SOUTH EAST EUROPE
Transnational Cooperation Programme

Co-funded by the EUROPEAN REGIONAL DEVELOPMENT FUND

MONITOR II

Monitor II

new methods for linking hazard mapping and contingency planning

MONITOR II is supported by means
of the European Regional Development Fund

Jointly for our common future

Editor:
Hubert Siegel, Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management, Subdivision for Landscape Planning and Risk Prevention

Authors:
Stefan Kollarits, Diethart Leber, Alessandro Corsini, Joze Papez, Tanja Preseren, Ingo Schnetzer, Albert Schwingshandl, Stefan Kreutzer, Kathrin Plunger, Martina Stefani

With valuable inputs from
Daniel Kozelj, Franci Steinman, Nina Dobrinkova, Christian Rachoy, Petriso Vica, Francesco Ronchetti, Thomas Plattner, Matteo Vischi, Michalis Aftias

Layout:
Barbara Veit, Veitdesign

ISBN:

Preface

While severe hazards are increasing also in the South Eastern European Space (SEES) hazards and contingency planning are lagging behind.

It is the scope of Monitor II to reduce gaps existing in hazard and contingency planning. Where relevant plans are existing, their usability is improved by implementing regular update procedures for emergency preparation and by integrating real-time situation maps in case of disaster.

Within the broad range of hazards, MONITOR II specifically deals with floods and landslides, as prominent examples of natural hazards. But the concepts and solutions of MONITOR II are being developed in a more general way, which allows for application and adaptation to other types of hazards as well.

MONITOR II aims to support disaster management by improving availability, reliability and communicability of hazard maps and contingency plans. Some major problems have been identified as obstacles to these aims, and they are common to all partner territories:

Lack of availability of hazard maps and contingency plans

- The effort of preparing hazard maps and contingency plans is high because no commonly accepted methodology in plan development is available. Standardised terminology and a common best-practice knowledge base are needed.

Lack of usability of hazard maps and contingency plans

- Most of existing contingency plans are well suited for providing experts and task forces with a clear course of actions in case of a disaster. But when it comes to usability and effectiveness, great potential for improvements can be found.

Lack of communication support between stakeholders

- Experts, practitioners, decision makers and the public have differing problem views and specific requirements on the presentation of information.

Lack of transnational approach

- Natural hazards do not end at national borders. Still, transnational standards in hazard mapping and contingency planning are fragmentary.

The main objective of MONITOR II is to improve information provision for disaster management.

This strengthens communication between hazard experts, decision makers and civil protection services with improved flow of information. By means of this improved situation the following goals are supported: Legal and organisational aspects: to minimize identified disparities in the SEE region regarding the degree of coverage with hazard plans and contingency plans according to identified priorities.

Technological aspects: to develop tools and procedures to integrate different sources of information, including (real-time) monitoring systems, records of past events, hazard analysis and expert knowledge on hazard processes:

- To improve the availability and effectiveness of contingency plans and hazard maps with respect to natural hazards;
- To improve reliability of information by dynamisation: make contingency plans reactive to real-time information and automate (partially) the update procedures of contingency plans

The results of MONITOR II are made available to a broad audience by a series of dedicated documents, which build on each other.
The present brochure deals with the state of the art of hazard mapping and contingency planning and provides a general framework for adaptations and improvements.

This brochure is intended to provide information to

- **experts of hazard mapping and natural hazards**
- **authorities competent for disaster management, esp. contingency planning.**

The goal of the brochure is to provide these groups with a better understanding of the tasks and needs of each other. The long term goal is to improve communication between these domain expert groups. As state-of-the-art analysis, this brochure reflects the discussion arising from the problems and issues encountered by the participating project partners in their testbeds.

Picture 1: Situation outside dambreak (Evros river, Greece)

The context: risk management

Natural hazards and disasters

Natural hazards account for a substantial and growing proportion of disasters in Europe. Between 1998 and 2002 alone, Europe suffered over 100 major damaging floods, including the catastrophic floods along the Danube and Elbe rivers in 2002. Since 1998, floods have caused some 700 fatalities, the displacement of about half a million people and at least € 25 billion in insured economic losses (EUROPEAN COMMISSION ENVIRONMENT 2011). In reaction to the floods of 2002 the European Union has started an initiave in order to mitigate the effects of these hazards – the Floods Directive Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks). For hazards related to floods this directive defines several obligatory measures of risk management.

Risk management aims at preventing or reducing damages resulting from hazardous events. As any other domain of expertise it uses a wide range of terms, which are quite often used in an ambiguous way. Ambiguity is a direct result of the broad range of actors involved in disaster management, the splitting of competences and the heterogeneity of experts and fields of expertise involved. In addition, actors, competences and fields of expertise usually change between the phases of risk management – leading to disruptures of communication, knowledge management and activities.

As a result practical experience shows that some of the definitions are not fully clear to the actors and are often used somehow contradictionary. Therefore a short introduction with a clear and concise definition is given below for those terms used in MONITOR II.

