MONITOR

2011

MONITOR II – CSA definitions and requirements

PRISMA solutions

Version 1.0

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SOUTH EAST EUROPE
Jointly for our common future

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Contents

1 Preface and versions

1.1 Preface

1.2 Version

Version	Date	Who	What
0.1	21st October 2009	Stefan Kollarits	Basic requirements; base structure
0.2	29th June 2010	Stefan Kollarits	Data sources, information fusion levels
0.3	9th September 2010	Stefan Kollarits	Stakeholder descriptions, User stories Information flow model
0.31	29th September 2010	Stefan Kollarits, Karl Rehrl	Define site inspector
0.5	17th January 2011	Martin Ortner	Complement usage scenarios for sensor management.
1.0	30th January 2011	Stefan Kollarits	Detailing of scenario manager and mobile client user stories. Finalisation of stakeholder roles and requirements.

1.3 Contents

2 CSA – basic information

2.1 Problem description

Concerning problems tob e tackled these can be summarised by the categories information access, knowledge exchange (communication) and tool support.

Information access

- Isolated information systems
    - Too many information sources
    - Relevant information is hetereogenous and not linked

Knowledge exchange

- No common knowledge about scenarios

Tool support (mainly contingency planning)

- Guidelines and standards missing
- Update procedures and dynamisation missing
- Tools missing

2.2 Introduction

2.2.1 Goals

The primary goal of the MONITOR II CSA (Continuous Situation Awareness) is to improve situation awareness and knowledge about situations, which are relevant for disaster management. This goal has to be achieved for different stakeholders in different phases of the disaster management cycle.

The main operational goal is thus to identify and assess situations, according to pre-defined types of situations and rules.

Situation awareness (SAW) is “knowing what is going on around oneself.”

More precisely, SAW is the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future (Endsley & Garland).

Situation awareness depends on the integration of a (large) number of information from different sources and to evaluate these in different levels of detail. This process is usually called information fusion and is shown in the following graphic.

Level	Fusion process	Task	Entity	Model
0	Signal assessment	Identify features	Signal	Perception
1	Object assessment	Identify objects	Object	Perception
2	Situation assessment	Identify relationships	Aggregation (Situation)	Comprehension
3	Impact assessment	Evaluate	Effect (Situation according to Plan)	Projection
4	Process refinement	Plan	Control	Action

Graphic 1: The Joint Defense Laboratories (JDL) model as a standard for information fusion systems (adapted)

2.2.2 Interaction with other systems

MONITOR II project is (accepting) the fact that partners have already developed systems, which cover parts of the functionality of the envisaged CSA. These systems have been built with considerable costs and many users are accustomed to using them. The consequences from this are

- MONITOR II CSA will provide solutions only as a complement to existing systems (subsidiary principle)
- MONITOR II CSA will strongly build and be dependent on interactions with existing and planned systems.

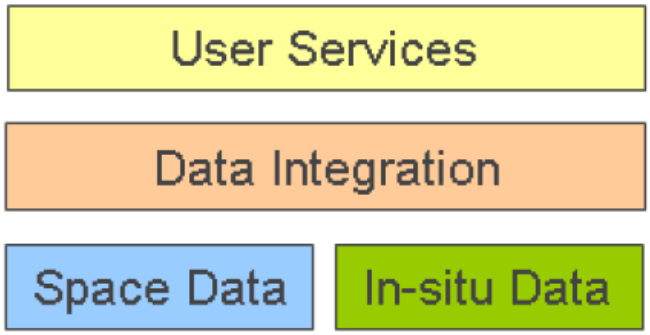
2.2.2.1 GMES as major related initiative

The GMES initiative was launched in 1998 and adopted by the ESA[6] and EU councils in 2001. It started with an initial exploratory period from 2001 to 2003. It was followed by a concrete implementation period that started in 2004 and ended in 2008. This phase is now followed by a

validation phase of the first three fast-track services (Emergency Response, Land Monitoring, and Marine services).

As illustrated in the figure below GMES consists of four major components:

- The space component providing earth observation satellite data.
- The in-situ component providing ground and airborne data as well as socio-economic data.
- The data integration and information management component providing access to and processing of the above space and in-situ data.
- The high level user services component allowing for monitoring of the various aspects of our environment.



The following key architectural and user-oriented requirements will therefore drive the implementation of GMES:

- Openness, based on agreed open standards, facilitating seamless communication and interoperability, i.e. the ability of different devices or systems (usually from different vendors) to work together, as well as enabling user service autonomy;
- Federated architecture, enabling systems to grow and evolve;
- Simplicity of architecture (e.g. modularity of components), to break the complexity barrier, systems must be made easier to design, administer and use;
- Self-configuration, programmability, scalability (e.g. to handle various levels of operational load and external conditions);
- Dependability, i.e. the system's resilience to security threats or breakdown;

- User-friendliness of services and interfaces, e.g. in the handling of user request services, access control, workflow management, delivery management, visualisation, data extraction (e.g. —multilinguality||), multiuser sessions, administration;
- Data security, protection of provider and user data against alteration, theft and misuse;
- Quality of service;
- Ubiquity of access, including global reach.||

2.2.2.2 GMES functional requirements

The following list of functional GMES requirements has been analysed preliminary according to the needs of MONITOR II project partners and stakeholders. The relevant functional requirements for the MONITOR II CSA are indicated in green.

1. SELECTION OF INFORMATION FROM HETEROGENEOUS SOURCES

a. Publishing

b. Discovery (data/information and services)

c. Catalogue (search, browse, etc.)

d. Tasking

e. Ordering

f. Access to data

g. Data/information Mining

2. INTEGRATION

a. Data/information fusion

b. Map overlay

3. TRANSLATION OF DATA AND INFORMATION BETWEEN VARIOUS SOURCES IN REAL TIME

a. Geo-referencing and re-projection

b. Feature translation

c. Semantic interoperability

d. Multilingual

e. Data formatting

f. Data generalisation

4. OTHERS

a. User management and Security (including Terms and Conditions to access GMES Services)

b. Service level agreement

c. Quality (for metadata7, data and services)

2.2.3 Benefits of CSA

2.3 Stakeholders (and their needs)

SYSTEM ADMINISTRATOR	
User Identification & Profile	Person in charge of the system.
Typical Users	Administrator of the system, IT staff
Application themes	Common
Description of the role	The system administrator is in charge of installing, updating and maintaining the system. He is concerned with all issues that can affect the integrity, efficiency, reliability, availability of the system.

HAZARD EXPERT (HAZARD MAPPER)	
User Identification & Profile	Domain expert of natural hazards, who is responsible for hazard assessment (specifically: hazard mapping).
Typical Users	Hazard expert within authority, technical office or research organisation, mandated by authority.
Application themes	Hazard assessment
Description of the role	The hazard expert is in charge of assessing hazards and for producing hazard maps and hazard scenario information.
Relationship with other stakeholders	Can be asked for ad hoc hazard assessment support in case of disasters pending.
Goals	Create and update hazard maps and hazard scenarios.

CONTINGENCY PLANNER	
User Identification & Profile	Person or institution, responsible for contingency planning.
Typical Users	Civil protection authority or expert, mandated by authority.
Application themes	Contingency planning
Description of the role	The contingency planner is a risk expert, who uses the outputs of hazard assessment for risk assessment and for the definition of

	organised countermeasures (defined as a contingency plan).
Relationship with other stakeholders	Is informed by hazard expert about hazards (relying on event scenarios defined by hazard expert). Interacts with hazard experts in order to monitor hazard processes and assess related situations. Interacts with relief units by providing information about hazard scenarios and respective countermeasures and related training. Interacts with civil protection authorities and other authorities.
Goals	Create and update contingency plans.

LOCAL / REGIONAL PLANNING AUTHORITY	
User Identification & Profile	The planning authority needs to know the risk (related to floods, landslides) in the region under its responsibility, for a better territory management.
Typical Users	Regional/ city/urban authority administration, in charge of territory planning, land use, etc.
Application themes	Risk evaluation and Mapping - Territory Management
Description of the role	The planning authority must ensure territory management and land use policy, taking into account the natural environmental risks, such

	as landslides and floods. Information about risk in the area allows it to make the best use of the territory, and adapt land use to the risks identified.
Relationship with other stakeholders	The authority must inform the inhabitant about the risks they can face. The authority works closely together with other authorities (regional or national) to conduct a coherent policy, and makes information they need available.
Goals	Ensure the best territory management for minimising risks related to (natural) hazards.

