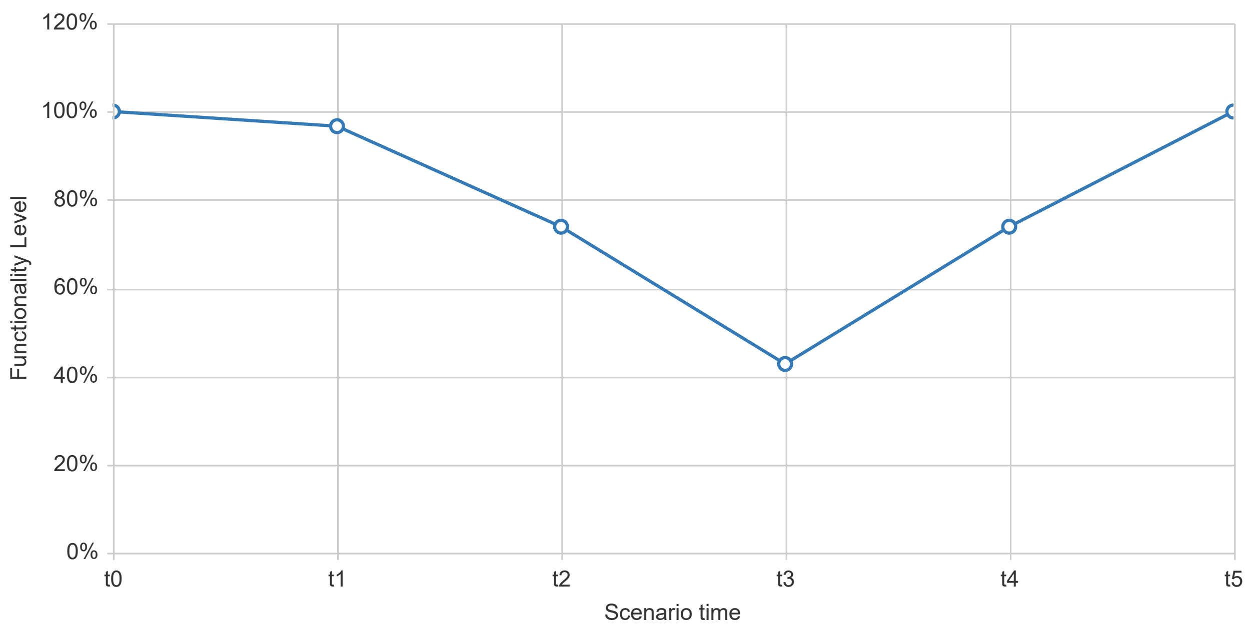
Name:	**Stress test**
On:	4/22/2018 12:00:00 PM
By:	Rahmberg Magnus (IVL)
Scenario:	Drinking water contamination
DCL:	FOXTROT stress test



Approved by Rahmberg Magnus / 25.10.2018

Time: Equidistant time ▼

Show legend



Functionality Time Series

Point	Real Time	Relative Time (h)	Acceptance Level (%)	Description	New Injuries	New Deaths	New Economic Loss
t0	05.12.2017 09:00	0		Process function normal			
t1	05.12.2017 12:00	3		Leackage of E. coli bacteria in to distrubtion system			
t2	05.12.2017 16:00	7		Raw water contamination of E. coli.			
t3	05.12.2017 18:00	9		Power break at treatment plant			
t4	05.12.2017 20:00	11		Power back at treatment plant			
				Total:	0	0	0

Point	Real Time	Relative Time (h)	Acceptance Level (%)	Description	New Injuries	New Deaths	New Economic Loss
t5	08.12.2017 09:00	72		Leackage in distribution system fixed			
				Total:	0	0	0

Name	Type	t0	t1	t2	t3	t4	t5
Functionality level	**Root**	**100.00**	**96.67**	**73.89**	**42.78**	**73.89**	**100.00**
1. FE Organizational; ID-3471	**Element**	**100.00**	**100.00**	**76.67**	**56.67**	**93.33**	**100.00**
1.1. What is the ability to stop or reduce operations in case of a disturbance?; ID-3070	Indicator	100.00	100.00	70.00	70.00	80.00	100.00
1.2. What is the value of of available external decision support?; ID-3079	Indicator	100.00	100.00	80.00	60.00	100.00	100.00
1.3. What is the ability to monitor effects and adapt?; ID-3087	Indicator	100.00	100.00	80.00	40.00	100.00	100.00
2. FE Communicative; ID-3472	**Element**	**100.00**	**100.00**	**100.00**	**36.67**	**73.33**	**100.00**
2.1. How fast can the organization repair equipment in unplanned situations?; ID-3094	Indicator	100.00	100.00	100.00	40.00	60.00	100.00
2.2. What is the ability to communicate status externally?; ID-3072	Indicator	100.00	100.00	100.00	30.00	100.00	100.00
2.3. What are the possibilities to reach the concerned citizens and organization; ID-3470	Indicator	100.00	100.00	100.00	40.00	60.00	100.00
3. FE Microbial; ID-3473	**Element**	**100.00**	**90.00**	**45.00**	**35.00**	**55.00**	**100.00**
3.1. Number of microorganisms?; ID-1946	Indicator	100.00	80.00	50.00	40.00	50.00	100.00
3.2. Time to identify contaminated raw water; ID-3474	Indicator	100.00	100.00	40.00	30.00	60.00	100.00