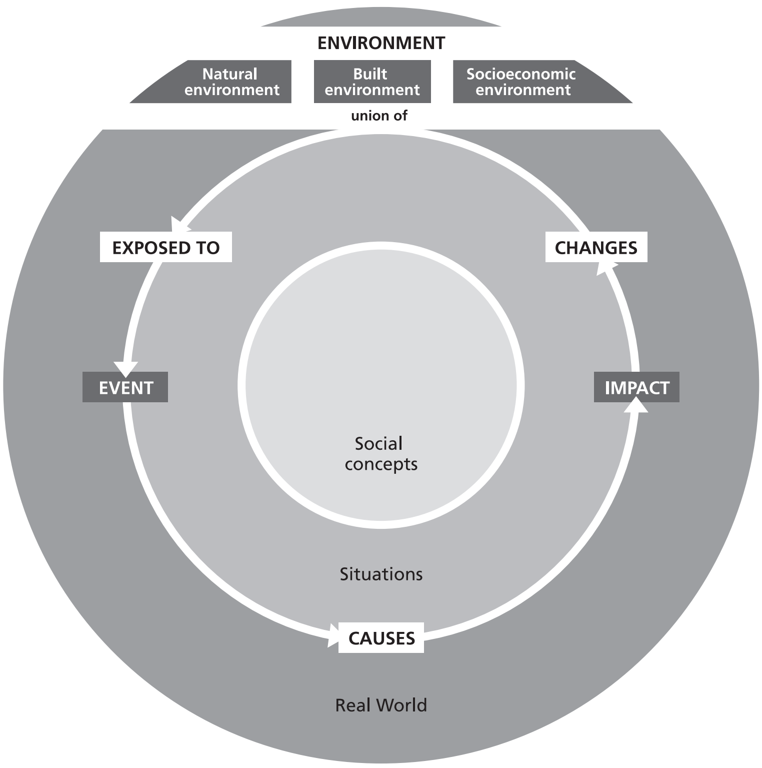


Figure 1: Risk management terms: real world (KOLLARITS, WERGLES et al. 2007)

PHYSICAL WORLD – WHAT HAPPENS?

Starting point for terminology development in the context of MONITOR II is the basic interrelation between the environment and events changing the environment: the physical world describes the "objective" world of objects, events and the impacts of events on objects.

If objects of the environment participate in events (which actually means a spatio-temporal co-location) we talk about exposure, they are exposed to these events. Events happen within this environment and cause impacts.

An impact "changes" (qualities of) the environment. A change of quality in this context may include substantial changes like generation and destruction of objects.

The main terms associated with the physical world are objects (of the environment), events and impacts. These are related to each other by exposure, causation and effect.

SOCIAL WORLD – HOW IS THE PHYSICAL WORLD INTERPRETED?

People perceive and evaluate events and their impacts on the environment in heterogeneous ways. There is not a single unified view of how these impacts are to be evaluated.

Social concepts classify elements of the real world in order to make them communicable and the associated knowledge interchangeable. Without social concepts no communication about objects and events is possible, because they provide the basis for mutual understanding. But this classification is always depending on context as much as on the social collective, which finds agreement on a specific social concept. Social concepts can thus not be seen as constants, but rather as changing views of the world, depending on a common agreement of some social collective.

The starting point for any discussion of disaster management is the term damage.

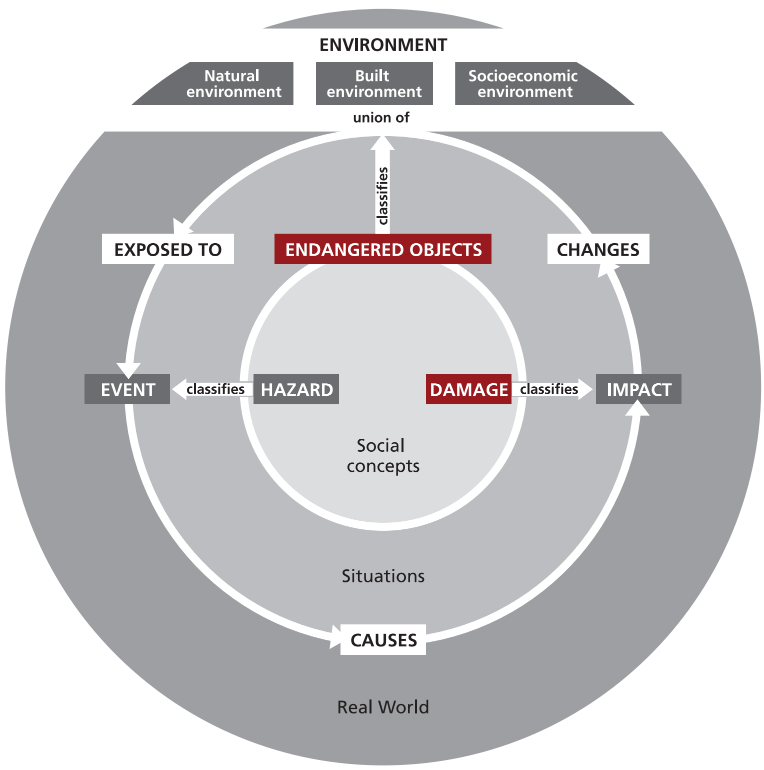


Figure 2: Basic social risk terms (KOLLARITS, WERGLES et al. 2007)

ON TERMS

DAMAGE
A damage (is the social concept which) classifies an impact of some event to have negative consequences.