INSTRUMENTATION MANAGER (DATA PROVIDER)	
User Identification & Profile	The instrumentation manager is in charge of installing and maintaining the sensor networks, as well as ensuring the good communication to collect the sensor data.
Typical Users	Instrumentation manager (e.g. University, Research institution, private company).
Application themes	Hazard process monitoring
Description of the role	The instrumentation manager relies on a sensor network and communication system to observe hazard processes, and collect the related data for their customers. They must ensure the measurements are done in good conditions, and that the data is available at any time and in time.
Goals	Improve information situation by providing

	data via sensor networks.

CIVIL PROTECTION AUTHORITY	
User Identification & Profile	Usually regional or local authorities, sections of ministries (environment, internal affairs, territory management). They exchange information with the end-user, provide it with policy guidelines, etc.
Typical Users	Ministry of environment, municipal autority, regional civil protection service.
Application themes	Risk evaluation and Mapping - Territory Management
Description of the role	The other regional and national authorities have some common goals and need to share information. AT the national level, ministries give guidelines for policy related to territory management, environmental rules, laws, etc.
Relationship with other stakeholders/ end users	Those authorities work together on common areas of interest related to environment, regional policy, and territory management.
Goals	Ensure the application of laws and directives; deal with information related to environment and territory.

SCIENTIST	
User Identification & Profile	They can be either universities where researchers study natural risks, or geographic institute that will need any

	information related to the territory they are interested in.
Typical Users	Researchers.
Application themes	Hazard assessment at several risk cycle phases (dominantly: prevention phase) and risk assessment.
Description of the role	They lead studies regarding the hazard / risk assessment and management in certain areas.

RELIEF UNIT – STRATEGIC COMMAND	
User Identification & Profile	
Typical Users	
Application themes	
Description of the role	
Other stakeholders	
Relationship with other stakeholders	
Goals	Generate, update and validate the Common Operational Picture (COP)

RELIEF UNIT – TACTICAL COMMAND	
User Identification & Profile	The tactical command ... on site
Typical Users	

Application themes	
Description of the role	
Other stakeholders	
Relationship with other stakeholders	
Goals	

RELIEF UNIT – OPERATION	
User Identification & Profile	
Typical Users	
Application themes	
Description of the role	
Other stakeholders	
Relationship with other stakeholders	
Goals	

OBSERVATION STAFF	
User Identification & Profile	Observes in the field single observation points or observation points along observation routes. Checks for critical events during warning or event (e.g. water level, clogging of rivers) at these points. Documents damages during / after event.

Typical Users	Dyke control, torrent control tasks.
Application themes	Danger assessment, documentation and mobile tools..
Description of the role	Observers have to collect information about existing objects (e.g: status of protective structures) and / or about parameters of ongoing / pending processes.
Relationship with other stakeholders	Hazard experts and contingency planners provide input (what has to be observed). Output of observation feeds back into hazard assessment, contingency planning or directly (real-time) into warning.
Goals	Observe relevant objects / processes in the field, supported with analogue and/or mobile tools.

DOCUMENTER	
User Identification & Profile	Document events and their effects during or after an event.
Typical Users	Trained documenter with a minimum of hazard expertise.
Application themes	Documentation and mobile tools.
Description of the role	The documenter is responsible for providing field information about ongoing events or shortly after an event: event parameters and event effects (especially: features and damages).

Relationship with other stakeholders	Hazard experts rely on documentations for detailed event analysis and event understanding.
Goals	Improve knowledge about ongoing events or previous events, by documentation the event and event impacts in the field.

TRANSPORT AUTHORITY	
User Identification & Profile	Railway company, highway company.
Typical Users	Operator of transport network.
Application themes	Risk assessment, contingency planning, warning and intervention, documentation.
Description of the role	A transport authority, which operates infrastructures (road, railway) in an area susceptible to (natural) hazards, must ensure the integrity of people using this transport way, as well as the integrity of the infrastructure.
Other stakeholders	Regional/local authority Transport users
Relationship with other stakeholders/ end users	They must liaise with the regional/local authority to exchange information about any threats. They must warn the transport users in case of danger for them to avoid using the transport infrastructure.
Goals	Ensure safety of people using their transport

	ways, and integrity of infrastructures.

INHABITANTS OF THE REGION	
User Identification & Profile	People living and working in the region under consideration.
Typical Users	Anybody exposed (currently or potentially) to threats.
Application themes	Hazard assessment, contingency planning, warning.
Description of the role	Inhabitants of the region must be informed of the natural risks existing and which can threaten them.
Relationship with other stakeholders/ end users	They get information about natural risks from the regional/local authorities (hazard assessment), about countermeasures taken (contingency plans) and about hazards impeding (warning).
Goals	Being informed about risks and countermeasures in a way which allows reaction if necessary.

3 Basic requirements

3.1 Functional requirements

3.1.1 Classification of functions

Management Support

Administration

Define work-flows (→ contingency plans, real-time information, alarm, communication)

Visualise work-flows (→ as schematic process scenarios, as classical work-flows)

Manage work-flows … (→ import, update, export)

Planning support

Prepare information

Integrate planning / measure information

Define scenarios

Real-time model

Develop real-time information interfaces (adaptors)

Integrate real-time information directly

Rules and DSS

Define rules with rule engine (→ manage rules, import rules; rules refer to semantically defined object – ideally: ontology)

Process real-time information – “Information fusion” (→ e.g. check ideal work-flow of pre-defined scenarios with actual states; assesss situations)

Communicate alarms and notify

Event management

Capture events and their properties (→ „Stabsarbeit“

Edit and process event information

Revise situation definition (→ manually define / evaluate situations)

Situation overview

„Situation map", visualise situations

List events and messages

Communication

Capture messages (manually, semi-automatically, automatically)

Edit and process messages

Communicate messages

Documentation

Document current situation (→ mobile tools for on site information generation)

Document situation development (→ reporting)

Provide feedback to planning, in cases of repeated events (→ histories information, report and statistic tools)

Disaster management situation → **Information fusion process ↓**	**NOMINAL situation** **Preparedness**	**ALERT & ALARM situations** **Warning**	**DISASTER & EMERGENCY** **Response**	**RECOVERY situation** **Recovery**
Signal assessment (information collection & correction)	Mid- to long-term information collection	For early warning and alarming: Short-term information collection	Short-term information collection	Short-term information collection
Object assessment (information processing)	Non-real time data analysis	Real-time or near-real time data analysis	Real-time or near-real time risk scenario definition	Non-real time data analysis
Situation assessment	Non-real time. Often complex models, estimation, interpretation and evaluation procedures are involved.	Real-time or near-real time assessment, but restricted to a simple pre-defined set of situations (often binary).	Real-time or near-real time; potentially complex situation definition	Non real-time with a focus on damages and objects with priority needs of repair.

Impact assessment	Non real-time. Similar as above.	Based on pre-defined alarm plans. Real-time automatisms for alarm-plan starting desirable.	Near real-time or non real-time. Potential for future automated support.	Ad hoc.
Process refinement (Planning of implementation)	Structural approaches (e.g engineering works) Non-structural approach (land-use planning, information, warning actions)	Early warning systems Alarming systems	Duty of: civil protection authorities public and private boards	Redesign for recovery.

