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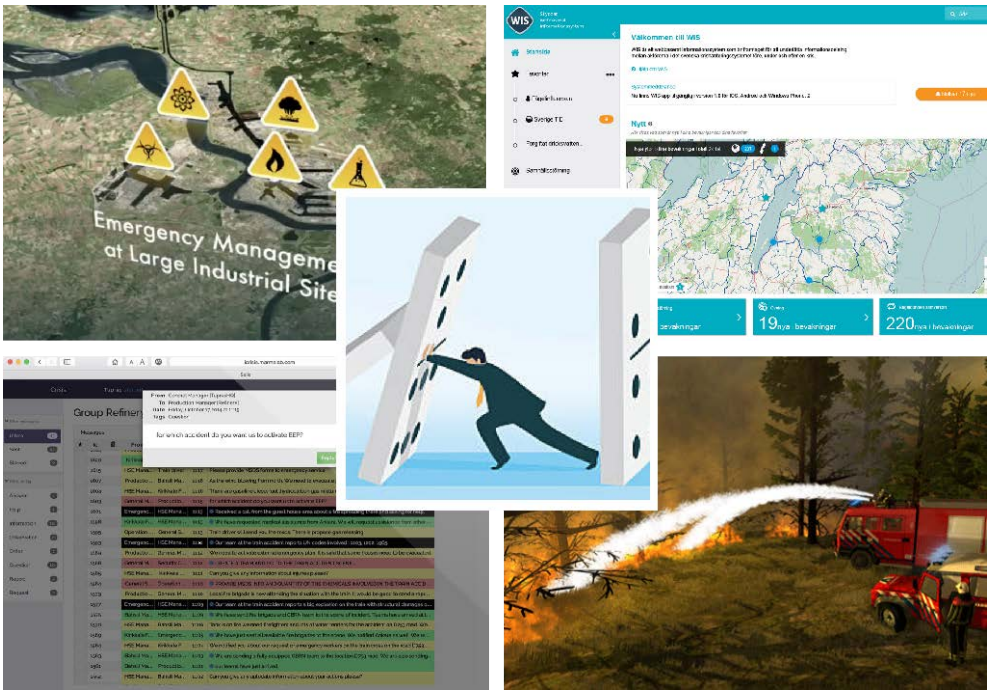
D5.2 - Debriefing reports from simulations using all the systems incorporated into the project: iCrisis™, NoKeos, XVR, and WIS



Deliverable Number:	D5.2
Date	2017
Due Date (according to DoW)	July 2017
Dissemination level	
Reviewed by	Florence CARRE

Grant Agreement No:	607665
Coordinator:	Anders Lönnermark at SP Sveriges Tekniska Forskningsinstitut (SP Technical Research Institute of Sweden)
Project acronym:	CascEff
Project title:	Modelling of dependencies and cascading effects for emergency management in crisis situations

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Executive Summary

This document reports the outcomes from the simulations using the partners' Incident Management Tools (IMTs) during the CascEff project. The report is the result of Task 5.2: "Initial testing and feedback to WP 1-4". First, it provides a general description of iCrisis™, NoKeos, XVR and WIS including how these tools are routinely used.

Following this, the deliverable discusses the use of two simulation tools (iCrisis and XVR) for the test of the philosophy of the Incident Evolution Tool (IET) prototype, and for the validation of the Incident Evolution Methodology (IEM). The philosophy of the IET is to provide incident managers with descriptive information on the potential incoming and outgoing effects of the systems, which could be involved in a crisis situation induced by a given incident, in order to enable managers to find information concerning dependencies between the systems, and to help them to anticipate the spreading of disturbances resulting from this incident. The test consisted of investigating the general interest of the philosophy, demonstrated through a paper prototype of the IET, prior to the design of the IEM and the web-based IET.

The test confirmed that the philosophy of the IET is understandable, and structured in a logical sequence. It also showed that the paper-based IET could provide useful information that allowed considering cascading effects since the participants with access to the IET felt that their decisions and actions to a greater extent influenced the incident resolution in a positive way, compared to participants who did not use the tool. However, the manual implementation of the philosophy (using the paper-based IET) was shown feasible until the first level of cascades. This justified the need to develop a software that would make automated calculations for modelling high order cascading effects. Moreover, this test provided the consortium with an idea on the potential added value of the awareness/knowledge on cascading effects in the process of decision-making when managing crisis situations.

The validation of the IEM with the use of iCrisis and XVR as supportive tools has shown that the IEM could be used in association with other existing tools. However, it revealed that the workload of the whole IEM hindered its complete use during response phase since incident managers do not have time to go through all the six steps of the IEM when facing a crisis situation.

Finally, it summarizes the lessons learnt from workshops/interviews organised with the potential end-users of two IMTs (NoKeos and WIS), concerning their views on the opportunities, challenges and methods of linking their IMT with the IET. The most relevant lessons learnt from the users' interviews are as follows:

- an integration of the IET with existing IMTs such as NoKeos and WIS could help their users offering them an overall snapshot visualisation of all the effects of an ongoing incident, and by providing support to deal with long-lasting and complex incidents in planning and response phase;
- the following points challenge the integration of the IET with these tools: the accuracy of the input data, the preciseness of the IET predictions, the translation of the IET objects into IMTs objects (and vice-versa), the confidentiality of the data, etc.

Glossary

Incident Evolution Methodology (IEM)
Methodology for predicting cascading effects, their impacts and emphasizing critical points as support to crisis and emergencies managers

Incident Evolution Tool (IET)
Tool, based on the IEM, intended for a computerized prediction of cascading effects, their impacts and emphasizing critical points as support to crisis and emergencies managers

1 Introduction

The CascEff project, through WP4 and WP5 which dealing with Incident Evolution Tool (IET) development and implementation in existing tools and scenario development and simulated exercises, addresses the integration of the Incident Evolution Tool within the existing tools included in the project. The ultimate purpose is to identify how to properly exchange data between the Incident Evolution Tool and other tools for providing incident management actors with useful information.

To achieve this goal, the project focused on the analysis of the feasibility of linking-up the Incident Evolution Tool under development with four tools involved in the project (iCrisis, NoKeos, XVR and WIS). This was carried out through two main approaches. The first one consisted of using or trying to use two of the tools (namely, iCrisis and XVR) for testing the philosophy of IET and/or validating the Incident Evolution Methodology (IEM). According to the DoW, task T5.2 will "*allow an evaluation/validation of the proposed Incident Evolution Methodology (IEM) both as a decision support tool in itself and through its illustration with other systems included in the project. [ ] In the case of the software provided by UL (iCrisis) and E-semble (XVR) these will support pre-incident planning, training and debriefing*". This concretely means that "*XVR and iCrisis simulation platforms will be used to enhance the observation of the behaviour of first responders in a controlled, measurable but realistic setup*".

The second approach was to conduct users' workshops with two different Incident Management Tools (IMTs) (NoKeos and WIS) for identifying the opportunities of an integration of the IET within an IMT using these 2 tools as examples. The workshops/interviews also addressed finding the potential challenges which could be faced when dealing with this integration and suggesting how an integration could be facilitated. These workshops were organised within the framework of the task T4.4 in which: "*specifications necessary to enable the software to be used for prediction and/or simulations of an incident with cascading effects in conjunction with other crisis management tools will be developed. These specifications will be made by the owners/developers of the software, easing the requirements arising from this task for IP considerations to include the source code of the software tools. Feedback from WP5 will be used for improvement both of the methodology and the implementation. The needed functionalities in the IET for the communication with existing incident management tool will be described in tasks 4.2 and 4.5*".

This report starts by introducing the tools; their usage and the benefits that they bring to the users with an emphasis on iCrisis. This specific focus is because iCrisis, a crisis simulation tool, was used during the first IEM validation meeting (held at University of Lorraine - France) to observe how the IEM would be used in a training exercise for incident response (see D5.4). Table 1 shows a synopsis of these tools.

In addition to the description of the four tools, this deliverable discusses the use of some tools during the testing (with iCrisis; following the exercise methodology presented in the D1.4, and using the Séchilienne scenario, one of the selected scenarios described in the D5.1), and the validation (with iCrisis and XVR) simulations that were performed along the whole duration of the project. It also presents the results of the testing simulations. Lastly, this document reports the findings from NoKeos and WIS users' workshops/interviews conducted with end users in order to collect their ideas on a potential integration of the IET with these tools. The outcomes presented in this deliverable do not focus on a technical description of this integration (this aspect is reported in D4.5, and relies on the architecture of the IET which is designed in the

D4.3 and D4.4), but the users' point of view on the feasibility or applicability of such an integration, as well as on the challenging points and the expected added value when deploying this integration.

The deliverable is organized into eight sections. The first one is a general introduction. Sections 2 to 5, present a general description, the technical characteristics and the routine operations process of each tool. Section 6 describes the setups applied when using the tools for testing and validating the IEM and/or the IET. Section 7 presents the viewpoints of potential IMT users of the IET prototype using NoKeos and WIS as examples during workshops. Finally, section 8 concludes the report.

Table 1 Synopsis of the tools

Tools	Description	Added value to the project
iCrisis	Web-based training simulator for crisis management at strategic level (during the response phase).	The iCrisis simulation approach enables to conduct table-top virtual full scale simulations. Crisis units play together to cope with the crisis situation created through iCrisis. The flexibility of iCrisis makes it very usable since it is adaptable to the level of participants (students or professionals) as well as to the scenario which is « open » accommodating to the reactions of the participants. Therefore, iCrisis serves as a support tool for the validation of the IEM in the context of a crisis situation which corresponds to a response phase.
XVR	Immersive 3D visualisation tool for providing simulation players with a pictorial view of the evolution of scenarios.	XVR is an on-scene simulator using pre-created incident scenarios or on the fly additions to scenarios. As such it serves as an example of the visualization of a situation in which the IEM is applied. XVR can be used in the various phases of crisis management and allows instructors to tailor the current situation to the resulting outcomes of the IEM. XVR provides the participants with a high fidelity first person perspective of that given situation, the effects of the cascade, the effects of mitigating actions and the regular enacted response.
NoKeos	Interactive IMT intended to foster a coordinated intervention of multiple incident management actors	NoKeos is an advanced IMT using structured data gathering. As such it serves as an example on how the IET can exchange data with similar IMTs. As NoKeos can be used both in preparation and response phases, integration of the IET in both phases can be validated. Information from Nokeos can be used to predict potential cascading effects in the IET. The results of the cascading effect modelling can then be fed back into NoKeos to activate certain scenario's and share a visual picture of the affected systems with all NoKeos users using the GIS interface.
WIS	IMT for collecting all the information provided by various actors about a given incident requiring management.	WIS is a web based platform for information sharing. Information added by the interacting organizations is both text-based (i.e. status reports, assessments, analysis), and structured data (i.e. specific resources available/needed). As such it serves as an example on how the IET can exchange data with similar IMTs. WIS is used for everyday incidents as well as large and prolonged incidents, primarily in the response phase but also for daily reporting. Integration of the IET can thus be validated in the preparedness as well as the response phase. Knowledge of potential or actual cascading effects can be included in the reporting and decision making process, improving the situational analysis and communication between stakeholders.

2 iCrisis™: A scientific approach to simulate crisis situations and the state of crisis

The scope of the iCrisis approach is to:

- create simulated situations defined by specific characteristics such as chaos, surprise, unexpectedness, important consequences, uncertainty, evolving, irregular rhythm, numerous stakeholders, information management issues, media involvement, and
- immerse players in a state characterised by astonishment, time pressure, disorder, anxiety, changes in relationship.

iCrisis aims at providing an internet-based platform to perform simulations of virtual crises and could be described as a role-playing game easy to implement and animated in such a way that players find themselves immersed in conditions similar to those experienced in real crisis-management situations. iCrisis simulations are not Master vs Players but Players vs Players based, where collaborative creativity is emphasized. Players are divided into different crisis management entities (crisis units) with people who virtually attempt to cope with a crisis situation at a strategical level.

Using iCrisis as a training tool has the following objectives:

- Reproduce the atmosphere of crisis situations with a certain degree of realism so that participants experience a range of typical effects in connexion with the characteristics defining a crisis (see Tables 1 and 2).
- Contribute to the sensitization about decision-making issues in the crisis steering process.
- Contribute to enhance team building for the groups of participants
- Improve the conditions of cooperative learning of the participants involved in crises management within closed groups through the sharing of their experiences, knowledge and points of view.
- Draw the attention of professional trainees to the weaknesses of their preparedness capacity by helping to assess the efficiency of their organizations in crisis situations.
- Raise situational awareness of participants (professionals and students) about challenges crisis situations may pose and the various behaviours which the actors involved in a crisis management could have.
- Let the participants develop some non-technical skills such as: ability to delegate, leadership, analytical synthesis, teamwork, communication, action in uncertainty, stress management, etc.
- Demonstrate crisis communication challenges (keeping in mind that communication has traditionally been the Achilles' Heel of crisis management operations) by placing participants under the pressure of media.

2.1 Technical characteristics

iCrisis is a flexible multi-player online tool which could be simultaneously used on several networked laptop-computers. Based on html5, iCrisis is an up to date web application which can be used anywhere without any installation. Thus, it can be used by strategic crisis management entities sitting in remote locations (even in different countries if necessary). It just needs the configuration of the simulation settings that are the simulation ID, and the login information for the different crisis units. It can be set by the simulation administrator for any

number of groups of decision-makers involved in each simulation. Last generation web browsers (chrome or safari) are required for iCrisis to operate smoothly.

Moreover, because it is a web-based tool, iCrisis can make use of or interact with any web-based platform. The use of iCrisis does not require any specific computing knowledge and skills: participants need to have only a basic knowledge on using computers for chatting with virtual interlocutors.

It records and stores all the messages exchanged between participants' groups, thus allowing the simulation team to track messages in real-time as well as to make a dynamic analysis in order to adapt the on-going scenario the actions/decisions taken by the participants.

2.2 Routine use process

Running a simulation with iCrisis is a four-stage process:

- Constructing the scenario to be used;
- Running the simulation;
- Debriefing with participants to share their experience and to analyse the outcomes of the simulation.
- Setting up an action plan for improvement (not described here).

2.2.1 Constructing the scenario to be used

The iCrisis approach begins with a given scenario but then allows for adaptation of the story depending on how the participants chose to cope with the situation. A key feature of the approach is to make simulations very adaptive and responsive: the simulations run using iCrisis execute an open scenario; that is, only the context of the scenario remains fixed. The story itself is left flexible to fit with the reactions of the participants, which is not foreseeable. Since the objective is to sensitize the participants about the crisis situation and state characteristics then the management of the simulated situation is not a crucial point for the players. In comparison, for an emergency situation simulation exercise the scenario is very precise since the objective in such exercise is to assess the response of the players.

2.2.2 Running the simulation

An iCrisis simulation involves one to several (at least three) physically separated crisis management entities (crisis units) described later on, a media office and an animation team; all of which are connected through iCrisis. The three crisis units generally consist of a Prefecture command post (at the county level), a Municipality command post and a Company command post (Figure 1). However, any configuration at a strategic level is possible. In each crisis units, there is a person observing the functioning of the players as crisis managers. iCrisis simulations are based on an observation methodology of the organization and management processes implemented by the groups. Observers are given observation forms to be used to observe players and giving feedback of the decision-making process in the group during the debriefing. They can send message to the animation team during the simulation to report any problem or incident which could disrupt the effective running of the simulation.

Generally, a whole training session (running simulation and debriefing) is full-day session. At the beginning of the training session all the participants are in one room for briefing them on the objectives of the training session and on the use of the iCrisis platform. Then they move to their separate rooms to start the simulation running. From the starting of the simulation, each

crisis unit receive scenario injects from the animation team and media office also. Groups can exchange messages (see full line arrows in Figure 1). The animation team can exchange messages with all groups and receives copies of all messages exchanged between the playing groups through the iCrisis application (see dashed arrows in Figure 1). This helps the animation team to follow, in real-time, the interactions between the groups and interact itself with the groups in order to introduce new events. These interconnections and the presence of observers (see solid grey arrows in Figure 1) allow the animation team to adapt the storyline based on the participants' reactions.