SMART RESILIENCE	**RESILIENCE ASSESSMENT REPORT FORM**

The template is proposed in the EU funded project: SmartResilience (the Grant Agreement No. 700621)
see more: http://smartresilience.eu-vri.eu/ (http://smartresilience.eu-vri.eu/)

Scenario name & ID:	**Drinking water contamination; ID-17**
DCL name & ID:	**RIL for MCDM; ID-85**
Assessment name & ID:	**RiL Drinking Water Production; ID-290**
Date:	**22.04.2018**

Executive summary of the exercise:

Historical data/ situational reporting of the similar events (real or simulated):

Main objectives and challenges of the exercise:

Description of the conducted exercise:

Main findings after the exercise:

Part A: Basic info

I. Resilience assessment/stress-test team member's information: Requestor		
I.1 Requestor's initials & last name:	I.2 Requestor's organization:	I.3 Requestor's position:
I.4 Requestor's phone number:	I.5 Requestor's email address:	
II. Resilience assessment/stress-test team member's information: Resilience Assessment Exercise (RAE) Manager		
II.1 RAE Manager's initials & last name:	II.2 RAE Manager's organization:	II.3 RAE Manager's position:

II.4 RAE Manager's phone number:	II.5 RAE Manager's email address:	
III. Resilience assessment/stress-test team member's information: Executive Team		
III.1 Main Analyst's initial & last name:	III.2 Main Analyst's organization:	III.3 Main Analyst's position:
III.4 Liaison Officer/Security Liaison Officer's initials & last name (if applicable):	III.5 Liaison Officer/ Security Liaison Officer's organization (if applicable):	III.6 Liaison Officer/ Security Liaison Officer's position (if applicable):
III.7 Resilience Tool Operator's initials & last name (if applicable):	III.8 Resilience Tool Operator's organization (if applicable):	III.9 Resilience Tool Operator's position (if applicable):
IV. Resilience assessment/stress-test team member's information: Team Members		
IV.1 Infrastructure Specialist's initials & last name (if applicable):	IV.2 Infrastructure Specialist's organization (if applicable):	IV.3 Infrastructure Specialist's position (if applicable):
IV.4 Other Experts' initials & last name (if applicable):	IV.5 Safety & Security/ Rescue Specialists' initials & last name (if applicable):	IV.6 IT/SCADA/data specialists' initials & last name (if applicable):
V. Scenario information (to be completed by the Resilience Assessment Exercise Manager)		
V.1 Scenario name: Drinking water contamination	V.2 Scenario description: The scenario takes place in a medium-sized Swedish city with 10-15,000 inhabitants. In the city there is a waterworks that supplies approximately 10,000 people with drinking water. The water is taken from a surface/ground water source and is after the purification process distributed out to the people in the city. It has been raining for about a week. At the beginning of the week about four to five millimeters a day and the soil begins to get saturated, the rain does not decrease but increases and after seven days it has reached about 40-50 mm. Then the city is suffering from an intense rainfall, a so called 100-year rain, and for about 24 hours it rains intensively. A total of about 150 mm falls on an already saturated field. SMHI (Swedish and Meteorological and Hydrological Institute) goes out with warning class 3. .The heavy rain is leading to floods. All low points in the area, such as road tunnels, are flooded and so are many basements.	
V.3 Type(s) of (smart) critical infrastructure involved:	☐ All/any infrastuctures ☐ Financial Systems ☐ Energy Supply Systems ☐ Health Care Systems ☐ Transportation System ☐ Industrial Production Systems ☑ Water Supply Systems ☐ ICT Systems ☐ Other SCIs	
V.4 Particular substructures (parts of infrastructures) involved in the exercise:		
V.5 Provide details on the smartness level of the selected infrastructure:		