Figure 1: Characteristics of information fusion processes in different disaster management phases with specific regard to time

3.1.2 Overview of user requirements (tasks and tools)

Who	Context (Plan)	What (Task)	How (tools, methods)
Regional authority	Prevention	Check hazard map update needs	Guidelines
Regional authority	Prevention	Check contingency plan update needs	Guidelines
Hazard expert	Hazard assessment	Prepare hazard map	Regional / national Guidelines Simulation models Event cadastre
Regional authority	Prevention	Assign hazard mapper (with hazard assessment)	Order
Hazard expert	**Hazard assessment**	**Get overview of defined event scenarios**	**Scenario Manager: WebClient**
Hazard expert	**Hazard assessment**	**Define event scenarios**	**Scenario Manager: ArcGIS**
Hazard expert	**Hazard assessment**	**Integrate model output into scenario manager**	**Scenario manager: ArcGIS**
Hazard expert	**Hazard assessment**	**Link event scenarios to GIS objects** **- hazard map objects** **- general GIS objects** **- ontology**	**Scenario manager: ArcGIS**
Hazard expert	**Hazard**	**View and query hazard**	**Scenario manager:**

	assessment	**scenarios**	**WebClient**
Hazard expert	Hazard assessment	"Run" event scenario	Scenario manager
Hazard expert	Hazard assessment	Evaluate alternative hazard related measures	Scenario manager (+ measure related rules/models → DSS)
Regional/local authority	**Prevention**	**Publish scenario information**	**Scenario manager: CSA server**
Civil protection authority	Risk assessment	Assess vulnerability of elements at risk	GIS model
Civil protection authority	Risk assessment	Calculate risk	GIS model
Civil protection authority	Risk assessment	Link elements at risk to GIS objects	GIS
Contingency planner	Contingency planning	Communicate scenarios to stakeholders	CSA web tool (scenario manager content)
Contingency planner	Contingency planning	Collect contingency plan base information	GI tools, used according to INSPIRE / MONITOR II standards
Contingency planner	**Contingency planning**	**Prepare site inspection**	**Scenario manager: WebClient**
Contingency planner	**Contingency planning**	**Perform site inspection**	**Documentation manager: mobile tool**
Contingency planner	Contingency planning	Evaluate alternative measures for capacity strenghtening	Scenario manager (+ measure related rules/models → DSS)
Contingency	Contingency	define contingency plan (flow-	Contingency manager

planner	planning	chart)	
Contingency planner	Contingency planning	define contingency plan (all tools)	Contingency manager
Contingency planner	Contingency planning	Review contingency plan	CSA web-tool with annotations
Contingency planner	Contingency planning	Communicate contingency plan	CSA web-tool, meetings
Contingency planner	Contingency plan implementation	Train contingency plan	Training material
Contingency planner	Contingency plan implementation	Define and guide contingency exercises	
Contingency planner	**Danger assessment**	**Plan sensor network (monitoring and early-warning systems)**	**Sensormanager (with input from scenariomanager)**
Instrumentation manager	Danger assessment	Install monitoring and early-warning systems	xxx
Civil protection authority, scientist	Danger assessment	Complement sensor network	Sensor manager
Instrumentation manager	Danger assessment	Register sensor service: search sensor service	Sensor manager
Civil protection authority, scientist	Danger assessment	Register sensor service: add sensor service	Sensor manager
Civil protection authority, scientist	Danger assessment	Configure sensor service: increase measurement density	Sensormanager
Civil protection	Danger assessment	Spatially fuse sensor data	GI interpolation

authority, scientist			models
Observation staff	Danger assessment	Observe (observation points, observation routes)	Mobile tool
Civil protection authority	Danger assessment	Forecast situation	Simulation and forecast models
Civil protection authority (+++)	Danger assessment (any)	Visualise, query, filter sensor data	CSA WebClient: sensor web components
Civil protection authority	Danger assessment	check ongoing scenario	CSA core: rules
Civil protection authority	Danger assessment	Generate danger map (current, forecast)	CSA core: rule-based situation map
Civil protection authority	Danger assessment	check land movement	
Civil protection authority	Danger assessment	check movement predictions	
Civil protection authority	Warning	Generate and communicate warnings	CSA core: sensor alert services
Civil protection authority	Warning	Receive automatic alert/alarm notification	CSA core: sensor alert services
Strategic command	Intervention	Generate and update Common Operational Picture (COP)	
Civil protection authority	Intervention	Start and monitor evacuation	
Tactical command	Intervention	Tactical operations	

System administrator	Prevention	Configure mobile tool	CSA administration
System administrator	Prevention	Exchange information with mobile tool (export / import)	CSA administration
Relief unit operator	Intervention		Contingency manager – measure leaflet CSA mobile tool (?)
Observer, helper	Intervention	Observe event (dangers, damages)	Mobile tool
Documenter	Documentation	Document event effects	Mobile tool
Civil protection authority	Documentation	Report sensor information	Documentation manager: report tool

3.1.3 User stories

The tasks defined above can be interpreted as user stories. A user story describes how a specific user (role) wants to use system functionality for a defined objective.

The structure of the user stories can be described very shortly:

User_Role Requirement Reason (+ Importance)

As a [User_Role] I want to [requirement], because [reason] with [importance]. Description.

3.1.3.1 Hazard assessment

SCENARIO01: define event scenarios

As a hazard expert I want to model hazard scenarios with a digital reference to hazard map objects.

I will define scenarios, their main parameters and assumptions.

I will define subprocesses and map the process area to GIS (or alternatively use process area defined in digital hazard map).

I will define the critical points along the defined processes and attach them to the processes (including cardinal points and situation assessment parameters).

I will optionally define references to additional objects, like documents (fotos, ...) as URL references.

I will optionally define/refine metadata for the resulting hazard scenario data.

REQUIREMENTS – SUCCESS CRITERIA

Use of standard GIS tools (ArcGIS) and standard GIS modelling capabilities (Geodatabase) will be sufficient.

Conformity of resulting data to MONITOR II concepts (scenario manager.

All resulting data can be stored and exchanged as one ESRI Geodatabase.

Choosing level of detail (min – std – opt) will assure conformity of resulting data to the data model of the level choosen.

Database model and legends must be fully defined in advance and available in structured form.

Metadata must conform to ISO19115 standard. Minimum profile for metadata of hazard scenarios has to be defined and available in advance.

SCENARIO02: integrate model output into hazard scenarios

As a hazard expert I want to integrate the output of process (simulation) models into hazard scenarios.

I will load results of models into ArcGIS for visualisation / manipulation.

I will transform features of model outputs into feature types usable within hazard scenarios (by using standard GIS functions, like aggregation, ...).

I will identify (transformed) features within model output layers and use them as hazard scenario features (especially: the feature geometry).

REQUIREMENTS – SUCCESS CRITERIA

Applicable model output formats, which can be used as a basis for integration, have to be identified in advance.

Applicable model output formats is restricted to formats directly usable within ArcGIS.

Instructions for integration have to be included in user manual.

Source of features must be traceable in the resulting scenario data (i.e.: model information, model parameters and assumptions, lineage).

SCENARIO 03: link event scenarios to GIS objects

As a hazard expert I want to link objects of the hazard scenario to other GIS objects.

I will link objects of the hazard scenario to external GIS layers (e.g.: hotspot of hazard scenario references to bridge in some infrastructure database).

I will link to zones of existing hazard maps (by defining a reference).

I will create new zones, linking to scenarios defined, allowing these zones to be later on used in hazard maps.

REQUIREMENTS – SUCCESS CRITERIA

A generic way of defining references must be defined in advance, which allows for standard linkage.

External (GIS) database to be linked must conform to some standard way of accessing data, ideally by web services which allow referencing by URL.

SCENARIO 04: publish hazard scenario(s) to CSA portal

As a hazard expert I want to publish hazard scenarios to CSA portal.

I will choose hazard scenario project in ArcGIS and publish this to CSA.

I will define identification parameters (project name, ...) for the scenario(s) in a simple form. This should be supported by well defined metadata (e.g.: area of coverage of hazard scenario, time, ...).

I will re-publish the scenario after changes / corrections in ArcGIS, leading to a complete reload (delete and create, no need for update).

REQUIREMENTS – SUCCESS CRITERIA

For each scenario and/or catchment an "area of interest" will be automatically generated in the portal (for direct access by user).

SCENARIO05: view and query hazard scenarios in CSA webclient

As a (hazard expert, contingency planner, regional/local authority, public) I want to view and query published hazard scenarios.

I will choose area of interest and visualise all hazard scenarios defined there.

I will choose hazard scenario(s) as filter and visualise all objects defined within this/these scenario(s).

I will

REQUIREMENTS – SUCCESS CRITERIA

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Login is only necessary for querying non-standard data (e.g. contingency plans which are not
yet finalised but in discussion).
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evaluate alternative hazard related measures

Show (potential future, current or historically documented) effects of measures. This should allow to explain measures and effects and to compare alternative measures.

3.1.3.2 Risk assessment

RISK01: assess vulnerability of elements at risk

As a contingency planner I want to assess the vulnerability of elements at risk at different levels (areas, objects).

RISK02: calculate risk

As a contingency planner I want to calculate risk, based on hazard assessment and vulnerability assessment.