A simulation starts with an unspecified length but is usually run for a duration corresponding to approximately two to three hours. The duration depends on the reactions of the players and the simulation ends when the animation team judges that the participants experienced all the characteristics of the crisis situation and the crisis state. Once this state is reached, the animation team sends a message notifying the end of the simulation to the players.

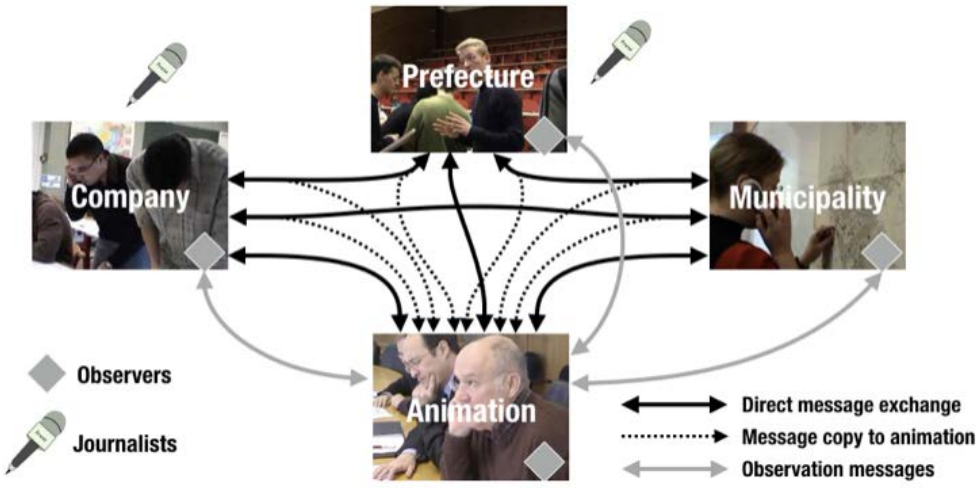


Figure 1 General overview of the iCrisis simulation approach (arrows represent the flow of information via text messaging)

2.2.3 Debriefing with participants

Each simulation is followed by a debriefing that lasts for approximately two hours and is carried out in one room for all the attendees. The debriefing is the opportunity for the participants, the facilitators (from the animation team) and the journalists to share their experiences of the simulation in a frank and honest manner, no judgement is made on what they did to fit with the crisis sensitization objective.

Participants from each crisis unit speak first to relate the key events they have faced and how they have coped with these events. Observers speak then to share what they have watched regarding the team organization and management in the crisis units. The journalists present a press article and/or a TV news report based on the information they gathered during the simulation. The debriefing also gives the facilitators the opportunity to talk about the potential "*mistakes and misunderstandings*" made by the participants in a non-judgmental way as well as about the difficulties involved in dealing with the crisis situation and increase participants' awareness.

iCrisis also offers a set of statistical tools which will help the animation team during the simulation itself or during the debriefing. All messages exchanged during a simulation are stored in a database. Therefore, it is possible to draw some simple but useful statistics such as:

- The number of messages exchanged (sent and received) between the groups (as shown in Figure 2a).
- The number and ratio of the types of the messages (thanks to a tagging function) for any group; this either for sent or received or all messages (Figure 2b).
- The chronological stream of all sent and received messages by a particular group during a simulation which shows up the dynamics of the discussion (Figure 3). This stream includes a « search » option highlighting the occurrence of a given word. This option helps to bring out a misunderstanding or a dysfunction in the information processing. Etc.

Moreover, using a social graph (see Figure 4), key players can be highlighted and studied in further details.

→	Animation	Governorate	Bahsili	Tupras	Journalistes	Total
Animation	0	45	16	34	6	101
Governorate	59	0	30	14	22	125
Bahsili	37	30	0	12	4	83
Tupras	46	12	17	0	3	78
Journalistes	16	25	20	18	0	79
Total	158	112	83	78	35	

(a) (b)

Figure 2 Number of exchanged messages between crisis units (a) and chart of typology of messages for a unit (b)

#	Date	From	To	Tags	Message
1	11:01	General Manager	TV local, Radio Local, ...	Information	On 11:27 am, Production Manager of Kirikkale Refin...
2	10:50	Kirikkale Manager	Kirikkale GCC Manager	Answer	For the explosion, we have taken all measures requ...
3	10:31	General Manager	Kirikkale GCC Manager	Answer	Mr. Governor.. Please see below the message we re...
4	10:27	Production Manager	Kirikkale Manager		a company sates that they had experienced an exp...

Figure 3 Chronological stream of all sent and received messages by a unit

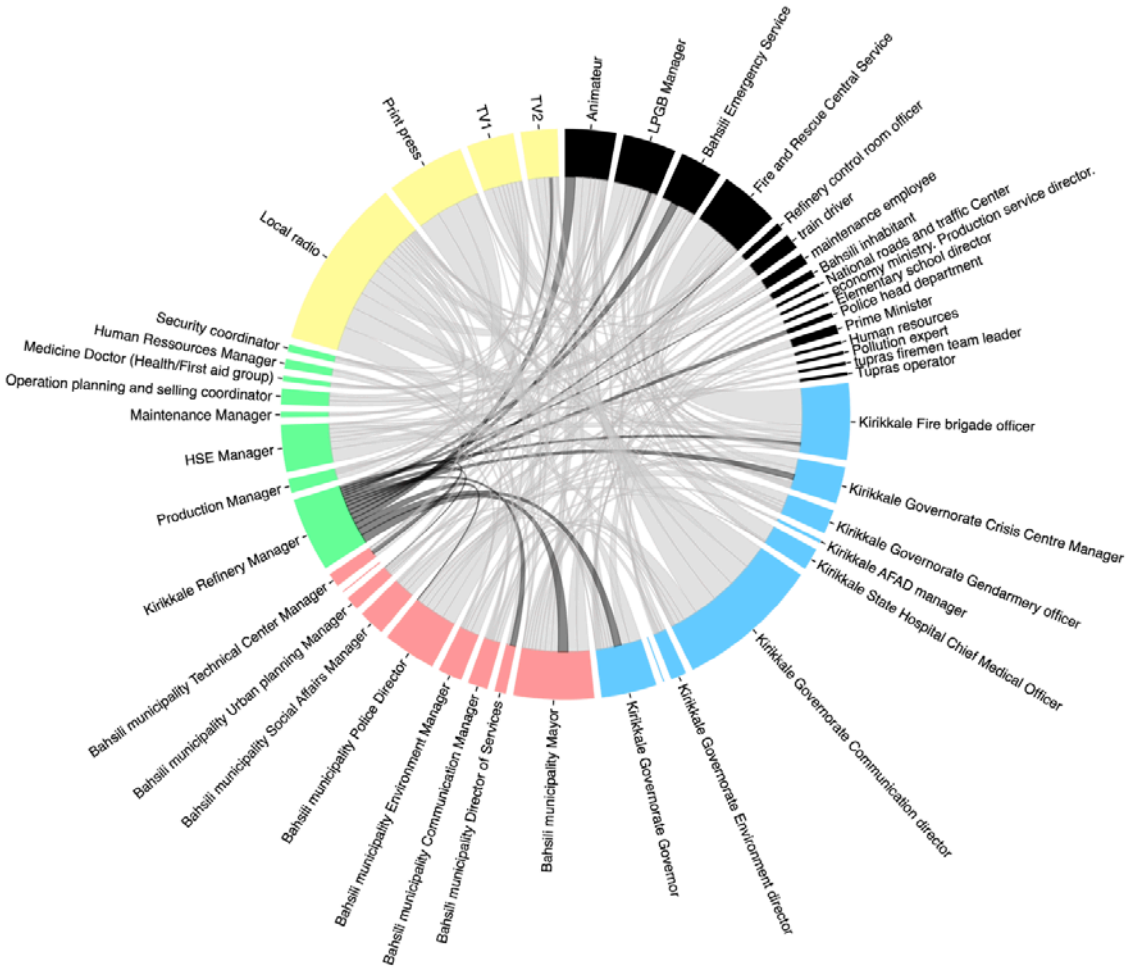


Figure 4 General overview of the iCrisis simulation approach (arrows represent the flow of information via text messaging)

3 XVR: A 3D simulation visualization platform

The XVR Simulation Platform is a simulation tool principally designed to support Incident Command training of various levels, to most known as bronze, silver and gold levels. By offering advanced simulation software in the fields of immersive 3D virtual reality environments, 2D maps and fictive communication and media flows. The 3D virtual reality module in the system, XVR On Scene, was primarily used in the CascEff Project. XVR On Scene allows the creation of an unlimited number of incident scenarios and use them to present participants in an exercise with realistic visuals of the ongoing incident.

The participant visualisation can be static, dynamic or interactive (see Table 2). The objective of presenting a participant with a realistic 3D scenario is to allow participants to obtain situational awareness of the scene. The realistic view provides an insight in the scale of the incident, the level of damage to people and infrastructure. By using the visual injects in combination with other information sources, the participants can obtain a good understanding of incident at hand.

Table 2 Intended tasks according to the type of visualization

Type of visualization	Operator / Instructor	Participant
Static	Create screenshots or screen-videos of the scenario before the training.	View the screenshots and screen-videos to obtain situational awareness.
Dynamic	Create scenario to be used during the training. Prepare an event timeline to evolve the incident.	Walk, drive, fly, sail around or view the incident through one or more static or dynamic CCTV cameras.
Interactive (operator-led)	In a dynamic incident, the operator can initiate virtual interventions and adapt the incident evolution to match the effect of these interventions.	In addition to viewing and moving around, the participant can tell the operator which interventions are to be initiated.
Interactive (participant-led)	The operator no longer initiates interventions but supervises the progress of the scenario. The operator can intervene if, for example, the instructor wishes to overrule certain interventions taken by the participant or, if the instructor wishes to purposely introduce unexpected outcomes as result of mistakes made by the virtual crews.	The participant has access to a User Interface with which he/she can task the rescue teams under his/her command to initiate interventions to control the ongoing incident.

When used as static incident visualizer, the participants are presented with screen images or videos taken from the XVR On Scene Simulator. When applied in a dynamic manner, the participants can access the incident scene and view the incident by moving around in the virtual reality scenario. Dynamic viewing options include: walking, driving, flying, sailing and looking at the incident through CCTV (which stands for Closed-Circuit TeleVision) cameras. When used in an interactive mode, the participant will interact with the virtual incident. Based on decisions taken by the participant, the scenario will change. For example, if the participants take an intervention decision like deploying fire fighters to rescue victims, the scenario will

evolve accordingly. Interactive interventions can be implemented either through an operator who controls the simulator or by the participant themselves having access to a user interface with “intervention options”.

During the IEM validation session, the XVR On Scene simulator was used in “static” mode.

3.1 Technical characteristics

XVR On Scene (XVR OS), the 3D virtual reality module in the XVR platform can provide any required 3D view of an incident environment (Figure 5). Using a joystick, gamepad or mouse and keyboard or other more advanced ICT (for Information and Communication Technology) inputs, one or more students can walk, sail or fly around in the simulated reality of an incident. Students can also view the environment through CCTV cameras. They can observe and explore the incident scene, assess risks and dangers, decide which measures to take, what procedures to apply and report to the other rescue crew members.

Figure 5 A sample of 3D virtual reality view

The key features of XVR OS are the following:

- Training in immersive 3D environments.
- Instructors can build scenarios according to specific training needs following receipt of appropriate training.
- Availability of an extensive scenario database and object library.
- Extensive possibilities for interventions during scenarios.
- Possibility to create localized scenarios (including location specific aspects such as street plans, emergency exits and water hydrants).
- High quality visuals and sound effects.

XVR OS uses 3D virtual environments based on realistic surroundings. Over thirty-five standard resolution environments are available in a license, which include generic and specific shore based areas, airports, industrial areas, generic port areas, vessels and offshore platforms.

XVR Simulation works together with several partners to visualize real environments and grow their training environments library every year. As soon as an environment has been finished and no restrictions are added to the delivery, it will be made available to all users. XVR

Simulation works together with governmental organizations to use geo specific information to create environments with realistic touch and feel.

A shown in the Figure 6, the XVR OS library includes thousands of 3D people (avatars), vehicles, equipment and resources to simulate scenarios. The instructor has full control over the scenarios.

Figure 6 Samples of objects included in the XVR On Scene library

3.2 Routine use process

XVR OS supports a wide variety of training methods, from self-led exercises to classroom education, to large scale multi-agency exercises involving operational, tactical and/or strategic decision makers:

- Single student, self-led exercises.
- 1 on 1 training – for On Scene commanders, job competency assessment, etc.
- Team Training – classroom, single & joint agency.
- Hybrid – combine live and virtual reality training scenarios.

In the XVR Simulation Platform, the instructor has maximum control and can inject interventions, incorporate any procedure, deployment tactic, or scenario outcome.

3.2.1 Observation training

XVR scenarios are effective training tools to teach observation techniques and exercise memory skills. Students are confronted with a virtual 3D scenario which could be of a traffic accident, a house fire, a hazmat incident or any other scenario which requires Civil Defence intervention. The scenario could be shown in a classroom setting or on an individual basis using the HTC VIVE or an individual LCD screen.

3.2.2 Communication effectiveness training

XVR scenarios are used regularly to train emergency responders to communicate effectively and efficiently. A simple but effective way to train with XVR is to form teams of students, one playing the role of the first arriving unit and the other(s), the role of backup units or dispatch centre.

The student playing the role of first arriving unit on scene enters into a virtual incident and has to give a situation report to the dispatch and backup units. The situation report is recorded.

The dispatch and backup units have to create a written and drawn sketch of the situation based on the verbal report.

3.2.3 Incident command training for on scene commanders

XVR is used extensively for command training for on scene commanders. An example of this type of training is an exercise in which the participant is the leader of the first arriving crew on scene which is deployed to an incident scene (Figure 7). The participant has to complete a first 360° assessment, communicate with dispatch and task the crew under his command to initiate the first response measures.

The exercise can either end when the incident has been successfully contained. The instructor can also decide to escalate the incident beyond the control of the first commander in which case he needs to escalate to the next level of command.

Figure 7 Example of a typical single agency exercise at an industrial fire brigade

3.2.4 Incident command training for high level decision-makers

XVR OS is also used to train higher level decision makers. Much used setups for these types of training and exercises include:

- On scene command of a single (complex) incident: multiple On Scene sector commanders in one incident, 1 On Scene senior commander who can use his Forward Command Post to coordinate with his senior command support team.
- Bronze / Silver command of a single (complex) incident: same as under 1, but with inclusion of the Dispatch Centre and/or the Emergency Operations Centre.
- Command of multiple parallel incidents: multiple On Scene senior commanders (with or without a Forward Command Post) all coordinating with/through the Dispatch Centre and feeding back their information into the Emergency Operations Centre. The Gold Senior Command team have to prioritize and decide how resources are divided between the multiple incidents.

Many more setups are possible with the flexible setup of the Simulation Centrewhich allows to hold one large, multi-level exercise or multiple parallel, single incident exercises. The Academy is then able to optimize the student throughput in the Simulation Centre.

4 NoKeos: An interactive incident management tool

NoKeos is a crisis information management decision support tool for tactical and strategic levels of the emergency response organisation. It is used in the preparation, response and recovery phases of emergency management.

Proper emergency response starts with adequate preparation, consisting of information gathering and analysis. NoKeos provides a methodology and tools to accomplish this in a structured way. Scenarios are designed and roles and responsibilities of all parties are agreed upon. The scenarios are loaded into NoKeos and made available for training and real-time use.

During an incident, NoKeos provides a common operational picture to all parties involved in the emergency response. It supports all aspects of the crisis management decision process with structured incident data gathering, a formal validation process and intelligent suggestions based on validated incident data.

When the situation is under control and the organization starts its business continuity plan, NoKeos provides factual management reports of the incident response. These can be used for post mortem analysis and to optimize the scenarios for future incidents

NoKeos provides businesses, governments and emergency services with shared situational awareness of the incident. NoKeos suggests actions based on the incident data and the scenario at hand.

Using NoKeos, the public and private partners can manage incidents in a coordinated manner. NoKeos:

- collects structured data about the incident from beginning to end;
- shares geographic data on card, serving as a virtual whiteboard;
- provides an unambiguous operational image to all roles and policy makers;
- anticipates and suggests decisions through intelligent scenarios;
- indicates in the incident dashboard at any time an overview of the status and organization of the incident;
- supports optimal crisis communication to press and population due to accurate reporting.