V.7 Other CI(s) possibly affected:	
V.8 Type(s) of threats:	☐ All/any threats ☐ Terrorist attack ☐ Cyber attack ☐ Natural threats ☐ Social Unrest ☐ New Technology Accident ☐ Cascading Effects ☑ Other Threats
Other (description/details):	
V.9 Task Nr.:	V.7 Case Study "identifier" and name: SmartResilience Project: FOXTROT: Drinking water supply system

VI. EXCERCISE INFORMATION (to be completed by Resilience Assessment Exercise Manager)		
VI.1 Start date, time:	VI.2 End date, time:	VI.3 Event place/venue:
VI.4 Type event (cf. FEMA 2013):	☐ Seminar ☐ Workshop ☐ Table-top ☐ Game ☐ Drill ☐ Functional Exercise ☐ Full-Scale Exercise ☐ Other (describe)	
Other (description/details):		

Part B: Resilience Assessment Setup

VII. SmartResilience analysis setup (to be completed by the Exercise coordinator)	
VII.1 Type of resilience analysis:	☑ resilience level assessment (RL) ☐ stress-text / functionality assessment (FL) ☐ other (describe)
VII.2 Other (description/ details):	
VII.3 Dynamic Check-List (DCL) ID: 85	VII.4 DCL name: RIL for MCDM

VII.5 Issues and indicators for Resilience Level assessment (RL)* with theirs IDs: * - alternatively attach the full list as Appendix	Phase, issue, indicator **I. Understand risks** I.1. RSA used in planning; ID-394 I.1.1. Is the RSA known in relevant parts by various critical groups?; ID-1822 **II. Anticipate/prepare** II.1. Contamination risk of raw water; ID-1289 II.1.1. Number of potential sources of contamination?; ID-1887 II.2. Quality of drinking water; ID-486 II.2.1. How often do representatives (drinking water) assess data from healthcare?; ID-1831 **III. Absorb/withstand** III.1. Assessing Barrier status; ID-1812 III.1.1. Number of microorganisms?; ID-1946 **IV. Respond/recover** IV.1. Information within organization; ID-404 IV.1.1. Has it been identified who to inform and how within the organization?; ID-1872 IV.2. Communication; ID-1808 IV.2.1. What is the ability to externally communicate status during recovery phase?; ID-3090 **V. Adapt/transform** V.1. Implementation and follow-up of lessons learned ; ID-3043 V.1.1. Quality of the lessons learned process?; ID-3101
VII.6 Resilience Level (RL) critical limits:	Safe zone:
	Alert zone:
	Alarm zone:
	Critical zone:

Part C: Resilience Assessment Results

VIII. Resilience level assessment results		
VIII.1 Resilience level assessment performance date: 22.04.2018	VIII.2 Location:	
VIII.3 Resilience Level assessment : * - alternatively attach the full list as Appendix	See: Annex 1: Resilience Level assessment results for RiL Drinking Water Prc	
VIII.4 Evaluation of Resilience Level assessment: * - alternatively attach as Annex		
VIII.5 Evaluation of the results compared to the critical levels:	Resilience Level: 3.3	Critical zone to which belongs the results:
VIII.6 Preventative/ protective/ corrective measures to be implemented:		
VIII.7 MCDM results: * - if applicable	Dricksvattenproduktion; ID-5 >>Default analysis setup; ID-5 See: Annex 2: MCDM Analysis	
VIII.8 Selected alternative:		

VIII.9 Other relevant information:	
VIII.10 Approved by (name, affiliation):	VIII.11 Date:

VIII.12 List of attachments:

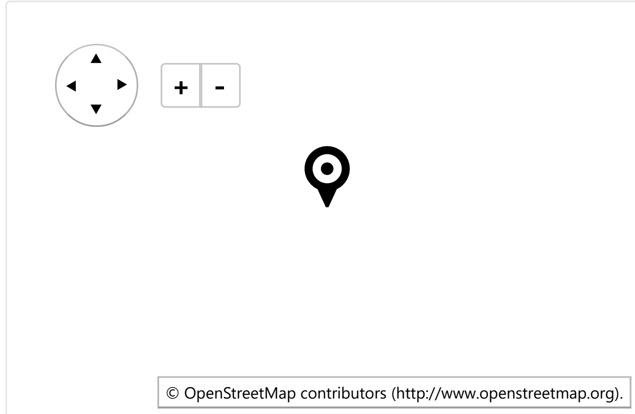
File Name	Download	Delete
No records to display.		