RISK03: link elements at risk to GIS objects

As a contingency planner I want to link vulnerability and risk information to existing GIS objects.

3.1.3.3 Contingency planning

CP01: communicate scenarios to stakeholders

As a contingency planner I want to communicate hazard scenarios to stakeholders involved in contingency planning.

I will explain hazard scenarios by analogue maps or direct with GIS tools.

I will explain the usage of CSA portal for further investigation by stakeholders directly.

CP02: collect contingency plan base information

As a contingency planner I will use ArcGIS to capture base information for contingency planning.

CP03: prepare site inspection

As a contingency planner I want to plan the site inspection and provide this information adequate for usage in the field.

I will identify the main locations to be visited and what has to be checked there. This should result in a site inspection route.

I will define a draft version of event flowchart, focused on event (only minimum information about measures).

I will output the information as analogue map and/or to mobile tool.

CP04: perform site inspection ("site inspector")

As contingency planner I want to use a mobile tool to perform the site inspection. Basic intervention planning and intervention review will be done during field trip. This includes the identification of measures taken in former operations and necessary actions / resources in case of future operations.

For this end I want to show scenario related information with augmented reality functionality (e.g. border lines of the scenario defined processes).

I want to comment the scenario (with fotos or voice recordings related to the scenario elements).

I want to use the prepared (draft) flowchart elements as augmented reality background and as base elements for documentation.

I want to add or update scenario elements (e.g. new intervention point, update of critical point information).

I want to annotate scenario elements with actions (measures), resources, comments.

All new / updated information must be directly linked (online) to the CSA scenario information, in order to allow for smooth continuation of work back in office.

- This will be assured with a location referencing of all objects (if feasible) to base geographic layers (i.e. mainly transportation network and/or hydrographic networks.
- If feasible the user attaches the new information to existing objects of the hazard layer (e.g. process elements, critical points), which are defined within the scenario view of the hazard expert.

CP05: define contingency plan – flow-chart

As a contingency planner I want to define the contingency plan, starting with the complete event flowchart, including all measures resulting from field trip; review and redesign.

I will design the draft and further versions of the contingency plan with a (graphical) flowchart tool.

REQUIREMENTS – SUCCESS CRITERIA

```
The flowchart tool should conform to the standard graphical modelling language of work-flows.
The flowchart tool should allow structured output as XML for further automated processing.
```

CP06: define GIS based contingency plan

As a contingency planner I want to complement the basic contingency plan (flow-chart) with a spatial GIS based version.

Details: see SM01

CP07: publish contingency plan to CSA portal

As a contingency planner I want to publish the contingency plan (draft + final versions) to CSA portal, for providing access to stakeholders and reviewing functionality.

Details: see SM04

CP08: review contingency plan with CSA webclient

As a (civil protection authority, transport authority, inhabitant of the region) I want to review and comment contingency plan draft.

The finalisation of a contingency plan can only be done after a comprehensive review, because this is the only way to assure acceptance. This review should be done by providing annotation webservices to the user groups.

I want to add comments (type of comment, free text) to specific features (one or more) of a contingency plan. Alternativly I want to add a comment with free (= new) spatial reference.