4.1 Technical characteristics

NoKeos is a web based internet application built on a Microsoft .Net architecture. The server consists of an application server, a database server and a GIS server. The user can use any browser which supports Microsoft Silverlight to interact with NoKeos.

Its map interface supports open interfaces with GEO databases using .shp files.

4.2 Routine use process

NoKeos supports organizations to properly structure all data and is unique in how it translates static procedures in dynamic and interactive response scenarios thereby offering a solution to deal with the time-based character of incidents. Credible incidents are defined and scenarios are developed that clearly display response strategies for varying incident conditions. The NoKeos Emergency Response Planner (NERP) is an intuitive graphical user interface enabling

seamless integration and maintenance of captured data. It is composed of a set of maintenance tools and a procedure designer where the interactive crisis and emergency management processes are created. Figures 8 and 9 describe how to define an emergency response procedure for a specific scenario, and a task within this procedure with the NERP.

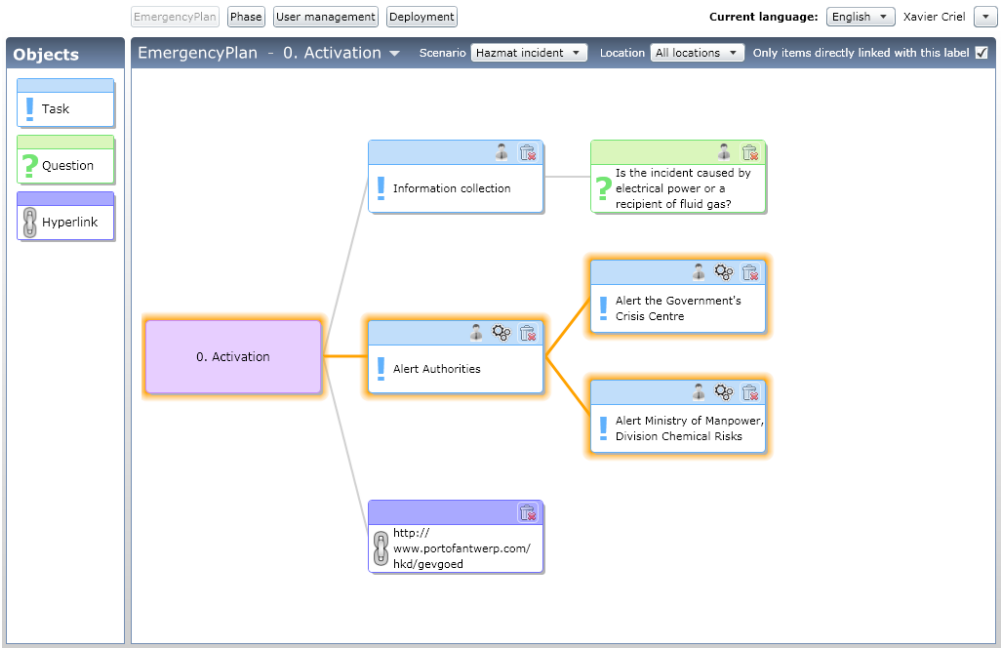


Figure 8 Defining an emergency response procedure for a specific scenario

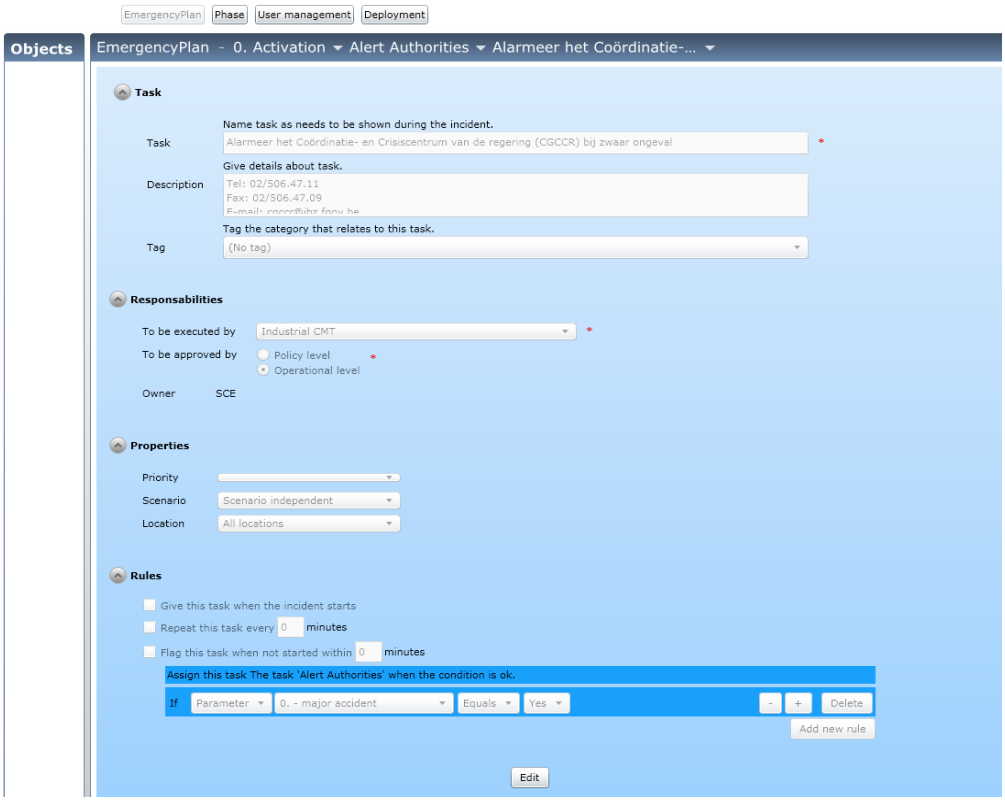


Figure 9 Defining a task in an emergency response procedure

In trainings and during incident response the user can report a new incident, select the scenario(s) and is then prompted for incident data (as shown in Figure 10).

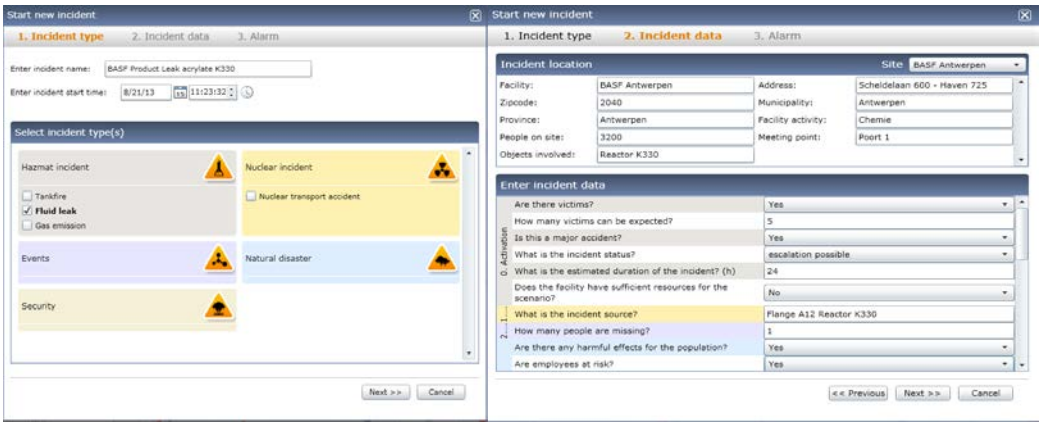


Figure 10 Reporting a new incident and entering initial incident data

Once the incident is created an activation phase is selected by the user and an emergency response organisation is assigned based on the location of the incident. From then on, a command & control dashboard and a GIS map provide a shared situation awareness for all emergency response agencies involved (as shown in Figures 11 and 12). Based on validated data and the selected scenario every actor at the silver and gold level of the emergency response organisation is assigned specific tasks and requested to provide feedback on specific incident information (see Figure 13). Once the set data are validated by the appropriate command level, NoKeos will suggest appropriate actions to take to the different emergency response functions. All information entered, validated and all decision taken are automatically logged into an incident log.

During and after an incident, incident status reports and detailed incident reports can be distributed to other stakeholders in a pdf format. These reports can then be used for post-incident analysis and improvement of the scenario's and incident response procedures

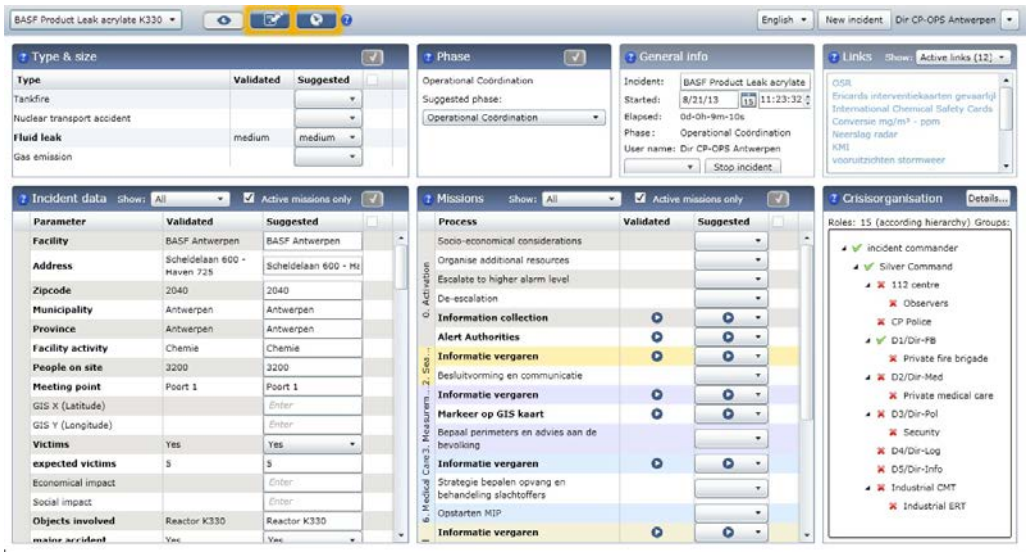


Figure 11 Command & Control provides shared situational awareness

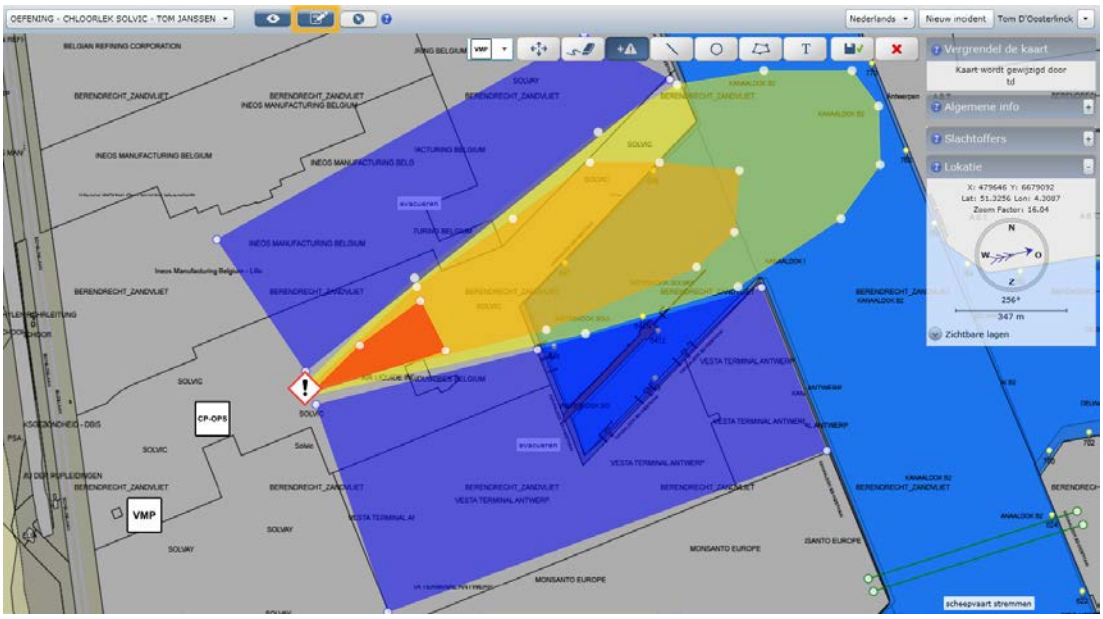


Figure 12 A GIS screen acts as a whiteboard across all parties involved

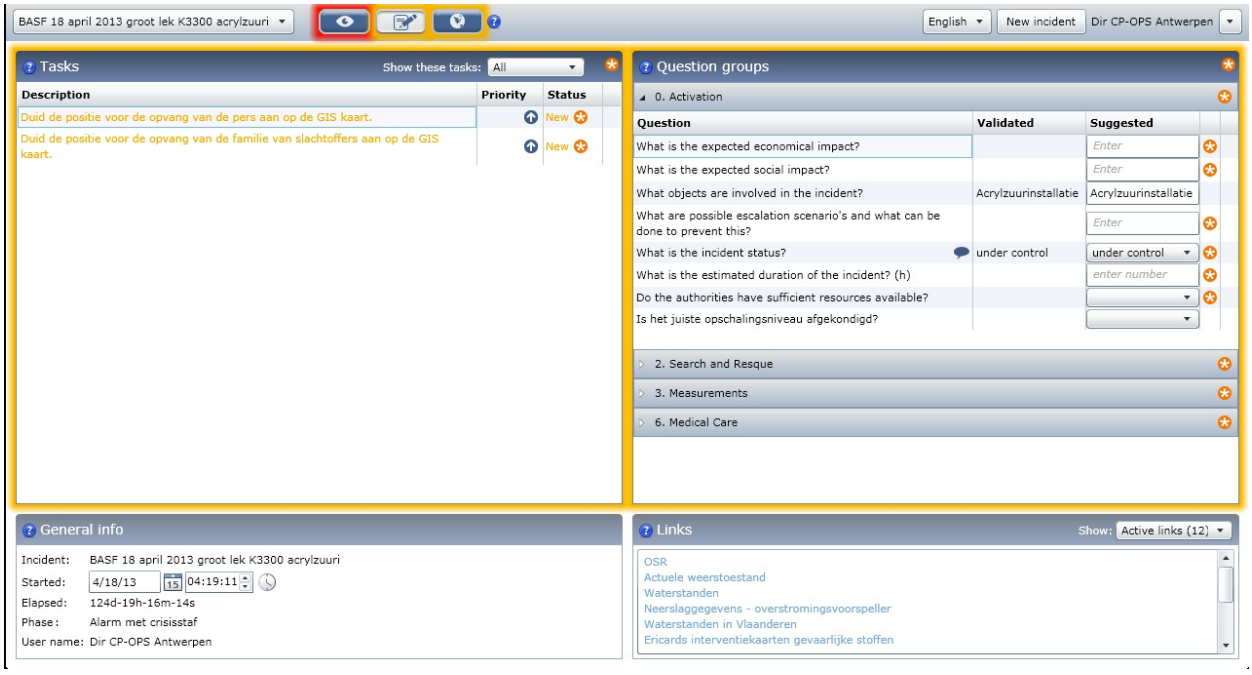


Figure 13 Every function has an individual checklist with tasks and questions

5 WIS: A web based platform for information sharing amongst actors in the Swedish emergency management and civil protection system

In 2004, the need for a national communication channel between entities in the emergency management system was identified by the Swedish government. This resulted in the design and implementation of WIS (Web based Information System) in 2005. WIS is a national, internet-based information system created to facilitate information sharing between actors in the Swedish crisis management structure before, during and after emergencies.

WIS provides emergency management actors with a simple and efficient tool for situational analysis, the creation of a common operational picture and a platform for information sharing between actors involved in an emergency situation. The objective is to enable coordination between the entities involved on multiple levels:

- Sharing information according to the Swedish emergency management structure.
- Enabling various stakeholders to share information before, during and after a crisis.
- Bringing together various entities from the private and public sector.
- Providing a log of information post-event, for review and lessons learned.

This includes responses and actions taken to handle the event in question, but also facilitating communication, for example to provide the public with unambiguous information when multiple entities are involved. When widely deployed, WIS creates the prerequisites to quickly obtain comprehensive situational assessments during emergencies. Figures 14 depicts a sample of starting page showing an overview of both new incidents and new information added to watched events/areas.