IX. Feedback from the resilience assessment exercise
IX.1 Issues/ suggestion methodologies:
IX.2 Issues / suggestions tools:
IX.3 Resilience of the SCI in the DCL based test compared another resilience or risk assessment method:
IX.4 New indicators which have been derived from the dataset:
IX.5 Other suggestions/general feedback:

Dynamic Checklist Assessment Results

Assessment Basic Information

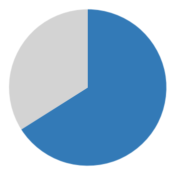
Name:	**RiL Drinking Water Production**
On:	4/22/2018 12:00:00 PM
By:	Rahmberg Magnus (IVL)
Scanario:	Drinking water contamination
DCL:	RIL for MCDM



Approved by Rosen Tal / 25.10.2018

R_{IL}=3.3

Good

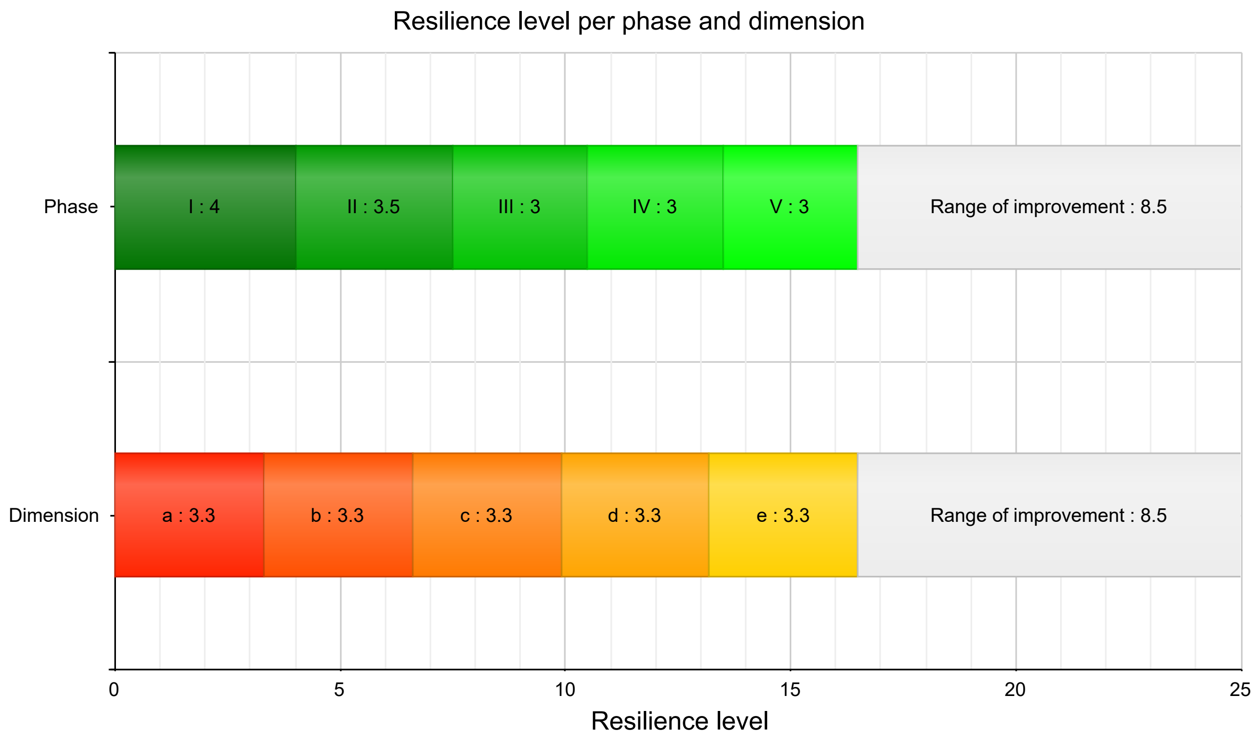


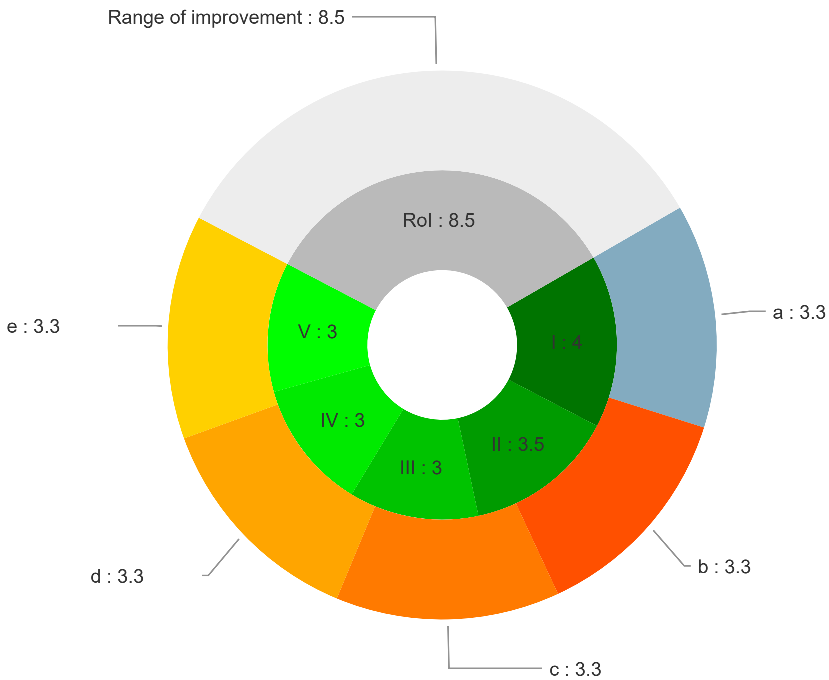
Number of indicators per cell

Phase Dim\	I.Understand Risk	II.Anticipate/ prepare	III.Absorb/ withstand	IV.Respond/ recover	VAdapt/ trandform
a. System/ physical	1	1	1	1	1
b. Information/ smartness	1	1	1	1	1
c. Organization/ business	1	1	1	1	1
d. Societal/ political	1	1	1	1	1
e. Cognitive/ decision making	1	1	1	1	1

Resilience level matrix

Phase Dim\	I.Understand Risk	II.Anticipate/ prepare	III.Absorb/ withstand	IV.Respond/ recover	V.Adapt/ trandform
a. System/ physical	4	3.5	3	3	3
b. Information/ smartness	4	3.5	3	3	3
c. Organization/ business	4	3.5	3	3	3
d. Societal/ political	4	3.5	3	3	3
e. Cognitive/ decision making	4	3.5	3	3	3





Name	Type	Syst a	Info b	Org c	Soc d	DeM e	Score	Resilience Level
Resilience index level	**Root**						**3.3**	**Good**
I.Understand risks	**Phase**						**4**	**Good**
I.1. RSA used in planning; ID-394	**Issue**	✓	✓	✓	✓	✓	**4**	**Good**
I.1.1. Is the RSA known in relevant parts by various critical groups?; ID-1822	Indicator						4	Good
II.Anticipate/prepare	**Phase**						**3.5**	**Good**