REQUIREMENTS – SUCCESS CRITERIA

```
Reviewing shall be possible only for user who are logged in personally.
All comments have to be clearly traceable (user who edited the comment, datetime).
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CP09: define contingency plan – all tools

As a contingency planner I want to complement the basic contingency plan with all tools, based on commonly agreed event flowchart.

3.1.3.4 Assess danger situation

SENSOR01: plan sensor network

As a (scientist, instrumentation manager) I want to plan a sensor network according to the needs of monitoring and early warning concerning one or more specific hazard processes.

SENSOR02: install monitoring and early warning system

As an instrumentation manager I want to install sensors in order to monitor processes and provide adequate early warning.

SENSOR03: register sensor service

As a (scientist, civil protection agency, hazard expert, instrumentation manager) I want to subscribe for sensor services in order to observe sensor status and visualise/analyse sensor data.

SENSOR04: complement sensor network

As a (civil protection authority, scientist) I need to complement the sensor network on critical points, where no existing monitoring network/ sensors are installed.

> Because I need to get this extra information fast, the deployment of „classical" geotechnical sensors is not appropriate, due to the installation constraints (wiring, powering, etc) and the time required for installation and testing of the network.
>
> Therefore I need to deploy wireless smart sensors, which require minimum installation, and which have automatic networking properties. The integration of those new sensors in the system must also be fast and immediate access to the data.

SENSOR05: increase measurement density

As a (civil protection authority, scientist) I need to increase the measurement density of sensors in case of warnings, in order to have detailed information available for situation assessment.

SENSOR06: fuse sensor information spatially

As a (civil protection authority, scientist) I need spatial fusion methods to complement the existing data and be able to have estimated data at locations where no sensor network/data is available.

> I will first look for information from other sensor networks in the area of interest.
>
> In the second step, the spatial fusion may be used to complement the existing information.

SENSOR07: forecast situation

As a (civil protection authority, scientist) I need to forecast situations of process development.

SENSOR08: visualise sensor data

As a (civil protection authority, scientist) I want to visualise data from sensors and retrieve this data or use it in other services, because I want to check/visualise the current situation.

Therefore I must have the rights to read, download, and process the data. Sensor information includes thematically all types of land movement sensors (landslides), gauge data (floods) and rainfall related sensors.

These sensor data (e.g. weather-forecasts) must be integrated from different services, because of spatially / sectorally split sensor networks.

Ideally the integration of different services should be based on quality based integration (fusion) rules.

SENSOR09: configure sensors for warning generation

As a civil protection agency I want to define warning levels and release warnings if approporiate.

I will configure the sensors (using rules) so that warnings on different levels can be generated.

check ongoing scenario

As a civil protection authority I want to continuously check, if the situation is still within the identified scenario (concerning the process), because I need to be able to initialise the right work-flow of measures within minutes with very high importance.

generate threat maps (current situation, forecast situation)

As a civil protection authority I want continuously fusioned (aggregated) information about threats, both about the current situation and one or more forecasted situations. The information shall be derived from different sensorsm, shall be provided for one hazard type or combined for several hazard types and aggregated to different spatial (administrative or catchment) levels.

check land movements

As a civil protection authority I want to know if the land movement is regular or if it is accelerating, because I want to take counter measures in time.

Displacement acceleration is often one sign of landslide risk. Therefore, the authority is not only interested in the displacement measurements but also into their acceleration. If such data is not available directly, the user needs to use an acceleration calculation service to calculate the movement acceleration.

check displacement predictions

As a civil protection authority I want to have displacement prediction linked to forecasted rainfall, because I want to be prepared and take preventive measures.

Heavy rain can function as trigger events for landslides, therefore it can be useful to have such predictions. That will permit to anticipate and react more quickly in case the prediction is

confirmed by in-situ measurements. It will search for available models for landslides applications on the portal. This service can be chained to alert/alarm service.

3.1.3.5 Warning and intervention

receive automatic warning notifications

As a civil protection authority, I want to be alerted if a suspicious danger is detected, because a complete manual 24x7 observation of dangers is not possible.

Therefore I subscribe to different alarm levels and to notification service.

I receive a notification when an alarm is activated.

The notification is sent by the means of communication I choose.

communicate warning

As a civil protection agency I want to communicate warnings (if appropriate) in a correct and reliable manner.

I will check automatically generated warnings and release / communicate them if correct. In case of no manual interaction possible or manual interaction overdue automatic communication must be done.

generate and update Common Operational Picture (COP)