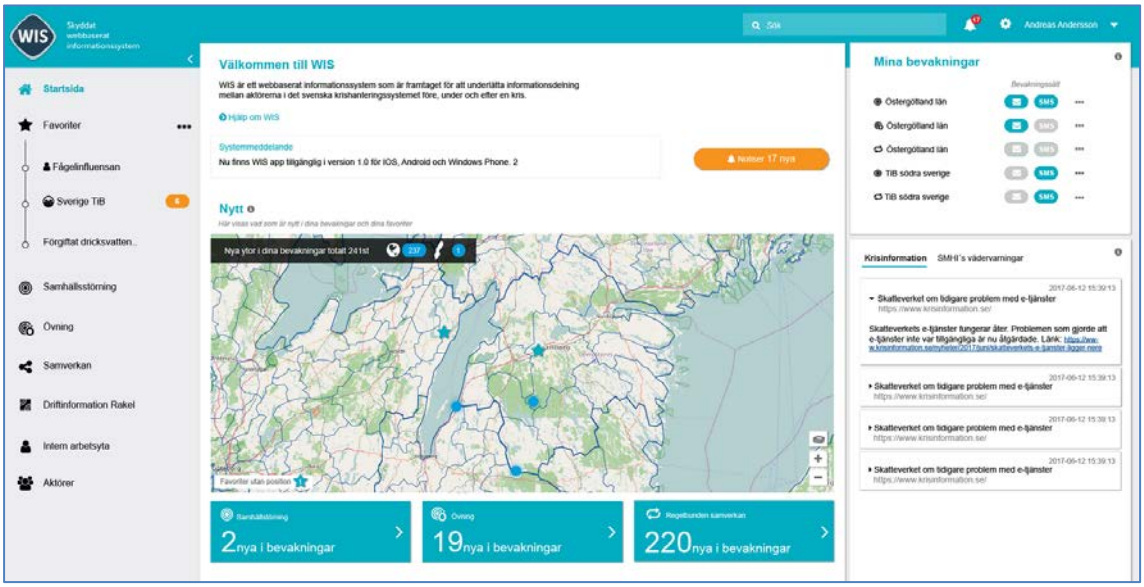


Figure 14 Sample of WIS start page

WIS users include national authorities, municipalities, county councils, NGOs and private actors. Currently most Swedish relevant entities are registered WIS users, including all county administrative boards and county councils, all law enforcement actors and 95% of municipal actors. A total of 500 actors are registered with a total of more than 7000 users. This widespread use of a unified system ensures less dependence on personal contacts in inter-agency communications (i.e., the maintenance of mailing lists, missing information if someone is sick or absent etc.).

5.1 Technical characteristics

WIS is a platform for information exchange between actors in crisis management sector. Both a web-based platform and a mobile app are currently offered to the users. Usage of the WIS platform requires internet connectivity. Several login options are available for user organizations, including password and two-factor options.

The web-based platform is developed using the Microsoft .NET framework, supplemented by a number of other technologies and frameworks. The frontend was updated during 2016 to responsive design for use on tablets and smaller screens, and supports all major web browsers. Another major update will take place during 2017, with both frontend and backend updates, bringing WIS to version 3.0. The screenshots in this document are taken from the prototype and test version of the upcoming WIS 3.0 version.

The app is offered for iOS, Android and Windows Phone, and was released in early 2017. The app is simplified compared to the web platform, offering a subset of functions. This includes posting and reading information, but not administration, creation of events and similar more complex user interactions.

The backend consists of geographically redundant servers (primary/standby configuration) located in protected locations.

APIs (which stands for Application Programming Interfaces) are available for communication or integration with other systems. Currently two other systems are connected:

- SUSIE, used to monitor the power grid and consumption. Certain events can be escalated and published in WIS.
- LUPP, used by rescue services for command and control. Certain events can be escalated and published in WIS.

5.2 Routine use process

Information sharing in WIS is based on events/incidents. For each event, actors are able to share management information with one another by publishing notes, analysis and situation reports a log that is attached to each event. The information shared can consist of documents and reports as well as notes and map positions (see Figure 15). The user is able to categorize, filter, search and share information in accordance with situational needs. Each actor is able to decide which other actors should be authorized to access the information published. Information such as entity, user, time logs and revision history is collected in order to allow for a review of the event and the creation of lessons learned following an event (see Figures 16 to 18).

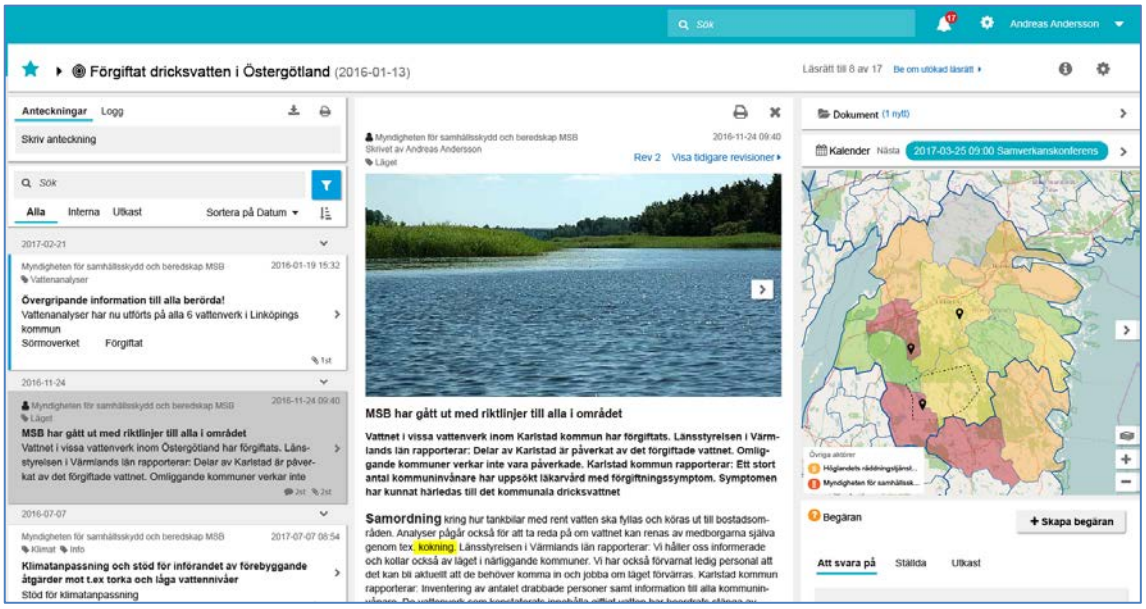


Figure 15 Detail view of note/logpost with attached picture

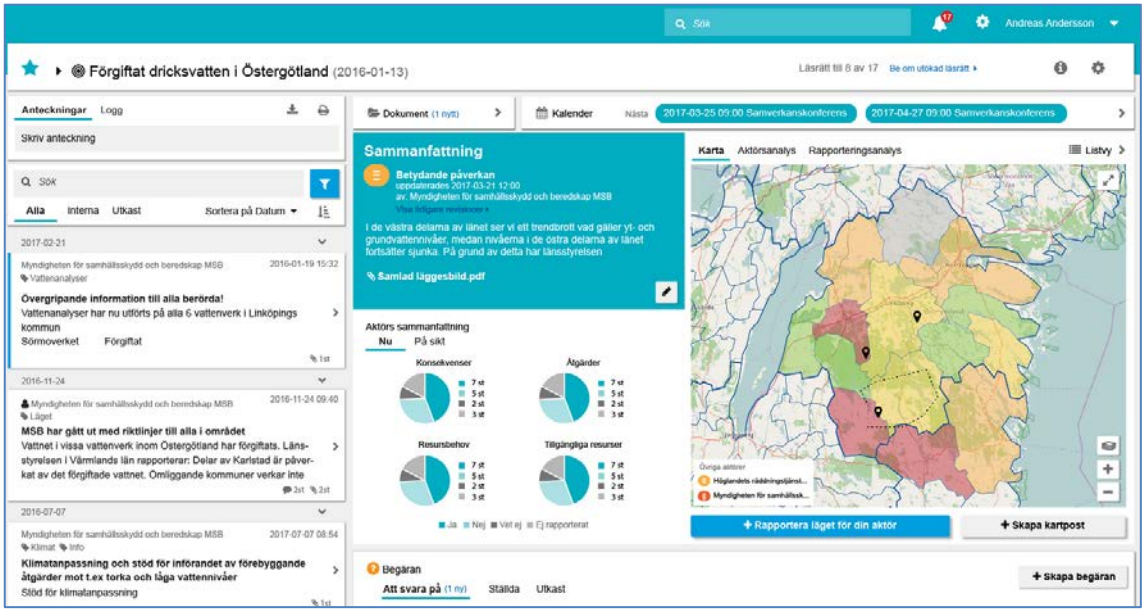


Figure 16 Handling of specific event, including logposts by different actors, event overview (pie charts with consequences, actions and needed/available resources), and overall status assessment by municipalities (map)

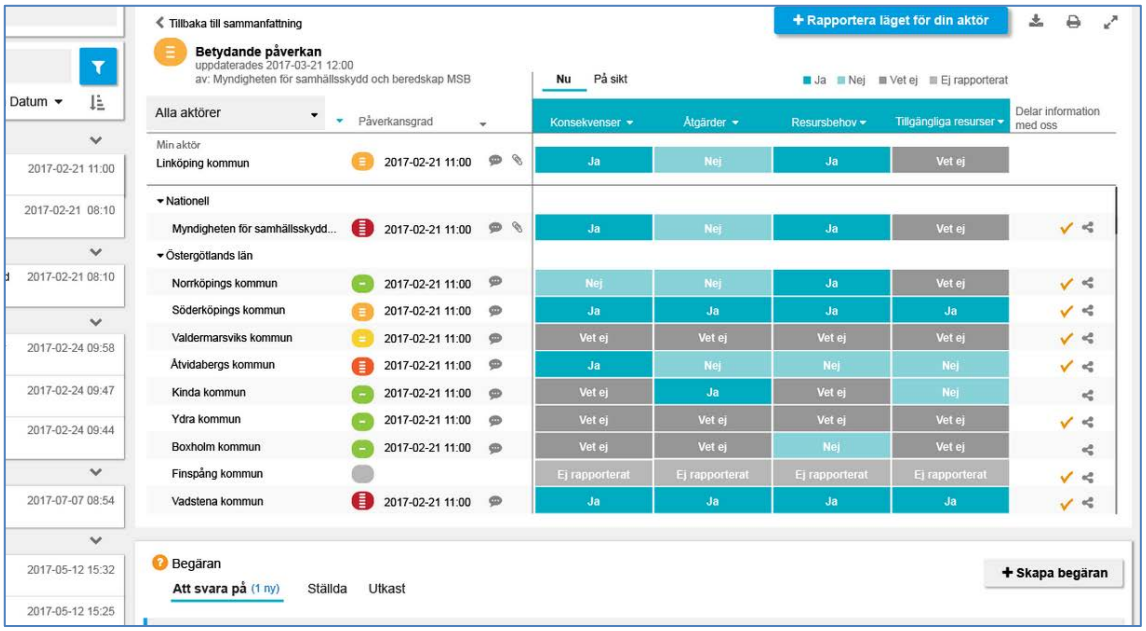


Figure 17 Detail view of status reporting from involved actors, including timestamp of latest update

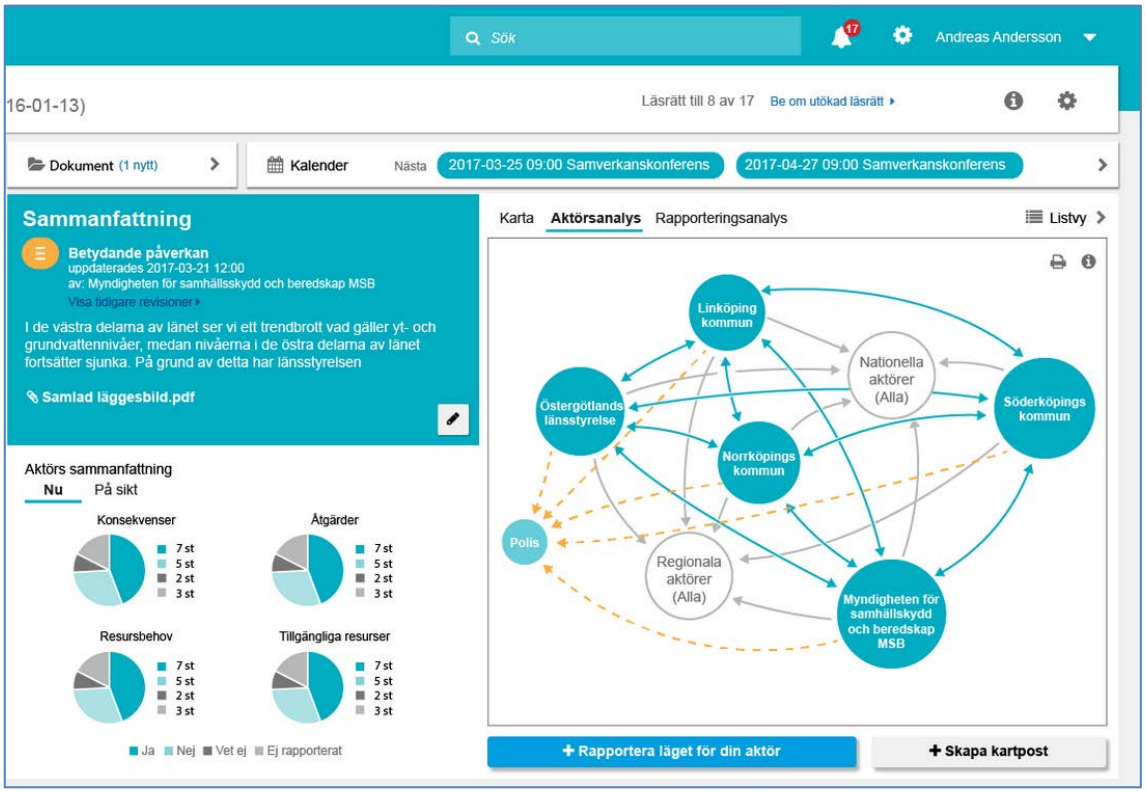


Figure 18 Actor analysis in a specific event, to make sure all relevant organizations are included in the information sharing

Recent updates of the system enable entities to request specific information from other participants. This, for example, allows a national agency to request information from municipalities, while keeping track of responses received (and which responses are still pending). Other improvements include a graphical analysis of which actors are involved in the event.

Primarily, WIS is used during ongoing incidents (see Figure 19 showing an overview of ongoing events on the national stage), but in preventive work it can also be used as a knowledge bank for lessons learned and as supportive tool during exercises and training. MSB encourages the use of WIS during everyday events that are not linked to incidents or social disturbances. WIS was used heavily for coordinating efforts during the refugee situation of 2015-16, both to assist in collecting, summarizing and disseminating data. This included both hard data such as number of available beds, as well as more general status of municipalities, regions and nation as a whole.