II.1. Contamination risk of raw water; ID-1289	**Issue**	✓	✓	✓	✓	✓	**3**	**Average**
II.1.1. Number of potential sources of contamination?; ID-1887	Indicator						3	Average
II.2. Quality of drinking water; ID-486	**Issue**	✓	✓	✓	✓	✓	**4**	**Good**
II.2.1. How often do representatives (drinking water) assess data from healthcare?; ID-1831	Indicator						4	Good
III.Absorb/withstand	**Phase**						**3**	**Average**
III.1. Assessing Barrier status; ID-1812	**Issue**	✓	✓	✓	✓	✓	**3**	**Average**
III.1.1. Number of microorganisms?; ID-1946	Indicator						3	Average
IV.Respond/recover	**Phase**						**3**	**Average**
IV.1. Information within organization; ID-404	**Issue**	✓	✓	✓	✓	✓	**3**	**Average**
IV.1.1. Has it been identified who to inform and how within the organization?; ID-1872	Indicator						3	Average
IV.2. Communication; ID-1808	**Issue**	✓	✓	✓	✓	✓	**3**	**Average**

Name	Type	Syst a	Info b	Org c	Soc d	DeM e	Score	Resilience Level
IV.2.1. What is the ability to externally communicate status during recovery phase?; ID-3090	Indicator						3	Average
V.Adapt/transform	**Phase**						**3**	**Average**
V.1. Implementation and follow-up of lessons learned ; ID-3043	**Issue**	✓	✓	✓	✓	✓	**3**	**Average**
V.1.1. Quality of the lessons learned process?; ID-3101	Indicator						3	Average

Annex 2: MCDM analysis

MCDM analysis name: Dricksvattenproduktion
MCDM analysis setup name: Default analysis setup

Alternatives	Criteria		
	Kostnad / SEK / [0.00 - 5,000,000.00]	Tid [0.00 - 730.00]	ΔR [0.00 - 5.00]
RIPM 1	3,500,000.00	365.00	0.60
RIPM 2	1,500,000.00	145.00	0.80
RIPM 3	800,000.00	90.00	0.50

Alternative	Mean value	Minimum value	Maximum value
RIPM 3	60.56	60.56	60.56
RIPM 2	55.38	55.38	55.38
RIPM 1	30.67	30.67	30.67