Not defined within MONITOR II.

start and monitor evacuation

Not defined within MONITOR II.

3.1.3.6 Documentation and mobile tool

MOBILE01: configure mobile client

As a system administrator I want configure the mobile tool for a specific task at hand.

I will configure the mobile client (forms and attributes, pageflow) with standard configuration files (like XML), no need for a specific user interface.

MOBILE02: install data on mobile client

As a system administrator I want to install data (background maps and specific data, like hazard scenarios and contingency plans) on the mobile client, prior to fieldwork.

I will choose background map and extent for installation.

I will choose hazard scenario, contingency plan, observation route or site inspection (route) for installation.

MOBILE03: export data from mobile client

As a (documenter, observer) I want to import data collected with mobile client directly into CSA portal and/or legacy GIS system.

I will connect my mobile tool to a (fast) network.

I will choose export from mobile client and choose target (e.g. CSA portal, regional GIS portal etc.). Data will be sent to export service and processed according to parameters defined.

MOBILE04: observe (observation points, observation routes)

As a observer I want to collect information about state of process and/or objects directly in the field.

For this purpose I need support of a mobile tool, which provides methods for documenting processes and objects (fotos, voice recording, simple forms).

I need to see the current status of observation tasks, which objects have already been qualified, which objects must/should be qualified; based on a list of objects to be qualified.

I will qualify existing objects (e.g. as part of scenario) with pre-defined forms.

I will add and qualify new objects, where necessary (e.g. protective structure).

I will add comments (comment type, foto ...) to existing objects where appropriate.

Tracking for location recording should be possible.

Additional sensors should be available (e.g. inclination, angle measurement). They should generate measurements automatically, depending on category of documented object, and then directly be linked to it.

REQUIREMENTS – SUCCESS CRITERIA

Look and feel must be similar to existing legacy applications, like forest portal of region of Tyrol.

Use of existing authorisation / rights (e.g. catchment related) management systems must be done.

MOBILE05: document event effects

As a documenter I want to document the event on site, considering event process (e.g. water level or water velocity), damages and other effects of event (e.g. levee).

For this purpose I need support of a mobile tool, which provides methods for documenting damages (fotos, voice recording, simple forms) and features (again fotos, simple forms).

Tracking for location recording should be possible.

Additional sensors should be available (e.g. inclination, angle measurement). They should generate measurements automatically, depending on category of documented damage/feature, and then directly be linked to it.

REQUIREMENTS – SUCCESS CRITERIA

Each information element needs to be geocoded.

Output in standardised formats, in order to be easily attachable to in house applications and databases, is necessary.

DOCUMENT01: report sensor information

As a user I want to produce regularly reports of all events that happened within the area of interest, because I have to keep a record of hazard processes, history of alarms, and all other relevant information related to the activity within the area of interest.

Therefore I want to have a service that provides me with the following information:

- Summary of measurements for all points (e.g. median/average values of all the displacements over a defined period),
- Graphical representation of the site information: isolines of movements over the same period,
- Time/series graph,
- History of alarms.

DOCUMENT02: analyse history of event development

As a user I want to analyse how a specific event has developed.

Therefore I want to use a reporting tool that

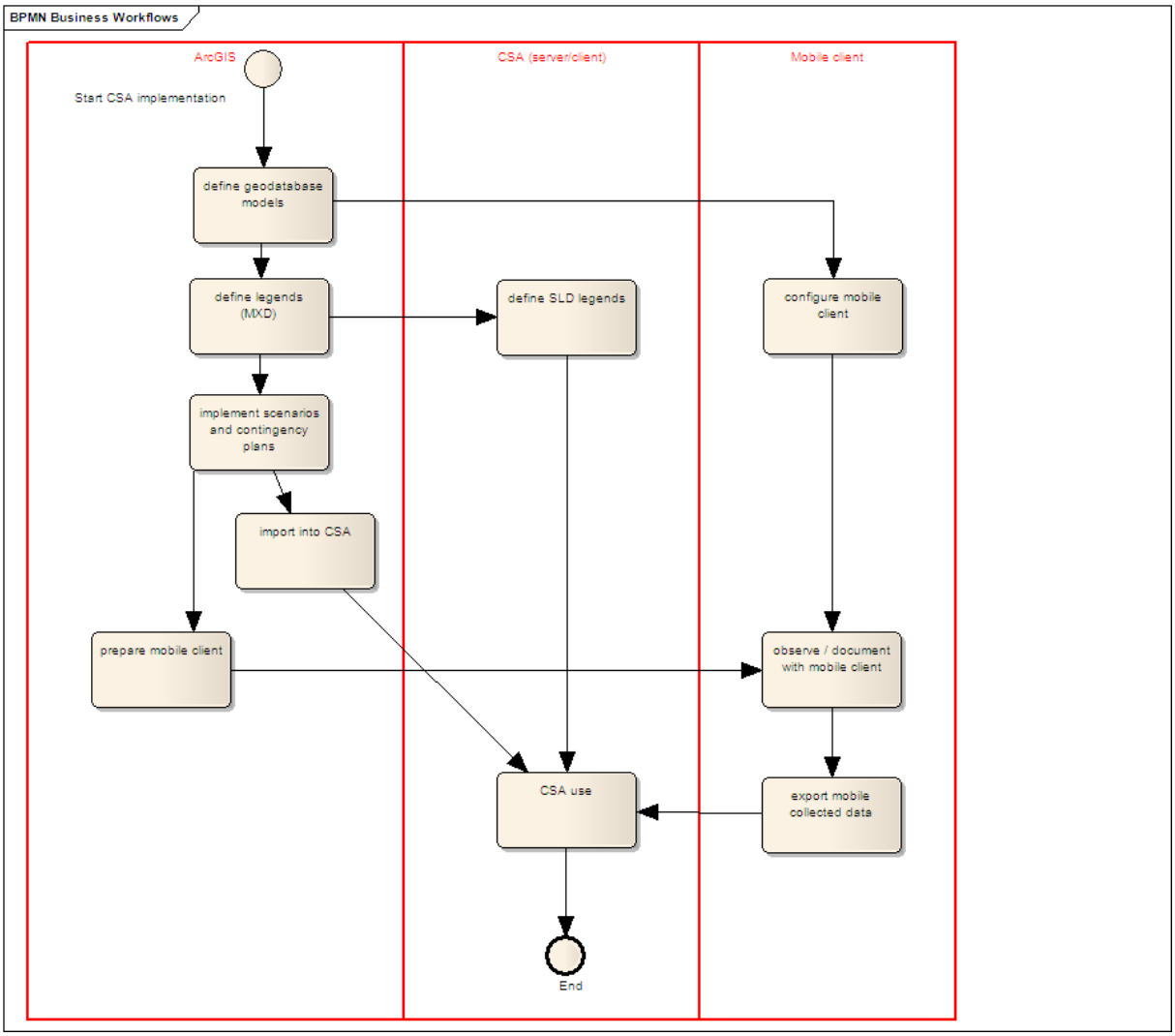
- shows the development of the event at different points in time (using the event data archive)
- shows the development on map view, scenario graph, time series graphs and tables in parallel
- produces a report as document

3.2 Non-functional requirements

Integration with DIS-ALP platform must be possible.

4 Requirements specification

The CSA – with the use cases detailed above – will be generated in a structured way, which can be shown clearly with the work-flow shown below:



Graphic 2: work-flow for generation of CSA

4.1 Usage scenarios (by module)

Task	Navigation
Administration	
Sensor manager	Add sensor service(s) Configure service(s)
Scenario Manager	Show available scenarios Define scenario Run scenario
Contingency Manager	
Documentation Manager	Define mobile tool settings Synchronise mobile tool Define documentation report Create report

4.1.1 Define scenario

1. Choose scenario maker template *Form* (here: BASIC EVENT SCENARIO)

2. Define scenario (*Form*)

   - hazard process (including multi-hazard) *DropDown*

   - name *Text*

   - description *MultiText*

   - type of evolution (slow, rapid …) *DropDown*

   - intensity *Quantity*

   - categorisation (base scenario, alternative scenario, unlikely scenario ...) *DropDown*

The following steps might differ between rapidly evolving events and slowly evolving events

3. Define start conditions and/or start event and their (parameters) *Form* with content depending on hazard process

4. Define subprocesses by area

- characterise subprocess *Form* (type of subprocess, name, description)

- map subprocess area in GIS (digitise or link existing process area from hazard map → choose appropriate *Tool*)

- define current measures influencing the subprocess area (protective measures, …)

4.1 Define scenario-specific subprocess parameters *Form* (intensity, timeline from process start, level of uncertainty for intensity and time)

4.2 Define critical points (linked to process area)