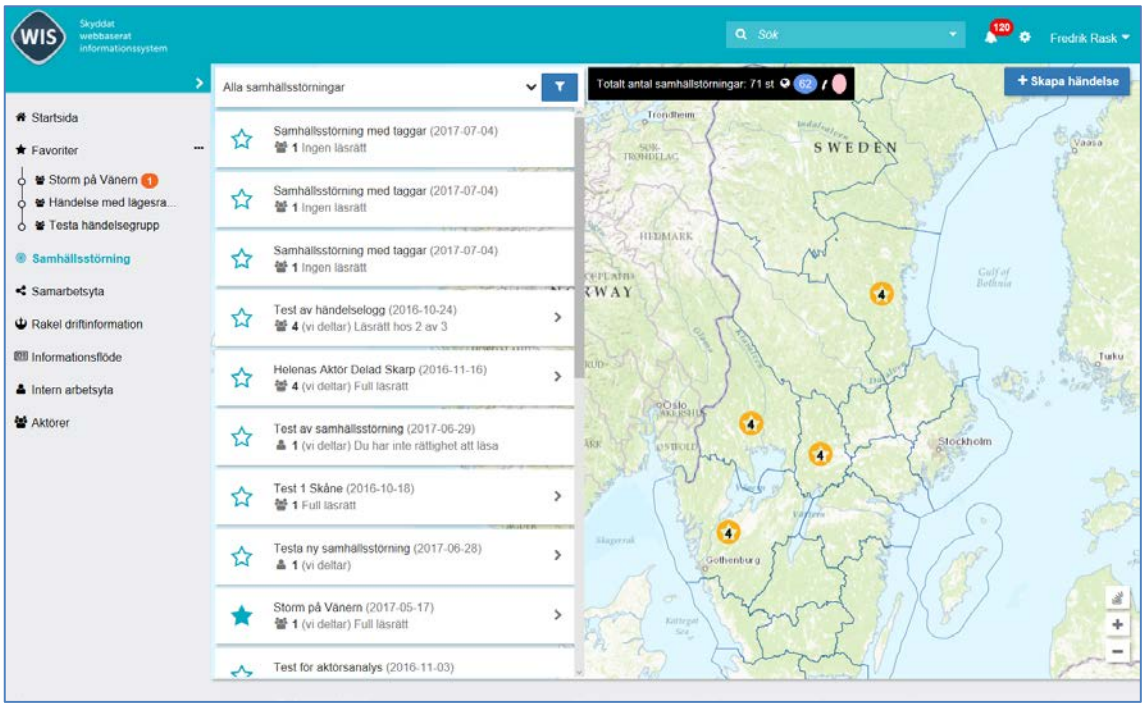


Figure 19 National overview of ongoing events, can be filtered/searched to discover ongoing events to watch

Previous experiences, such as the large-scale Swedish forest fire of 2014, have shown that a lack of daily use among actors can cause problems during an actual incident, as well as the authorization process of sharing information between actors. This implies that the system requires a certain amount of use in everyday situations in order to ensure that users are registered and familiar with the tool when an event occurs. Thus, getting all relevant actors registered and proficient in using the tool is a long-term commitment.

6 Use of iCrisis and XVR in test and validation sessions

The aim of this chapter is to describe the setup through which these two simulations tools have been used for testing and for validating the IEM.

6.1 Testing and validating the incident evolution modelling with iCrisis

Apart from being involved in the IEM validation process (see D5.4), iCrisis has been used prior to the design of the IEM and the development of the Incident Evolution Tool (IET) to test the concepts that underlies these two main results of the CascEff project.

6.1.1 Testing the philosophy underlying the incident evolution modelling

Once the design of the desired Incident Evolution Tool (IET) was defined, and prior to the development of the IEM (in February-March 2016), it has been decided to make an assessment at this stage whether the philosophy of this tool would be understood and if it would bring an advantage in the context of a crisis situation.

To carry out this investigation a paper based prototype of the IET has been developed and prepared to be applied on the Séchilienne scenario (see D1.4 & D5.1) chosen as a support to run crisis situation simulations. In short, this fictive yet realistic scenario consists of a potential ground movement of more than three million m^3 of block in the Séchilienne village (France). It may lead to huge consequences resulting from the following sequence of events:

- landslide over a national road and a river;
- creation of a natural dam over the river;
- creation of a lake behind the dam;
- breach of the dam rupture;
- flooding of the valley downstream (several villages concerned);
- flooding of a big chemical plant located downstream and
- potential industrial accidents due to the flooding.

The test comprises two simulations conducted using the iCrisis simulation approach described previously. It was performed using the following steps.

6.1.1.1 Identification of the assets

The first step of the development of this tool is to identify the assets on the chosen territory. In the CascEff project, the term "*system*" has been chosen to define any type of assets (cf. D1.6). The Incident Evolution Methodology (IEM) proposes to classify the systems with these three dimensions: category (cf. D2.1), sub-category (a second level of description of the assets; cf. D2.1), and spatial location in order to facilitate their positioning on a map.

6.1.1.2 Identification of the vulnerabilities and potential effects of the assets

The vulnerability of a system (sensitivity to a given incoming effect), as well as its capability to generate an effect that could affect another system are considered only through the nature of the effects that were identified based on the list proposed in the CascEff project (cf. D4.4) that has been simplified for usability concerns as follows:

ES: Energy service degradation
FS: Food supply degradation
MI: Missile effect
PRI: Explosion
TS: Transport service degradation
WFS: Workforce degradation
FI: Fire
GM: Ground movement
PB: Public health degradation
TO: Toxic effect
WA: Water / Flood
WS: Water service degradation

Incoming and outgoing effects are identified for each system regarding the categories previously presented. The intensity is not considered to keep this paper based tool easy to use. Then, regarding a specific outgoing effect along with a reflection on distances and logic, the possibly impacted systems have been identified. This procedure allows for creating dependencies between systems based on their vulnerability and their potential generated effects.

The information on the systems is presented through a map (Figure 20) and a table (see full table in Appendix 1). On the map, the systems are geo-positioned and named with an ID which is similar than in table. They are presented in different colours representing a category of system. This enables to make quick selections considering one or another category of system. The flooding area is also shown on this map.

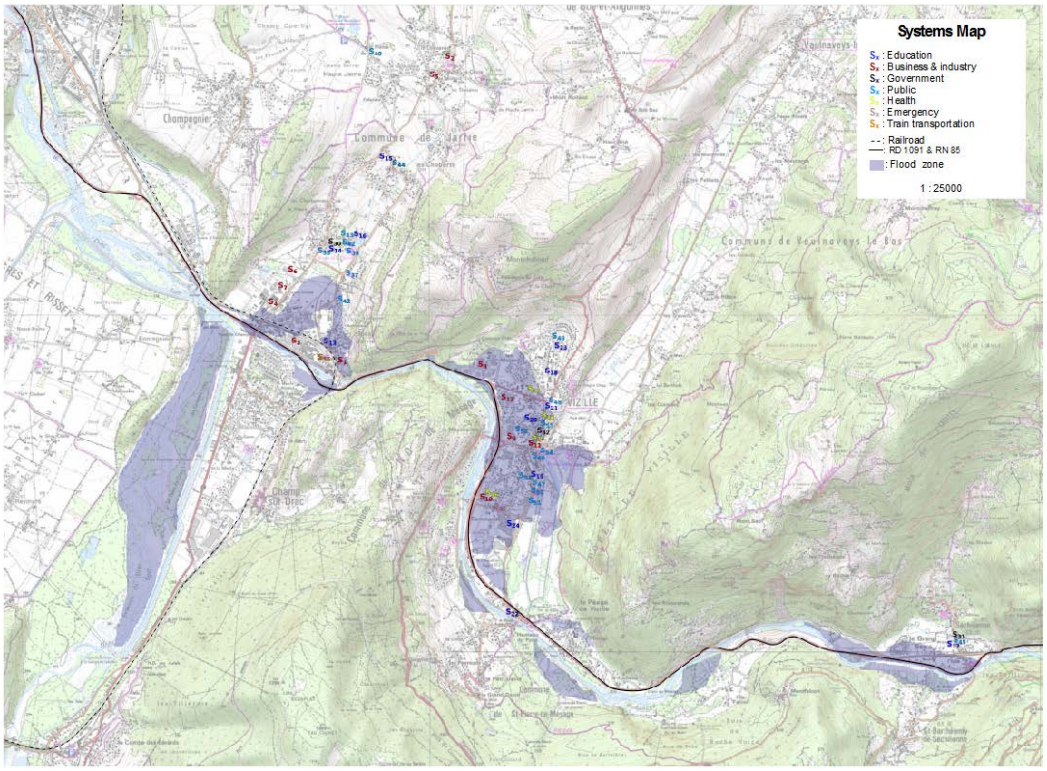


Figure 20 Paper-based IET map

The table presents the list of the systems whose lines are in colours following the same as those used for the map to help linking-up both documents. Beyond the information that describe the system (such as the category of system, the name, the geolocation for example), the effects are listed. First the table provides a list of the effects to which the system is vulnerable and secondly the potential generated effects. To read this table, the user must

identify whether for example a system S_i is vulnerable to a given effect. Once defined as an impacted system that can potentially generate an outgoing effect, the reader looks at the line related to this outgoing effect to see that all systems which could the potentially be impacted by the given outgoing effect generated by the system S_i.

6.1.1.3 Calculation of the likelihood of an asset to be impacted given the originating asset

A probabilistic calculation was done relying on the past incidents with cascading effects database (used in the D2.3) to determine the occurrence rates of cascading effects in each system category in respect to the category of system where the originating effect occurs. Then, a Markov chain process was used to estimate the likelihood of a system category to be impacted by first to fifth order cascading effects resulting from effects generated by a given originating system category (see appendix 2).

6.1.1.4 Running iCrisis simulations in association with the use of the paper-based IET

For this test, two iCrisis simulations were conducted using the paper-based IET in February and March 2016 with two groups of students from engineering schools in France. These participants did not have specific prior requirements about the IET, so they provided unbiased answers to questions on the tool. Because the general interest of the IET had to be tested for decision-making process at strategic level, only the 21 participants of “Prefecture” crisis unit (over 55 participants in total) used the paper based IET.

For estimating the potential interest of the IET philosophy in crisis management decision-making process (considering the context of incident response), a questionnaire has been submitted to the participants for gathering their opinion about the tool (see appendix). In order to make comparison with the participants (in the crisis units apart from “Prefecture”) who did not use the paper-based IET, some questions have been asked about their perception of the situation to identify whether the IET would have an influence. Both questionnaires were distributed to the participants providing feedback on the perception of the situation and more precisely on the notion of cascading effects. The group with the paper-based IET received additional questions concerning the use of the tool. This setup on one hand allows to have feedback on the paper-based IET and on the other hand on how this tool could affect the perception of the handled situation compared to other groups who were managing the situation without it.

6.1.1.5 Analysing results from the testing of the philosophy of the incident evolution modelling

The questions about the influence the crisis units have on the situation either for groups with and without the paper-based IET, used to demonstrate the philosophy of the IEM, give results that are similar regarding their feeling on their actions influencing the situation (69 % for players without the IET and 70 % for those with the IET) and more precisely when this influence is favourable (without: 48 %; with: 50 %). Otherwise, when asking if their influence was unfavourable regarding the course of the events, then a major difference between the participants without the tool answering almost 2 times more (71 %) than the participants with the tool (39 %). To conclude, we can say that in general, all the participants feel that they are quite influencing the situation. This influence is felt to be positive at a medium level whereas it is felt to be unfavourable at a high level for the participants without the tools and lower for the participants with the tool.

Regarding the use of the IET, Figure 21 shows that it has been used in general at an interesting level since they have mainly marked “often”.

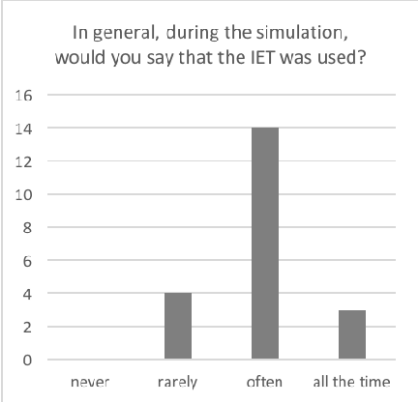


Figure 21 Frequency of the use of the paper-based IET by participants during the simulation

The graphs shown in Figure 22 emphasize on the use of the paper-based IET to visualize the involved systems. The results show that it has been used quite often and the participants have considered that it helped to do so.

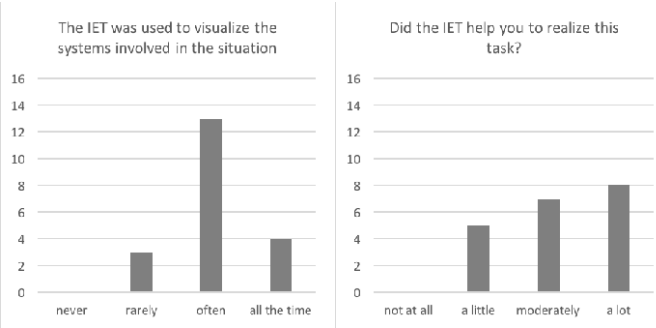


Figure 22 Use of the paper-based IET to visualize the systems involved in the handled situation

The question about the identification of dependencies between systems presents results that are mainly around “rarely” and “often” (Figure 23). These two intermediate levels represent the major proportion of the answers whereas only three participants said that they did not use the tool. Regarding the help that the tool could bring, the results are heterogeneous with a higher score for “moderately”. This enhances the fact that in a group people do not share the same actions and visions.

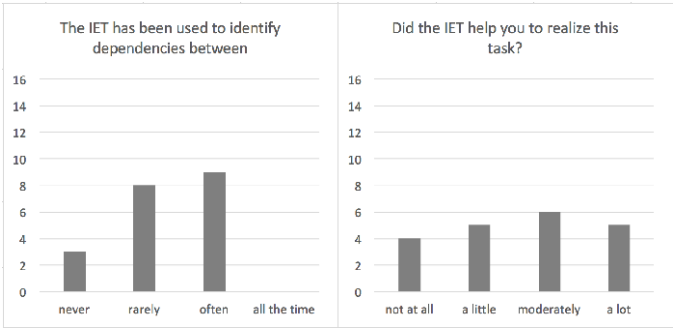


Figure 23 Use of the paper-based IET to identify dependencies amongst the systems involved in the handled situation

The IET was used to identify the first order of cascade in general but it could not be used all the time. This is probably because during a crisis situation, there is a high time pressure which prevents the managers to spend a lot of time on this reflection. The results also show that the IET helped to realize this task with only three people saying, “not at all” (see Figure 24).

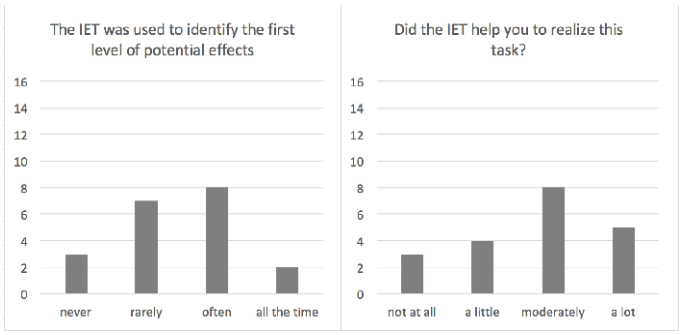


Figure 24 Use of the paper-based IET to identify the first order cascading effects

The potential second order cascading effects were less considered regarding the results shown in Figure 25. For the reflection at this level, the tool helped a little or moderately.

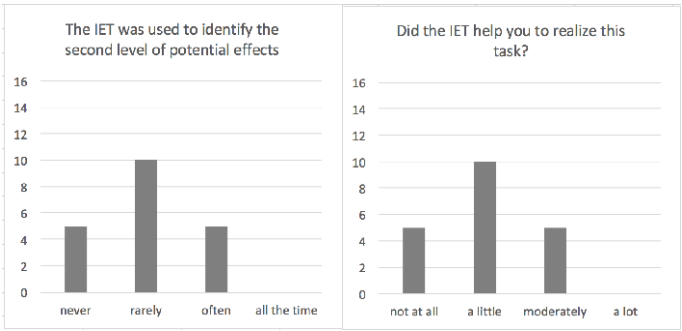


Figure 25 Use of the paper-based IET to identify the second order cascading effects

Regarding n^{th} order (n>2) cascading effects, the tool was almost not used because it probably could not really help to do so (see Figure 26). This could be explained by the fact that in a crisis situation the need to react quickly is important. The paper-based IET appears time-consuming, in the adopted setup, to gather needed information. This seems to be a limit of the format.

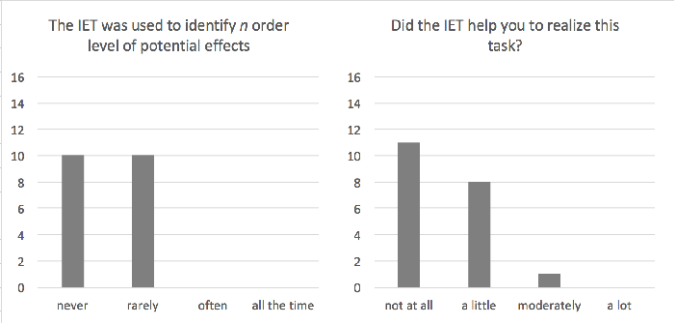


Figure 26 Use of the paper-based IET to identify the n^{th} order cascading effects

The graphs (Figure 27) show that the information from the IET has clear impact on the process of decision making since it allowed to initiate quite often a decision and confirm it. At a lower level, it permitted to challenge sometimes the decision and even correct a prior one.