- define type of critical point (e.g. intervention point, observation point, observation route, intervention line) *DropDown* in *Form*

- map critical point in GIS (digitise or link existing element from hazard map or link existing element from INSPIRE conforming data source → choose appropriate *Tool*)

- define parameters (e.g. threshold values to identify scenario specific situation, category, …)

5. define sub scenarios (usually linked to critical point; e.g. dam break or Verklausung at bridge or dam overflow)

5.1 define link to general process scenario

- Type of cause of sub scenario (e.g. dam break …) *DropDown* process specific

- Link to element of general process (choose in map or scenario graph)

5.2 define sub scenario (steps 2 – 4 of general scenario definition)

Torrential process and subprocesses

- Trigger event (heavy rainfall in catchment)

- Start zone

- Transfer zone

- Accumulation zone

4.1.2 Work-flow documentation manager (documentation report)

Define documentation report

1) Filter

Define time period (= time filter)

Define spatial coverage (space filter)

Define situation types (= thematic filter: choose)

2) View

Viewing areas:

<table>
<tr><td rowspan="2">Map

(Situation map)</td><td>Situation

Situation classification (eg: Alert, coloured; Evaluation (notification) + measures / actions</td></tr>
<tr><td>Diagram

Measurements at different stations. Current time is shown as vertical line</td></tr>
</table>

Additional tool „comment“ → Klick in map creates comment (symbol+simple form)

3) Create document

4.1.3 Work-flow sensor manager – add service

Search services (input: type of services like water gauge, precipitation measurement; spatial coverage)

Show service parameters (what is being measureds, time interval, ...)

Define service filter (which values, spatial + time filter)

Define service legend (how are the values to be classified for mapping, which symbols)

➔ Service is added to “service list” (rechts außen), includes information about type of service, capabilities of service (Icon of service classifies basic type of data, like sensor point, remotely sensed image, ...)

➔ Sensor points are shown as symbol in map (active / not active)

4.1.4 Define contingency plan

(1) Area of interest

- can be viewed at different scales (1:200 000 – 1:2 000)

(2) Hazard map = map of flood areas

- *Attention*: different class limits between WLV and „Schutzwasserbau“
- water depth, flow velocity, flow direction, sediment transport, potential sedimentation/erosion areas

(3) Risk analysis

- risk elements within threatened areas and vulnerability / capability (mainly: buildings) → for categorization see INSPIRE drafts
- *Problem*: this sort of data is difficult to get in Austria

(4) Risk evaluation

- (pre-)defined rules for evaluation (done by an expert!)
- field assessment of parameters (includes both hazard potential of elements at risk as well as their vulnerability/capacity)
- GI model
- Risk map

(5) Checklist, contingency plan

(6) Additional plan

- for counter measures to protect buildings (“Ortsverteidigungsplan”)

(7) Evacuation plan

- Zone A, Zone B, Zone C

4.1.5 Check contingency plan activation

- Start: Hazard identification
  - ZAMG rainfall prognosis (140mm/24h)
- Task: make a decision, if a contingency plan has to be activated
  - E-mail to the stakeholder with warning
  - Checklist, contingency plan

4.1.6 Execute contingency plan

(1) Email from the warning and alarm centre

- What kind of hazard is expected within a certain time period

(2) Hazard identification

- ZAMG: rainfall prognosis (140mm/24h) within area of interest; different scales (1:200 000 – 1:2 000)
- Task: make a decision, if a contingency plan has to be activated

(3) Prognosis for the relevant gauge (“Pegelansicht”)

- Decision: alarm value will be reached in x hours/minutes
- Decision: internal warning of the own staff (fire brigade, etc.)

(4) Map of reference flood events (HQ 30, HQ100, HQ300)

- *Problem*: flow velocity, flow depth, flow direction, sediment transport and potential sedimentation/erosion areas are still missing (System should show if this data is available or not)
- areas … according to hazard map

(5) Risk analysis

- risk elements within threatened areas and vulnerability / capability (mainly: buildings); for categorization – see INSPIRE drafts

(6) Actual assessment map (“Lagekarte”)

- Documentation of actual progress (e.g. fire brigade: AMAP)

(7) Checklist, contingency plan

(8) Additional support plans

- for counter measures to protect buildings (“Ortsverteidigungsplan”)

(9) Evacuation plan

- Zone A, Zone B, Zone C

(10) Actual ortho images from plane

- if its possible and useful (this should be tested during stakeholder meeting

5 System specification

5.1 Component model

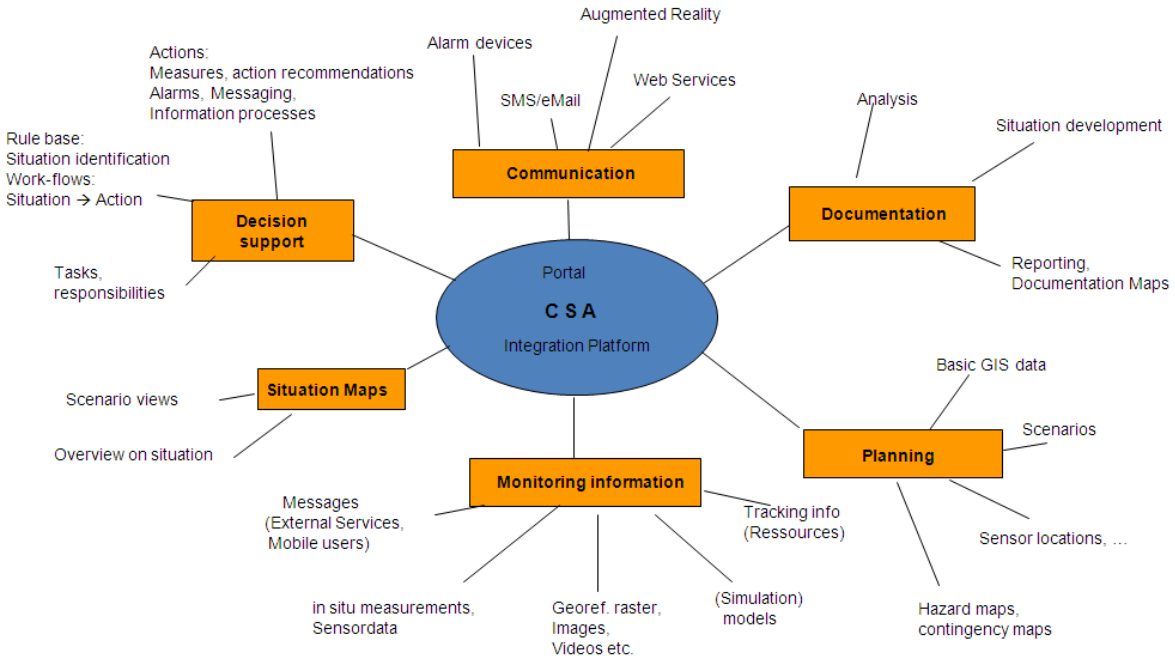


Figure 2: Components and sub-components

CSA core Service integration, rule engine and visualisation	
General	User administration
	Autorisation and security
	Service configuration
Preparedness	GUI components
	GIS integration services (WMS, WFS, …)
Warning / intervention	Sensor web integration
	Rule based data fusion
	Rule engine
	Sensor data visualisation and querying

Sensor Manager	
Prevention	Plan sensor networks
	Integrate sensor data into hazard mapping and contingency planning
Preparation	Implement sensor networks
Warning / Intervention	Observe processes and provide warnings
	Improve sensor networks
Recovery	Re-design sensor networks

Scenario Manager	
Prevention	define scenarios and link to hazard maps
Preparation	explain scenarios and link to contingency plans
Warning / Intervention	define thresholds and check scenario
Recovery	guide event documentation

Contingency Manager	
Preparation	define contingency plans
Warning	support monitoring and execute communication measures
Intervention	execute contingency plan (work-flow of measures)
Prevention	evaluate contingency plan after event and update contingency plan

Documentation Manager	
Preparation	History of previous events, reports, comment
Warning	Comment
Intervention	Comment