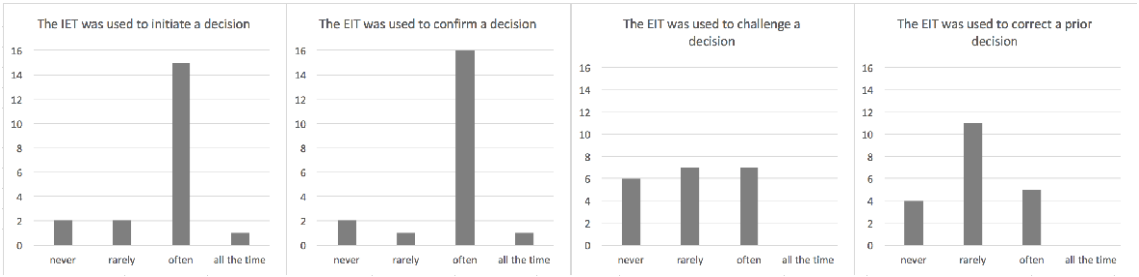


Figure 27 Use of the paper-based IET to identify the n^{th} order cascading effects

This investigation aimed at assessing the applicability and the interest of the information that could bring a tool such like the Incident Evolution Tool. It was assumed that this paper-based tool does no bring the same level of information as well as the same level of usability but the underlying expectation of this setup is that it could allow to evaluate its philosophy.

The main results show that although all the participants have thought that they have influenced the evolution of the situation, participants with access to the IET felt that their decisions and actions to a greater extent influenced the incident resolution in a positive way, compared to participants who did not use the tool. Regarding the applicability of such tool, the tests showed that it is generally used until the first level of cascades. It appeared that it would need more time to search and combine the information required for anticipating cascading effects at a higher level than the first one. This is interesting because this limit will be pushed with an informatics tool that will make automated calculations for modelling high order cascading effects. Moreover, this study allowed to have an idea on the potential interest of knowledge on cascading effects in the process of decision-making when managing crisis situations.

6.1.2 Use of iCrisis during the IEM validation meeting (session 3)

The main goal of the third session of the validation meeting held in University of Lorraine was the application of the IEM in association with other tools (see D5.4). The purpose of this session was to observe how the IEM would be used in a training exercise for incident response. iCrisis, being a simulation tool intended to create crisis situations environment, was used to immerse participants in a simulated crisis where they have to respond to an incident at

different strategic levels of incident management. For this simulation, the instructions given to them were to use any tool they would need. By doing so, the choice to use the IEM or not was left to the participants.

The results presented hereafter are complementary to those described in the D5.4 that mainly focus on the added value of the whole IEM as well as each of its six steps. The findings from this use have shown that the players do not have enough time to completely apply the IEM when trying to response to the crisis situation created during the iCrisis simulation. The Figure 28 shows the breakdown of responses to the question: "*have you completely applied the IEM?*" (x-axis represents the level to which the participants use the IEM with 0 corresponding to "*Not at all*" and 10 to "absolutely" and y-axis represents the number of answers). In the comments associated with their responses, it appeared that most of them did not use the IEM because the incidents that they dealt with were of too fast kinetics, and those who used it stopped the use at the step 4 *("Determining the temporal aspects*"). The detail of the use of each of the six steps of the IEM is presented in Figure 29 where the number of users and the levels to which the steps were used decreased from the earlier to later steps of the IEM.

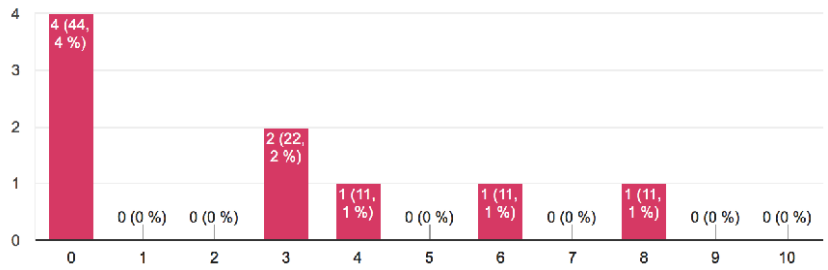


Figure 28 Answers on the complete use of the IEM during the iCrisis simulation for the IEM validation meeting (Session 3)

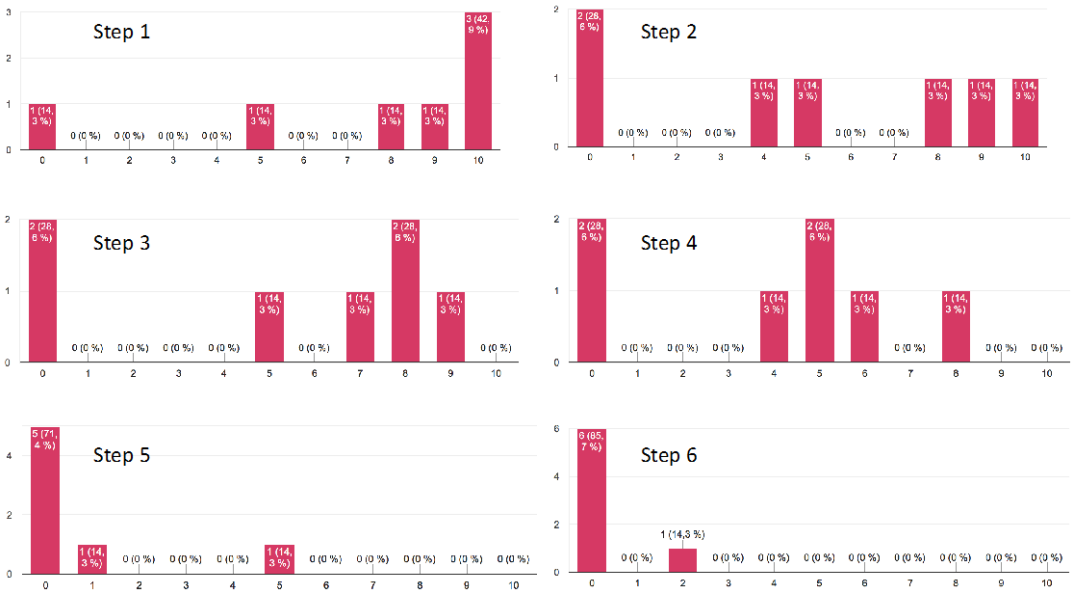


Figure 29 Use of each of the steps of the IEM during the iCrisis simulation for the IEM validation meeting (Session 3)

Considering what they have learnt about cascading effects during the validation meeting, most of the participants have considered cascading effects when handling the simulated situation (Figure 30), and this consideration of cascading effects were of added value as shown in the Figure 31. In conclusion, they recognized that the use of the IEM during a training for response to crisis situation could allow having a structured analysis unless one has enough time to do that.

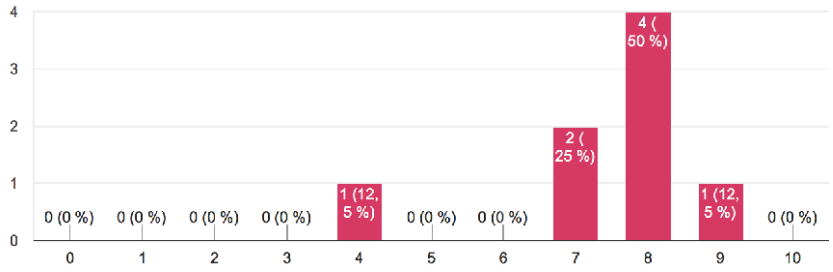


Figure 30 Consideration of cascading effects when handling the situation simulated for the IEM validation meeting (Session 3)

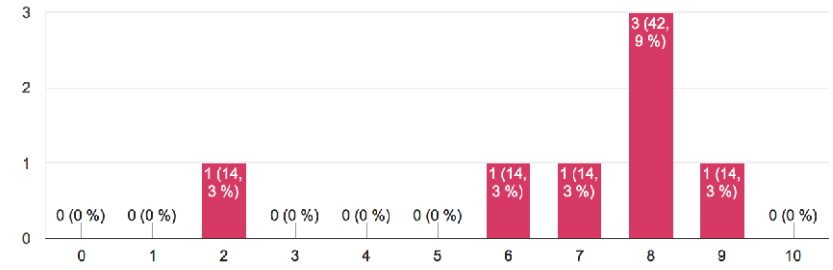


Figure 31 Added value of the consideration of cascading effects when handling the situation simulated for the IEM validation meeting (Session 3)

6.2 Use of XVR for validating the incident evolution methodology

XVR being a simulation visual support tool, was intended to be used to provide the validation session participants with a 3D first person perspective view of the simulated situations. This would have allowed for, as realistic as possible, a visual input into the process of dealing with the cascading effects of that situations; by simulating the effects on the crisis scene and the effects of choices made.

With the shift, away from the IET towards the IEM, the main focus of the validation changed from response to preparation. In that emergency management phase an on scene visualization is of less importance. After discussions and try outs, it was deemed that XVR was not to be used as a 3D simulation. Instead it would provide still pictures of situations created from taking screenshots of the created 3D simulation situations. The use of XVR during the IEM validation was thus in “static” mode.

The provided pictures (see Figures 32 to 34) were intended to allow the participants to wrap their mind around a visual representation, rather than having various mental images based on a textual description. Care has been taken to only represent the initial situation, such as to not hint or give away potential cascading effects, as that is part of the methodology to validate.

Besides the preparation phase, the first validation session (held at University of Lorraine) included an incident response situation fed by iCrisis™ simulation. In this, XVR was used the same to add images of situations to these messages. The added layer here was that actions taken or decisions made by the participants had to be reflected in later images. XVR nature of being a 3D situation simulation allowed for quick adjustments to these changes in the trial, bringing forth new images on the go.

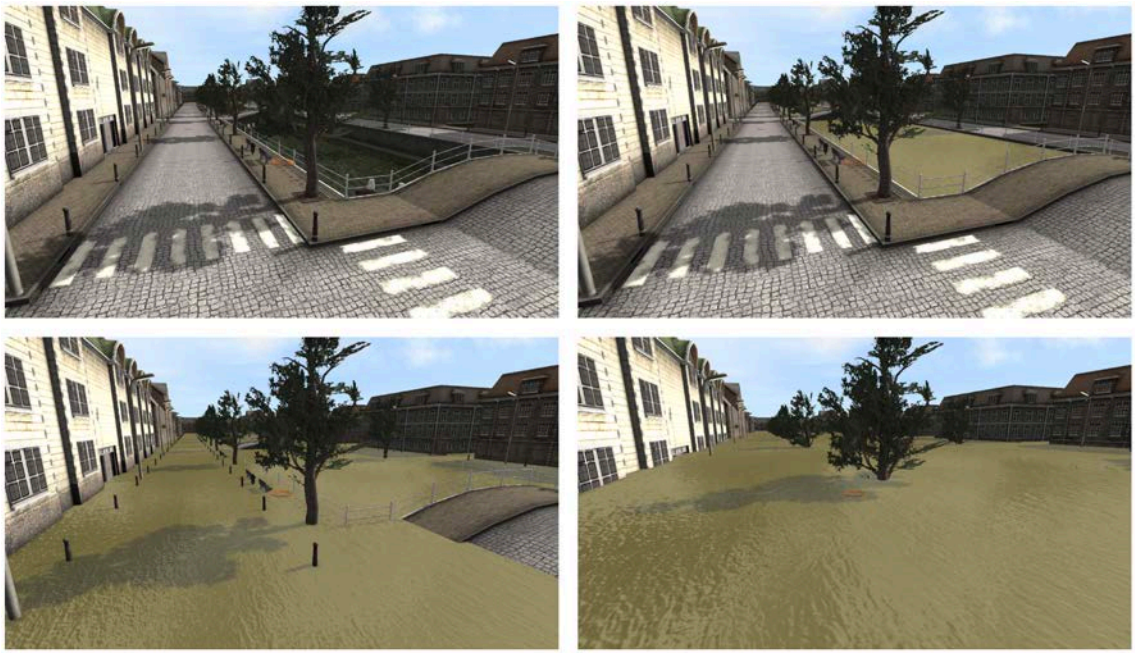


Figure 32 Pictures showing the raising level of the water in the river

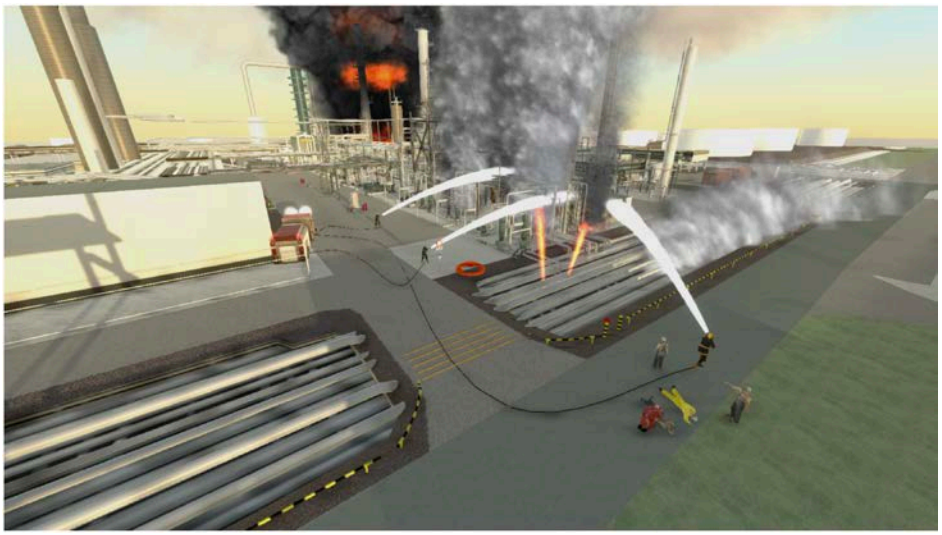


Figure 33 Firefighters trying to put out a fire at the industrial plant resulting from an incident due to the earthquake

Figure 34 Flooding at the chemical plant following the breach of the natural dam

7 Lessons learnt from IET-IMT integration workshop and interviews

The goal of the Task 4.4 was to allow data and information sharing between the IET prototype and some of the IMTs (NoKeos and WIS) involved in the CascEff project thanks to, amongst others, feedback from WP5. To support that objective, workshops/interviews have been conducted with potential users (WIS) and the developers (NoKeos) of these systems to bring all their needs and expectations together for providing constructive insights for the forthcoming integration of the IET prototype with NoKeos and WIS.

The technical aspects of the integration between IMTs and the IET are discussed in D4.5.

7.1 About the use of NoKeos

As the Belgian end-users, who were involved in the NoKeos pilot project in Antwerp, were not available in the short time period that was allocated for the workshop, a functional discussion was held between the IET development team and the FPC Risk pilot project leader and NoKeos product manager.

The objective of the discussion with the IET development team was to explore ideas for integrating the IET with NoKeos providing added value functionalities to the NoKeos users.

7.1.1 Opportunities of an integrated NoKeos-IET

The NoKeos user could benefit from the IET in the emergency preparation and response phases. As NoKeos is primarily used in industrial environments where incidents are typically complex with potential cascading effects, the IET can increase situational awareness and suggest cascading scenarios and actions based on IET predictions.

Once cases are defined in the IET, a user could invoke the IET from NoKeos using the incident type and coordinates. The user would then be presented with the cases already defined in the geo-localized area of the incident. Once selected, the IET could run with the NoKeos incident as an initiating event and present the user with the result of the simulation. The user would then continue doing simulations in the IET, including identifying potential cascade break points. From the IET the user should be able to send back snapshots of the timeline and map to NoKeos. Nokeos could then share this map with its users through a layer in its GIS system in essence sharing situational awareness of systems and effect areas with all NoKeos users. The impacted systems and cascading effects could also be used in Nokeos to suggest other scenarios. Impacts from the IET could be passed on to NoKeos users as incident parameters. In essence, the result of the IET simulation can be shared through maps and structured data within NoKeos to decision makers at the gold and silver command level whilst storing IET simulation results in log files as evidence for post-incident analysis.

7.1.2 Challenges of an integrated NoKeos-IET

Some of the challenges of integrating IET with NoKeos include providing explanation to the decision makers on the credibility of the IET modelling results. Decision makers will always question recommendations by tools if they are not in line with their experience or intuition. This can be tackled by having a respected and IET trained senior officer explaining the reasoning in the different timelines and the potential break points to the silver/gold command levels. It will also require the NoKeos user to be trained on the IET.

Other challenges include:

- Proper authentication of users and shared access to the IET cases for users who have not created these cases.
- Data integrity and accuracy: keeping the IET system data in sync with the other databases used in emergency situations and deal with systems that might not be defined at the time the case was defined in the IET (i.e. new risk, transport risk, etc.).
- Keeping the background GIS maps used in NoKeos and in the IET in sync to avoid discrepancies in the visualisation.
- Building an appropriate web service interface in NoKeos to communicate with the IET.
- Translating IET objects into NoKeos objects (i.e. system types, scenarios, etc.).
- Adoption rate of NoKeos (still in pilot) and the IET being a prototype.

7.2 About the use of WIS

Three interviews were held with typical WIS users in order to discuss their use of WIS during every day as well as extraordinary events and how using the IET could complement and enhance the use of WIS. The final aim was to explore whether an integration of the IET and WIS would be advantageous and, if so, how this should be done to be useful.

In addition to the WIS user, representatives from the WIS development team and the IET development team were present. The presentation/interviews were divided into several different parts:

- An introduction to the CascEff project.
- An introduction to the IET.
- A presentation of the IET itself.
- The interview, focusing on how WIS is used today and what the respondents think about the IET and their ideas on areas where the IET could support their work and support the use of WIS.
- Presentation and discussion of ideas for connection and communication between WIS and IET.

In total three interviews were held with WIS users for different parts of Sweden.

7.2.1 Potential areas of IET application

After the presentation, the WIS users identified several potential areas of application of the IET.

One such example was incidents that run over a longer period of time and have a certain level of complexity. As for many tools, the applicability of the IET was deemed to be limited in the case of fast and short incidents, but for a longer incident the IET can be useful for additional analysis, visualization and sharing of information, to create a joint and shared picture of the situation. During this type of incidents, the IET can also assist in identifying key decision points. Therefore, the IET is most valuable in the planning phase rather than in the acute response phase. As mentioned, it could be useful also in the response phase for incidents with longer duration. During such an incident, incident managers and involved personnel often need to make a new analysis at a later stage, when the situation might not be as acute. At this stage, using the IET can make it possible to incorporate and analyse information one did not have or did not see from the beginning.

The IET was also considered to be potentially very useful in risk and vulnerability studies and for other work relating to preparation for crises. It would give extra steps to the analyses which was seen to be valuable. The possibilities to create a variation of scenarios and to study similar scenarios with small changes were considered interesting and useful. It was also appreciated to have the possibility to successively build a database and bank of knowledge. Together with experience this could lead to more accurate analyses and results, and more systems could be included in the analyses. One of the WIS users particularly expressed the potential of the IET as a useful tool for their existing group of experts and their task of analysing and evaluating different risks. The great values lie in the possibility to connect different systems and see the dependencies between them, and also to facilitate the cooperation between experts from different fields in analysing and evaluating these dependencies. This confirms the interest in using the IET for risk and vulnerability studies expressed in connection with the focus group meetings. If the IET is used over time, more information and experience will be available and the results will become more exact. More systems will then also be included in the tool.

Another field that was specifically mentioned by several of the WIS users was the possibility to study systems important for the ensured supply of important services, e.g. energy supply and water supply.

7.2.2 Opportunities of an integrated WIS-IET

After having looked at the potential use of the IET as such, the interview focused on the possible integration of or communication between the two tools. The possibility of visualizing critical infrastructure and the connection between these systems was deemed to be very useful. Respondents stated that WIS at times is used when working with planned events such as festivals and demonstrations. In these cases, using the IET can facilitate the creation of a greater variation of scenarios and action plans with added information, while also visualizing them in a more comprehensive manner. Ultimately this could improve the planning of these types of events. The possibility to identify key decision points was also mentioned in relation to this connection.

One WIS user suggested that the IET first can be used (prepared) by very knowledgeable users, while information later could be “triggered” from WIS, implying that the results can be available in WIS. WIS is currently under development, with a major update to be released later in 2017, and different ways to present the results in WIS were discussed. While WIS today is mainly used as a platform for sharing information, often in text format, it has a map function that also could be used. The possibility to use the IET results together with different types of GIS data was also discussed.

One user aspect that was specifically mentioned was the possibility to register different types of action steps should a specific system be affected, i.e. predefined actions to take should certain situations arise. It was stressed that such decisions should not be taken by the IET, but rather that the information could be saved in the IET and be sent to WIS should a specific scenario arise or a specific system be affected.

7.2.3 Challenges of an integrated WIS-IET

There are of course challenges in connection with an integration of WIS and IET. One important issue, mentioned by all respondents, is the security of the information, i.e. both

what information should be made available and who should be able to use the tool and access the information.

It is also important that the information and the results can be trusted and is trusted by the user. One idea was that this could be achieved as WIS/MSB is perceived as a guarantor of the IETs results and relevance.

One further challenge is, as mentioned above, that a knowable user or expert is necessary for the IET simulation and therefore, relevant training is needed.

While some cases were identified where the IET can be suitable for the response phase, most users saw the real applicability limited to the planning phase.

Since some of the preparation actions (analyses) can be time consuming, the work needs to be structured and planned in a good way, and one needs to see this as a work developed over time.

If the tools should be really integrated, one also should look at the layout to make sure that it is easy to understand, easy to use, and preferably that it seems to be one tool.

7.2.4 Facilitating an integration between WIS and IET

The respondents expressed interest in both the IET as such and in the idea of being able to access it from WIS. In order to facilitate this, some specific functionalities or features were mentioned and discussed during the interviews.

The first major issue is language, as it was considered to be a big advantage to be able to use it in Swedish. A relating issue, which also has been addressed by the focus groups and during the validation sessions, is the possibility to use one's own terminology and add new and other types of impacts, e.g. "trust in authorities and governmental institutions" and "the will to communicate with the authorities".

Another specified wish was to be able to add specific systems outside and geographically relatively far from the case area of the IET case, e.g. dependencies between different airports.

The above-mentioned possibility to save schemes of action steps for affected systems was a feature that was very much wished by one of the WIS users. It would also be valuable to in the IET save information on the decisions taken by the user.

Furthermore, it is very important to clarify what the tool actually provides, i.e. that it does not make decisions but provides basis for decisions based on the available information.

The integration with other tools/systems is a key to usability and acceptance of the IET, in the future also the possibility to connect different types of simulation models. This also includes the possibility of merging information from or together with other maps or GIS data in order to further increase the visualization functionality of the IET.

In order to create an IET with a high level of acceptance, the above-mentioned security issue also needs to be solved.

8 Conclusion

The objective of the task T5.2 was to use the four tools (iCrisis, XVR, NoKeos, and WIS) along the duration of the project to test scenarios development using the methodology provided in the D1.4, to run simulated exercises with focus on cascading effects, and to test the IET implementation in existing tools. One of the most important activities of this task is to provide feedback which can be used by WP1-4 partners to, on one hand, formulate adequate recommendations on the use of the IEM/IET for the improvement of current incident management in crisis situations, and on the other, to refine the features and functionalities of the IET so that it could be used in combination with other existing tools.

This deliverable has described a set of simulation and management tools used to support the Incident Evolution Methodology and Tool (IEM/IET) in the CascEff project and the integration possibilities between these tools and the IET. The lessons learnt from the simulations run using these tools and the users' workshops conducted along the whole duration of the project included:

- The philosophy behind the IET - the Incident Evolution Methodology (see D4.2) - (as demonstrated with the use of the paper-based IET), supports the goal of improving the understanding of cascading effects by spreading and raising situational awareness of incident management actors on cascading effects. However, there is a need to develop a software to support its effective implementation because it appears time-consuming as such.
- The validation of the IEM with the use of iCrisis and XVR as supportive tools during the response phase shows that the IEM could be used in association with other existing tools to run simulated exercises. However, it also reveals that the workload of the whole IEM could hinder its complete use since incident managers do not have time to go through all the six steps of the IEM when facing a crisis situation.
- The participants to the workshops recognized that an integration of the IET with their IMT systems could help them by:
  - contributing to increase the situational awareness of cascading effects;
  - offering an overall snapshot visualisation of all the effects of an ongoing incident;
  - providing predictions results (timeline, map, etc.) on potential cascading effects to support decision-making using their tools;
  - allowing an early identification of cascading effects potentially involved in a crisis situation;
  - assisting them in the identification of the key moments for decision-making based on the IET predictions;
  - assisting them in risk and vulnerability analyses;
  - providing support to deal with long-lasting and complex incidents in planning and response phase;
  - allowing to create a variation of scenarios and to study similar scenarios with small changes; etc.
- The interviewees also identified these following points as some of the challenges of integrating the IET with NoKeos or WIS:
  - Accuracy of the input data and the IET predictions.
  - Translation of the IET objects into IMTs objects (and vice-versa).
  - Security of the information (what information should be made available and who should be able to use the tool and access the information?).
  - Need of a relevant training before using the IET.

On the basis of the above-mentioned lessons learnt, the following recommendations for an improvement of current incident management of cascading effects (task T1.5), and the application of the IET in existing systems (task T4.4) were formulated:

- Establish close collaboration with the end-users to ensure the use of the IEM/IET as supportive tools for decision-making in preparing for or responding to incidents with cascading effects.
- Applying the IEM/IET in the planning phase first to establish a relevant baseline of systems and simulation results before implementing it in the response phase.
- Stress the importance of accurate input data to the end-users of the IET to obtain reliable predictions of the evolution and impact of the cascade.
- Improve the usability of the IEM by integrating the IET with existing IMTs, risk databases so less data needs to be entered into the system.
- Ensure that the IET is developed to enable data sharing between the IET and existing tools (IMTs, simulation tools, databases, etc.).
- Provide training material to enable target audiences to implement the results of the CascEff project.
- Promote the use of data exchange standards with IMT developers in general.

Appendices

Appendix 1: Systems characterization table

ID	category system	System	City	Geolocation	Sensitive to	Potential created effects	Potential impacted systems
S1	Business and Industry	Zone commerciale Basse Jarrie	Jarrie	45°05'08.8"N 5°44'33.3"E	GM, RA, TE, PRW, PRI, WA, FI, TO, SO, WFS, ES, TS	FI	Neighboring buildings S56 S13 S57
						EP	Population
						FS	Population
						PRI	Neighboring buildings S56 S13
						MI	Neighboring buildings S56 S13 S57
S2	Business and Industry	Zone commerciale Haute Jarrie	Jarrie	45°06'53.4"N 5°45'26.2"E	GM, RA, TE, PRW, PRI, WA, FI, TO, SO, WFS, ES, TS	FI	Neighboring buildings S5 S59 S60
						EP	Population
						FS	Population
						PRI	Neighboring buildings S5 S59 S60
						MI	Neighboring buildings S5 S59 S60
S3	Business and Industry	Arkéma	Jarrie	45°05'13.7"N 5°44'11.7"E	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS	TE	Neighboring buildings S1 S4 S7 S13 S56 S57 S59 S58 S60
						PRI	Neighboring buildings S1 S4 S7 S13 S56 S58 S60
						FI	Neighboring buildings S1 S4 S6 S7 S13 S41 S56 S57 S58 S59 S60 S63
						TO	Population S1 S4 S6 S7 S13 S14 S15 S16 S30 S37 S38 S39 S41 S42 S43 S44 S56 S58 S60
						MI	Neighboring buildings S1 S4 S6 S7 S13 S41 S56 S57 S58 S59 S60 S63
S4	Business and Industry	Areva-Cezus	Jarrie		GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS	RA	Neighboring buildings S3 S6 S7 S58 S60
						TE	Neighboring buildings S3 S7 S59 S60
						PRI	Neighboring buildings S3 S7 S58 S60
						FI	Neighboring buildings S3 S7 S57 S58 S59 S60
						TO	Population S3 S6 S7 S57 S58 S59 S60 S63
						MI	Neighboring buildings S3 S6 S7 S57 S58 S59 S60 S63
S5	Business and Industry	RSA le Rubis	Jarrie		GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS	TE	Neighboring buildings S2 S59 S60
						PRI	Neighboring buildings S2 S59 S60
						FI	Neighboring buildings S2 S59 S60
						TO	Population S2 S59 S60
						MI	Neighboring buildings S2 S59 S60
S6	Business and Industry	Cofely-Axima	Jarrie		GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS	TE	Neighboring buildings S7 S59 S60
						PRI	Neighboring buildings S7 S59 S60
						FI	Neighboring buildings S3 S7 S59 S60
						TO	Population S7 S59 S60
						MI	Neighboring buildings S3 S4 S7 S38 S59 S60
S7	Business and Industry	Air liquide	Jarrie		GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS	TE	Neighboring buildings S4 S6 S3 S59 S60
						PRI	Neighboring buildings S4 S6 S3 S60
						FI	Neighboring buildings S4 S6 S3 S60
						TO	Population S4 S6 S3 S60
						MI	Neighboring buildings S4 S6 S3 S59 S60
S8	Business and Industry	Zone commerciale Intermarché	Vizille		GM, RA, TE, PRW, PRI, WA, FI, TO, MI, SO, WFS, ES, TS	FI	Neighboring buildings S60 S62 S63
						EP	Population
						FS	Population
						PRI	Neighboring buildings S60
						MI	Neighboring buildings S60 S62 S63
S9	Business and Industry	Zone commerciale Lidl	Vizille		GM, RA, TE, PRW, PRI, WA, FI, TO, MI, SO, WFS, ES, TS	FI	Neighboring buildings S52 S60 S62 S63
						EP	Population
						FS	Population
						PRI	Neighboring buildings S52 S60
						MI	Neighboring buildings S52 S60 S62 S63
S10	Business and Industry	Zone commerciale Carrefour	Vizille		GM, RA, TE, PRW, PRI, WA, FI, TO, MI, SO, WFS, ES, TS	FI	Neighboring buildings S36 S60 S62 S63
						EP	Population
						FS	Population
						PRI	Neighboring buildings S36 S60
						MI	Neighboring buildings S36 S60 S62 S63
S11	Business and Industry	Zone commerciale Centre ville	Vizille		GM, RA, TE, PRW, PRI, WA, FI, TO, MI, SO, WFS, ES, TS	FI	Neighboring buildings S32 S34 S46 S54 S55 S60 S62
						EP	Population
						FS	Population
						PRI	Neighboring buildings S32 S34 S46 S54 S55 S60
						MI	Neighboring buildings S32 S34 S46 S54 S55 S60 S62
S12	Business and Industry	Zone commerciale Nieto	Vizille		GM, RA, TE, PRW, PRI, WA, FI, TO, MI, SO, WFS, ES, TS	FI	Neighboring buildings S60 S62 S63
						EP	Population
						FS	Population
						PRI	Neighboring buildings S60
						MI	Neighboring buildings S60 S62 S63
S13	Education	Ecole Victor Pignat (maternelle, primaire)	Jarrie		GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, TS, WS, FS	PRI	Neighboring buildings S60
						FI	Neighboring buildings S57 S59 S60
						MI	Neighboring buildings S57 S59 S60
S14	Education	Ecole le Louvarou (maternelle, primaire)	Jarrie		GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, TS, WS, FS	PRI	Neighboring buildings S30 S38 S60
						FI	Neighboring buildings S30 S38 S57 S59 S60
						MI	Neighboring buildings S30 S38 S57 S59 S60
S15	Education	Ecole les Chaberts (primaire)	Jarrie		GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, TS, WS, FS	PRI	Neighboring buildings S44 S60
						FI	Neighboring buildings S44 S57 S60
						MI	Neighboring buildings S44 S57 S60
S16	Education	Collège Clos Jouvin	Jarrie		GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, TS, WS, FS	PRI	Neighboring buildings S43 S60
						FI	Neighboring buildings S43 S57 S60
						MI	Neighboring buildings S43 S57 S60
S17	Education	Ecole municipale (maternelle, primaire)	Séchilienne		GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, TS, WS, FS	PRI	Neighboring buildings S45 S60
						FI	Neighboring buildings S45 S60 S61
						MI	Neighboring buildings S45 S60 S61
S18	Education	Ecole Joliot-Curie (maternelle, primaire)	Vizille		GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, TS, WS, FS	PRI	Neighboring buildings S60
						FI	Neighboring buildings S60 S62
						MI	Neighboring buildings S60 S62
S19	Education	Ecole du Château (maternelle, primaire)	Vizille		GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, TS, WS, FS	PRI	Neighboring buildings S47 S53 S60
						FI	Neighboring buildings S47 S53 S60 S62
						MI	Neighboring buildings S47 S53 S60 S62