Recovery	Analyse history of event, reports, comment

Mobile Tools	
Preparation	Mobile information viewing and base data collection in the field
Warning	Mobile observation
Intervention	Mobile observation
Recovery	Mobile event (damage) documentation

5.2 Data model

5.2.1 General GIS data

For general data sources no specific data model shall be generated, but rather Inspire implementation rules shall be used and INSPIRE conforming services.

The data sources should be searched and evaluated based on metadata of data providers (which should allow to link the evaluation to the books of practice/dreams).

These data sources include

- Static data (DEM, DTM, geology)

- Semi-Dynamic data with defined update procedures (cadastre, addresses, TM)
- Semi-Dynamic data without defined update procedures (land-use, specific infrastructure) → define procedures (e.g. link cadastre to agricultural subvention database)

5.2.2 Hazard related data

There are (currently) no INSPIRE implementation rules available, but working groups for definition have been set up. There (interim) results have to be watched carefully.

There a standard definition seems to be necessary and/or **transformation rules**, which are definable by user (organisation). The definition can use an existing standard (e.g. Austria - WLV or Slovenia as a starting point).

These data sources include

- Former Event data, documentations
- Protective structures + status
- Scenarios and model results of hazard mapping
- Hazard map contents

5.2.3 Contingency related data

For contingency planning and implementation no standards are available. Thus MONITOR II should define a standards proposal.

These data sources include

- Work-flows (action plans including situations/measures)
- Ressources + locations (which links to transport network and/or addresses) → standard definition and/or transformation rule
- Norms / regulations (knowledge) → ontology (standard proposal)

5.2.4 Sensor data (monitoring)

Concerning sensor data the sensor web standards (SOS) shall be used. These standards becomes more and more widespread.

These data sources include

- Measurement data
- Remote sensing data (e.g. satellite data)
- Interpolated data

5.2.5 MONITOR II knowledge base

No standards available. Ad hoc solutions required.

These data sources include

- Factsheets, best practice examples (→ CMS, WIKI)
- Terms and definitions (→ ontology, WIKI)

5.2.6 Simple event data model

TYPE	DESCRIPTION
WHAT	Category of event
VALUE	VALUE (does not exist for all categories)
WHERE	Location
WHEN	Point of time, duration
STATUS	STATUS
IMPORTANCE	Priority and importance of the event
WHO	Source of information (observer, sensor, sensor platform,…)..
HOW	Optional addition Metainformation (esp. related to information generation methods = quality of event data)
REMARK	Free text comment

5.2.7 Types of data according to fusion process

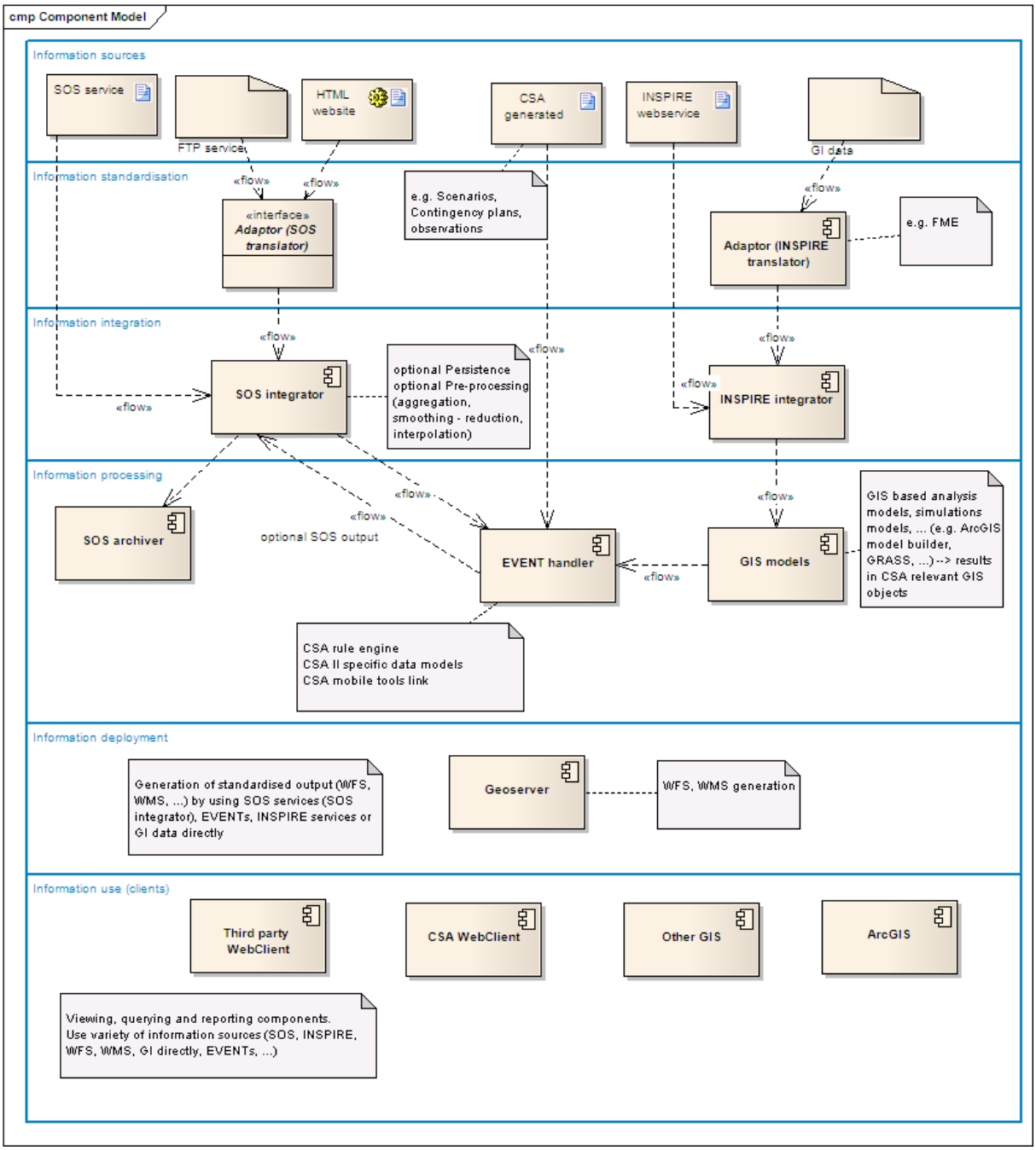
Information fusion: steps and results	Process	Description
Signal	Signal assessment	Basic information generated by a sensor
Detection		
Raw value		
Correction		Checking (consistency, plausibility) of value
Consolidated value		
Aggregation		
Statistical value		
Observation	Object assessment	Observe an event
Event		Observed event
Aggregation and Interpretation of events	Situation assessment	
Situation		Situation
Aggregation of situations		
Complex situation		A complex situation („Lage“) is the sum of related situations at the moment and the short-term projection of situation development.
Projection of situation(s)	Impact assessment	
Effect (projected situations)		
Planning	Process refinement	
Measure - Action		

Figure 3: General model of information fusion

Information type ➔ **Information fusion ➔**	**Observation**	**Measurement**	**Mobile Object**	**Image/Video**
Signal		e.g.: Reflexion from radar sensor		
Detection		Detection (usually done within the sensor itself)		
Raw value		e.g. single vehicle with parameters		Picture, Videostream, Audio
Correction		Plausibility checks and correcting		Image enhancement, Contrast improvement etc.
Consolidated value		e.g. single vehicle with parameters, corrected		Enhanced image
Aggregation		Aggregation		
Statistical value		e.g. vehicle count, average speed		
	Observation	Analysis (Threshold analysis, trend analysis)		
Event	Observed event	Derived event		
	Aggregation and Interpretation of events	Linking events with measurements		
Situation	Situation	Situation		
	Aggregation of situations	Aggregation of situations		
Complex situation	Lage	Lage		

Information type ➔ Information fusion ⬇	GIS objects	GIS categorised fields	GIS fields	Georeferenced Image
Signal				
Raw value				
				Georeferencing, Rectification
Consolidated value				Georeferenced and rectified image (e.g. Orthophoto)
Statistical value				
Object	e.g. land parcel with properties, road segment with properties	e.g. land-use categories, hazard zones, ...	e.g. DEM, DTM, Average yearly interpolated precipitation	
Situation				
Complex situation				

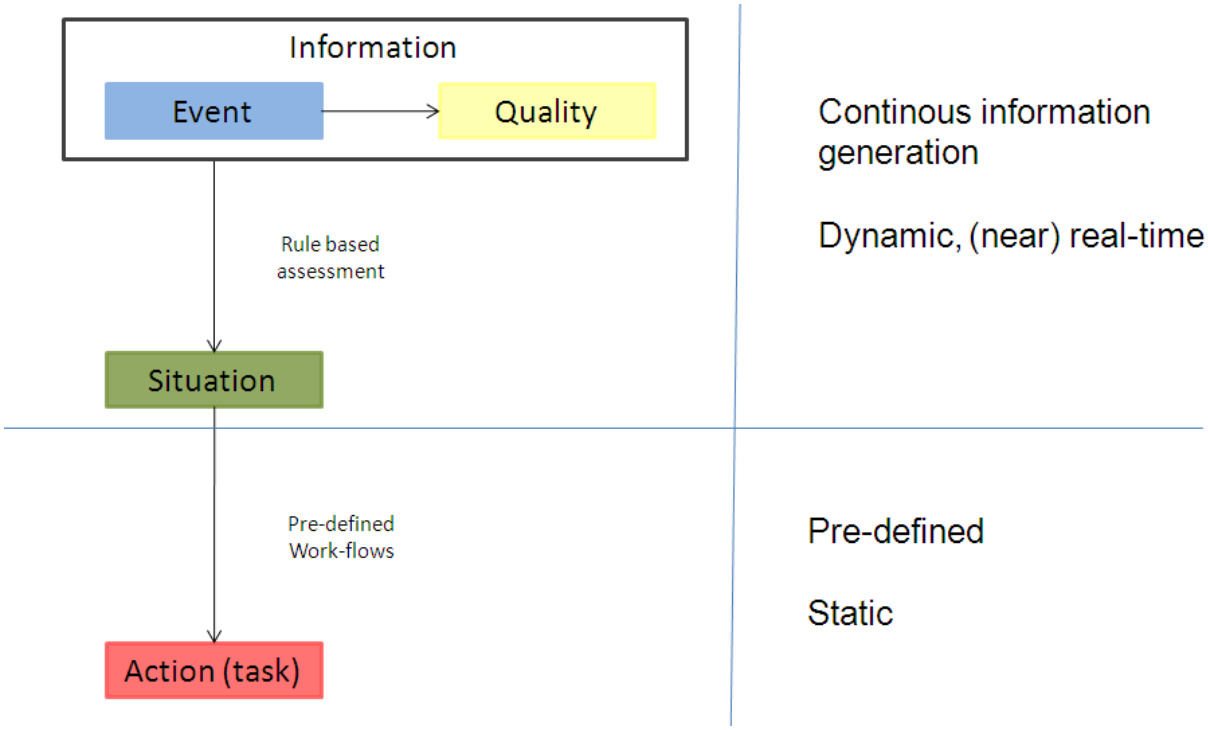
5.3 Interfaces and information-flow



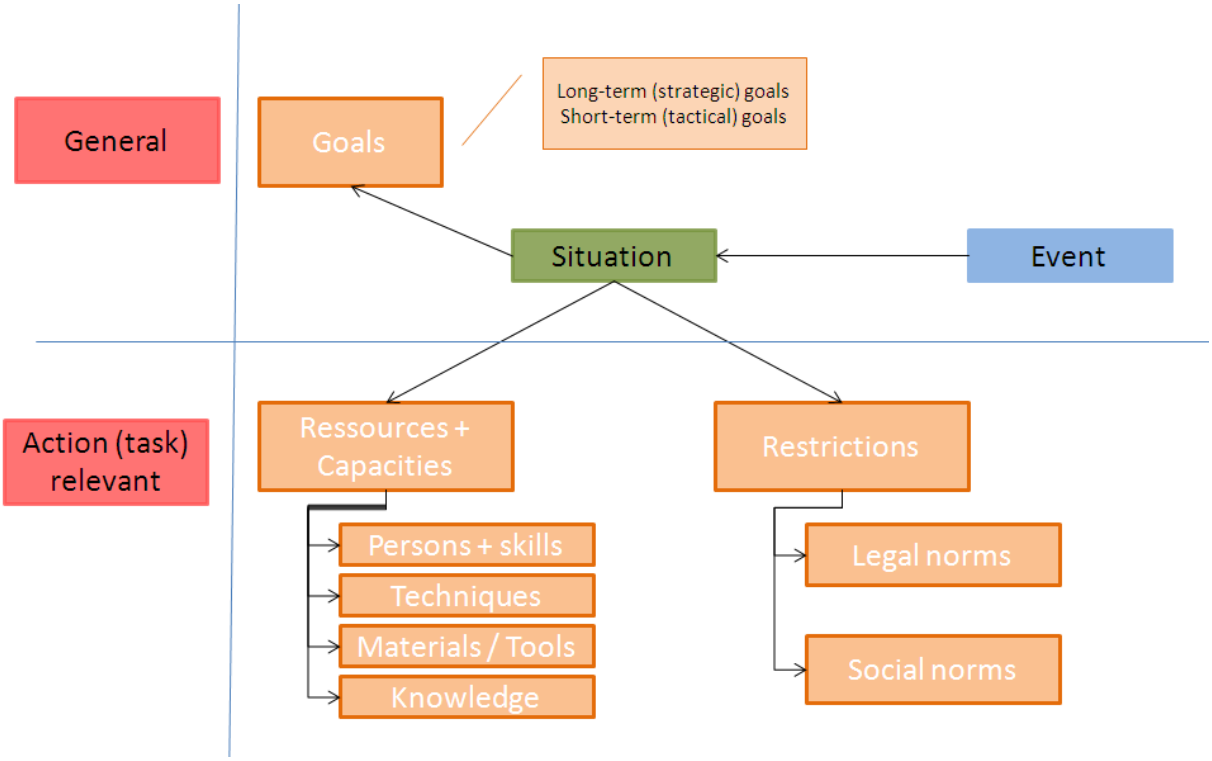
5.4 Information processing

5.4.1 Situation assessment basics

The basic task of information processing within CSA is to support situation assessment and to related situations to tasks (actions).



In later states the static part of information processing could / should become more dynamical. This would need self-learning components and allow for a semi-dynamic adaptation of work-flows.


General
Goals
Long-term (strategic) goals
Short-term (tactical) goals
Situation
Event
Action (task) relevant
Ressources + Capacities
Restrictions
Persons + skills
Techniques
Materials / Tools
Knowledge
Legal norms
Social norms

5.4.2 Simplified event ontology for situation assessment

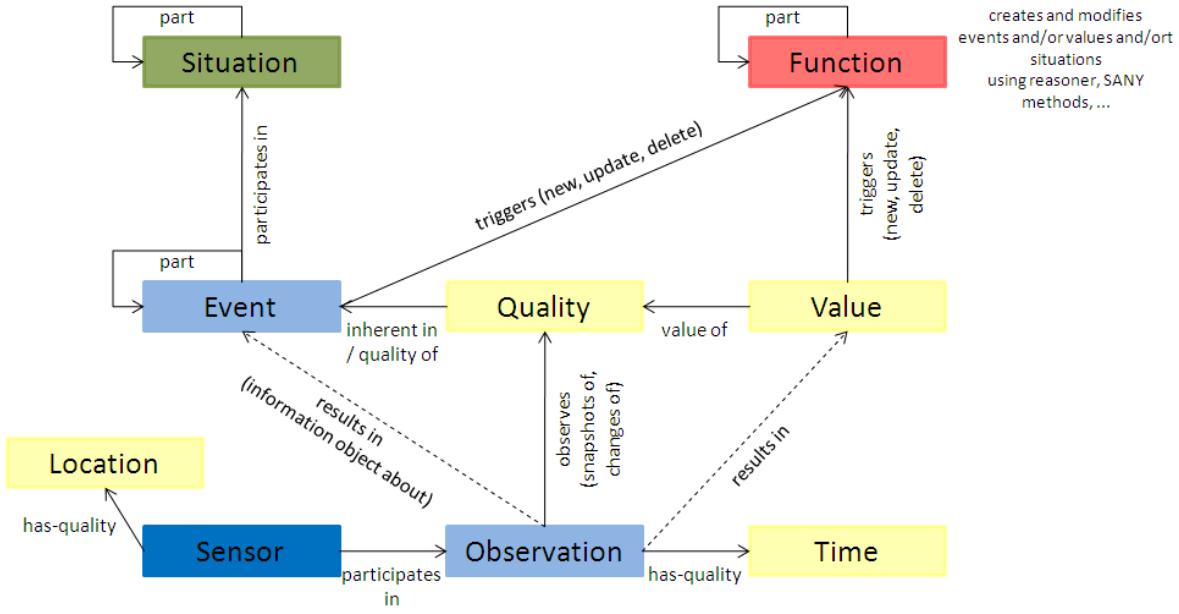


Figure 4: Simplified ontology of events for CSA

A sensor includes all types of information generating information sources; classical sensors (like gauges or satellite based remote sensors) as well as human observes and simulation models can be regarded as sensors.