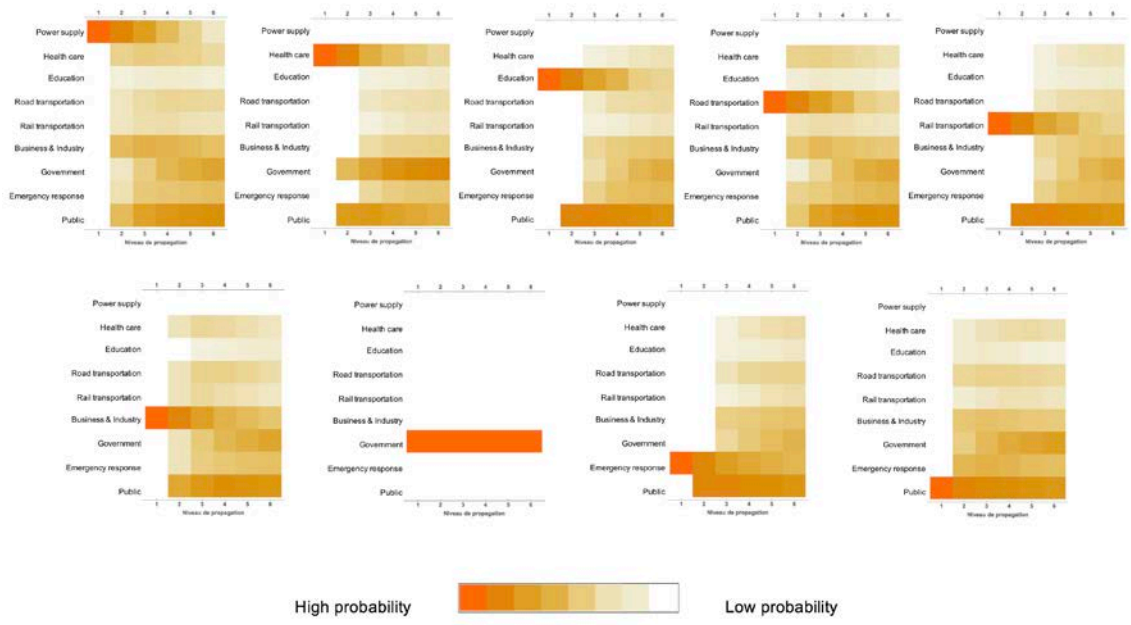
		primaire)		WFS, ES, TS, WS, FS	MI	Neighboring buildings	S47 S53 S60 S62
S20	Education	École du Centre (maternelle)	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, TS, WS, FS	PRI	Neighboring buildings	S60
					FI	Neighboring buildings	S60 S62
					MI	Neighboring buildings	S60 S62
S21	Education	École Jean Jaurès (primaire)	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, TS, WS, FS	PRI	Neighboring buildings	S48 S60
					FI	Neighboring buildings	S48 S60 S62
					MI	Neighboring buildings	S48 S60 S62
S22	Education	Crèche-Halte garderie Les Petits Drôles	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, TS, WS, FS	PRI	Neighboring buildings	S60
					FI	Neighboring buildings	S60 S62 S63
					MI	Neighboring buildings	S60 S62 S63
S23	Education	Collège Les Mattons	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, TS, WS, FS	PRI	Neighboring buildings	S49 S60
					FI	Neighboring buildings	S49 S60 S62
					MI	Neighboring buildings	S49 S60 S62
S24	Education	Lycées des Portes de l'Oisans	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, TS, WS, FS	PRI	Neighboring buildings	S60
					FI	Neighboring buildings	S60 S62
					MI	Neighboring buildings	S60 S62
S26	Emergency response	Système d'envoi de messages vocaux à la population	Jarrie	WFS, ES, CS			
S27	Emergency response	SDIS38	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, SO, WFS, ES, TS	PRI	Neighboring buildings	S33 S60
					FI	Neighboring buildings	S33 S60 S62
					MI	Neighboring buildings	S33 S60 S62
					PB	Population	
					SO	Population	
S28	Emergency response	Système d'envoi de messages vocaux à la population	Vizille	WFS, ES, CS			
S29	Emergency response	Gendarmerie	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, SO, WFS, ES, TS	PRI	Neighboring buildings	S60
					FI	Neighboring buildings	S60 S62
					MI	Neighboring buildings	S60 S62
					PB	Population	
					SO	Population	
S30	Government	Mairie	Jarrie	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, SO, WFS, ES, CS	PRI	Neighboring buildings	S14 S60
					FI	Neighboring buildings	S14 S60 S59
					MI	Neighboring buildings	S14 S60 S59
					SO	Population	
S31	Government	Mairie	Séchilienne	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, SO, WFS, ES, CS	PRI	Neighboring buildings	S45 S60
					FI	Neighboring buildings	S45 S60 S61
					MI	Neighboring buildings	S45 S60 S61
					SO	Population	
S32	Government	Mairie	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, SO, WFS, ES, CS	PRI	Neighboring buildings	S11 S60 S62
					FI	Neighboring buildings	S11 S60 S62
					MI	Neighboring buildings	S11 S60 S62
					SO	Population	
S33	Healthcare	Maison de retraite La Romanche	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES	PRI	Neighboring buildings	S27 S60
					FI	Neighboring buildings	S27 S60 S62
					MI	Neighboring buildings	S27 S60 S62
S34	Healthcare	Centre Médico Psychologique adulte	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES	PRI	Neighboring buildings	S11 S60
					FI	Neighboring buildings	S11 S60 S62
					MI	Neighboring buildings	S11 S60 S62
S35	Healthcare	Centre médico Psychologique enfant	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES	PRI	Neighboring buildings	S60
					FI	Neighboring buildings	S60 S62
					MI	Neighboring buildings	S60 S62
S36	Healthcare	Clinique Vétérinaire du Château	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES	PRI	Neighboring buildings	S10 S60
					FI	Neighboring buildings	S10 S60 S62
					MI	Neighboring buildings	S10 S60 S62
					EP	Population	
S37	Public	Centre Social et culturel André Malraux	Jarrie	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES	PRI	Neighboring buildings	S60
					FI	Neighboring buildings	S60 S59
					MI	Neighboring buildings	S60 S59
					SO	Population	
S38	Public	Musée de la chimie	Jarrie	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, HU	PRI	Neighboring buildings	S14 S60
					FI	Neighboring buildings	S14 S60 S59
					MI	Neighboring buildings	S14 S60 S59
S39	Public	Courts de tennis (2)	Jarrie	RA, TE, PRI, WA,FI, TO, MI			
S40	Public	Stade de Rugby du plâtre	Jarrie	RA, TE, PRI, WA,FI, TO, MI			
S41	Public	Stade Pierre Pillet (stade de rugby)	Jarrie	RA, TE, PRI, WA,FI, TO, MI			
S42	Public	Piscine du clos jouvin	Jarrie	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, WS	PRI	Neighboring buildings	S16 S43 S60
					FI	Neighboring buildings	S16 S43 S60 S59
					MI	Neighboring buildings	S16 S43 S60 S59
S43	Public	Gymnase du clos jouvin	Jarrie	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES	PRI	Neighboring buildings	S16 S42 S60
					FI	Neighboring buildings	S16 S42 S60 S59
					MI	Neighboring buildings	S16 S42 S60 S59
S44	Public	Ludothèque et salle communale	Jarrie	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES	PRI	Neighboring buildings	S15 S60
					FI	Neighboring buildings	S15 S60 S59
					MI	Neighboring buildings	S15 S60 S59
S45	Public	Bibliothèque	Séchilienne	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, HU	PRI	Neighboring buildings	S17 S31 S60
					FI	Neighboring buildings	S17 S31 S60 S61
					MI	Neighboring buildings	S17 S31 S60 S60
S46	Public	Centre Communal d'Action Sociale	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES	PRI	Neighboring buildings	S54 S60
					FI	Neighboring buildings	S54 S60 S62
					MI	Neighboring buildings	S54 S60 S62

S45	Public	Bibliothèque	Séchilienne	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, HU	PRI	Neighboring buildings	S17 S31 S60
					FI	Neighboring buildings	S17 S31 S60 S61
					MI	Neighboring buildings	S17 S31 S60 S60
S46	Public	Centre Communal d'Action Sociale	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES	PRI	Neighboring buildings	S54 S60
					FI	Neighboring buildings	S54 S60 S62
					MI	Neighboring buildings	S54 S60 S62
					SO	Population	
S47	Public	Gymnase du Parc	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES	PRI	Neighboring buildings	S19 S50 S60
					FI	Neighboring buildings	S19 S50 S60 S62
					MI	Neighboring buildings	S19 S50 S60 S62
S48	Public	Gymnase de l'école Jean Jaurès	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES	PRI	Neighboring buildings	S21 S60
					FI	Neighboring buildings	S21 S60 S62
					MI	Neighboring buildings	S21 S60 S62
S49	Public	Gymnase Guy Mocquet	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES	PRI	Neighboring buildings	S23 S60
					FI	Neighboring buildings	S23 S60 S62
					MI	Neighboring buildings	S23 S60 S62
S50	Public	Tennis du Parc	Vizille	RA, TE, PRI, WA,FI, TO, MI			
S51	Public	Stade Municipale du Parc du Château	Vizille	RA, TE, PRI, WA,FI, TO, MI			
S52	Public	Piscine municipale	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, WS	PRI	Neighboring buildings	S60
					FI	Neighboring buildings	S60 S62
					MI	Neighboring buildings	S60 S62
S53	Public	Cinema	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES	PRI	Neighboring buildings	S19 S60
					FI	Neighboring buildings	S19 S60 S62
					MI	Neighboring buildings	S19 S60 S62
S54	Public	Château	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, HU	PRI	Neighboring buildings	S11 S46 S60
					FI	Neighboring buildings	S11 S46 S60 S62
					MI	Neighboring buildings	S11 S46 S60 S62
S55	Public	Médiathèque	Vizille	GM, RA, TE, PRW, PRI, WA, FI, TO, MI, WFS, ES, HU	PRI	Neighboring buildings	S11 S35 S60
					FI	Neighboring buildings	S11 S35 S60 S62
					MI	Neighboring buildings	S11 S35 S60 S62
S56	Rail Transportation	Gare Jarrie-Vizille	Jarrie	WA, GM, PRI, PRW, TO, TE, TS	PRI	Neighboring buildings	S3 S1 S60 S57
					FI	Neighboring buildings	S3 S1 S60 S59 S58 S57
					MI	Neighboring buildings	S3 S1 S60 S59 S58 S57
					WFS	Local Business, Industries and services	
					TS	Local Business, Industries and services	S58 S57
S57	Rail Transportation	Voie ferrée	Zone entière	WA, GM, TE, TS, MI, FI	TS	Local Business, Industries and services	S58 S56
					WFS	Local Business, Industries and services	
					FS	Local supermarkets	
S58	Rail Transportation	Trans	Zone entière	GM, RA, PRW, PRI, WA, FI, TO, MI, ES, TS	TS		S57 S58
					WFS	Local Business, Industries and services	
S59	Road Transportation	Reseau routier urbain (Jarrie)	Jarrie	WA, GM, TE, TS, MI, FI	TS		S60 S63
					WFS	Local Business, Industries and services	
					FS	Local supermarkets	
S60	Road Transportation	Réseau TAG + Trans'isère (bus de transport en commun, transport scolaire)	Zone entière	GM, RA, PRW, PRI, WA, FI, TO, MI, ES, TS	TS	Population	S59 S61 S62 S63
					WFS	Local Business, Industries and services	
S61	Road Transportation	Reseau routier urbain (Séchilienne)	Séchilienne	WA, GM, TE, TS, MI, FI	TS		S60 S63
					WFS	Local Business, Industries and services	
					FS	Local supermarkets	
S62	Road Transportation	Reseau routier urbain (Vizille)	Vizille	WA, GM, TE, TS, MI, FI	TS		S60 S63
					WFS	Local Business, Industries and services	
					FS	Local supermarkets	
S63	Road Transportation	RD 1091 et RN85	Zone entière	WA, GM, TE, TS, MI, FI	TS		S59 S61 S62 S60
					WFS	Local Business, Industries and services	
					FS	Local supermarkets	

Appendix 2: Dependence probability of system categories involved in the Séchilienne scenario

Because on one hand, the database of studied events is not enough statistically representative for placing a high confidence level on the occurrence rates, and on the other hand, the process whereby systems impact each other during these historical events is not precisely understood, the value of the calculated occurrence rates was not presented. Only their relative importance (in terms of dependence probability level) was illustrated using colour gradient. The darker the colour, the higher the rate.

For example, the dependency probabilities of other system categories regarding an incident that occurs within a system belonging to the “Power supply” category are represented by the first graph. This graph shows on the x-axis the order of cascading effects (with 1 representing the originating incident; thus, the occurrence rates of the cascading effects start from 2 for the first order effects).



Appendix 3: Questionnaire (for the paper-based IET)

You will participate in a crisis situation simulation. During this simulation, groups of decision makers to which you belong will be placed in a virtual situation where you will have to face the complexity and uncertainties, characteristics inherent to these situations. These simulations generally allow participants to experience the difficulty in driving such crisis situations and to learn about their reactions in such contexts. In order to contribute to a better understanding of how the participants live and perceive these situations, we are currently conducting a study on cascade effects and decision-making in simulated crisis situations. This work is undertaken under the framework of the CascEff project (FP7 EU project, www.casceff.eu). This is why we ask you to fill out these questionnaires. There are no right or wrong answers. It is your sincerity that counts above all.

We ask you to fill-up this questionnaire once the simulation is over. ALL INFORMATION SHALL BE STRICTLY CONFIDENTIAL.

The decisions made by the crisis unit have influenced the course of events
0%_____100%

The decisions made by the crisis unit have positively influenced the course of events
0%_____100%

The decisions made by the crisis unit have adversely influenced the course of events
0%_____100%

In general, during the simulation, would you say that the IET was used
☐ never ☐ rarely ☐ often ☐ all the time

The IET was used to visualize the systems involved in the situation
☐ never ☐ rarely ☐ often ☐ all the time
For this task the IET has helped you
☐ not at all ☐ a little ☐ moderately ☐ a lot

The IET has been used to identify dependencies between
☐ never ☐ rarely ☐ often ☐ all the time
For this task the IET has helped you
☐ not at all ☐ a little ☐ moderately ☐ a lot

The IET was used to identify the first level of potential effects
☐ never ☐ rarely ☐ often ☐ all the time
For this task the IET has helped you
☐ not at all ☐ a little ☐ moderately ☐ a lot

The IET was used to identify the second level of potential effects
☐ never ☐ rarely ☐ often ☐ all the time
For this task the IET has helped you
☐ not at all ☐ a little ☐ moderately ☐ a lot

The IET was used to identify the n^{th} level of potential effects
☐ never ☐ rarely ☐ often ☐ all the time
For this task the IET has helped you
☐ not at all ☐ a little ☐ moderately ☐ a lot

The IET was used to initiate a decision
☐ never ☐ rarely ☐ often ☐ all the time
The IET was used to confirm a decision
☐ never ☐ rarely ☐ often ☐ all the time
The IET was used to challenge a decision
☐ never ☐ rarely ☐ often ☐ all the time
The IET was used to correct a prior decision
☐ never ☐ rarely ☐ often ☐ all the time