LOSS
A loss is the quantification of damage according to a specific value system.

VALUE
A value (is the social concept which) classifies an object according to a specified value scale.

This scale reflects the social principles, goals, or standards held or accepted by an individual, class, society or other social object. Based on this general view of a value system the value in a narrower sense can be defined in money or goods (market price).

ON TERMS

Based on the concept of damage the term hazard can be defined:

HAZARD
Hazard is an event, which causes damage. This includes both the actual event and the potential event. The term hazard thus depends on the definition of damage.

VULNERABILITY
Vulnerability is the quality of (objects of) the environment, which determines damage, given a defined (hazardous) event. Vulnerability is thus the quality of an object, which describes its probability of getting harmed in an event. Vulnerability can be seen as inversely related to the capacities of objects to anticipate, to cope with, to resist and to recover from an extreme event.

RISK
Here risk is seen as a quality (the probability) of an impact, which is classified as damage. In more casual language this would mean that risk is the probability that something (anything) negative will happen.

ELEMENTS AT RISK
Objects of the environment, which are (spatially, temporally) exposed to hazards.

A SCENARIO is a description of a course of future events, based on a consistent and plausible set of assumptions about future conditions.

Risk management

Risk management deals with hazards and is the continuous, process-like management which aims at reducing risk to an acceptable level (acceptable risk). The corresponding goal situation is security.

For risk management the society – explicitly or implicitly – first defines the acceptable level of risk (normatively). Risk management assesses risk and defines and implements the measures necessary to reach this acceptable level of risk. The risk remaining is the residual risk.
If all measures defined have been implemented then the residual risk is the risk resulting from hazardous events, which have not been accounted for in terms of intensity of the event.

Risk management is concerned with extreme events, which are not accounted for in the everyday routines of dealing with risk and can thus lead to severe negative consequences.

SCENARIO

In order to be able to treat risk, i.e. to implement measures for risk reduction, assumptions about possible events and their impacts must be defined. These assumptions are called scenarios and serve as a starting point for all risk management activities.

These conditions usually describe parameters of events (e.g. rainfall intensity above a certain threshold) and capacities of objects (e.g. function or failure of protective structures).

All disaster related management strategies are related to a scenario of a defined extent (characterized by the intensity of the the event and the vulnerability of the elements at risk). Thus any risk management strategy depends on pre-defined scenarios.

Risk treatment strategies provide different principles (methods) for the definition of risk treatment measures.

Seen from the perspective of a disaster event, risk management is a cycle of recurrent activities. This cycle has been named “risk management cycle”. For MONITOR II the current definitions of PLANALP where taken as a starting point (figure 4).

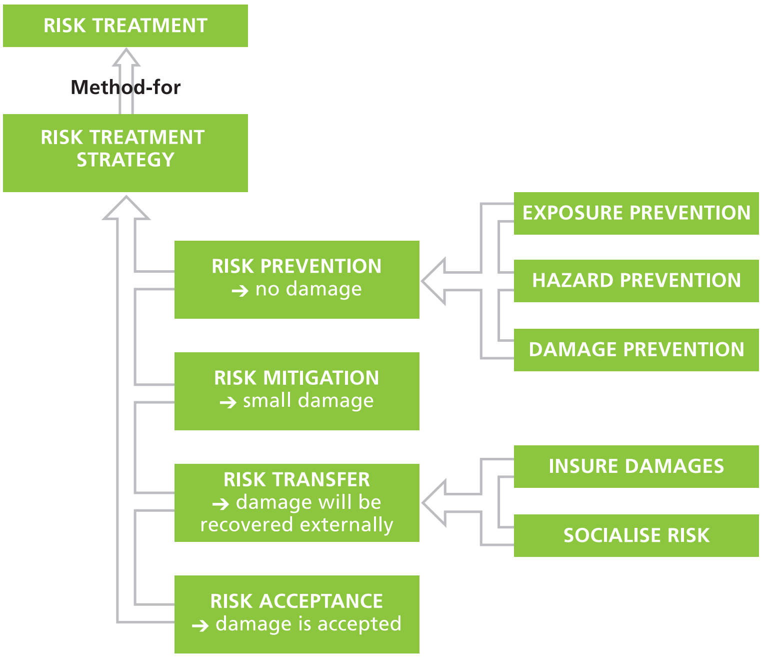


Figure 3: Strategies of risk treatment (S. KOLLARITS et al. 2007)

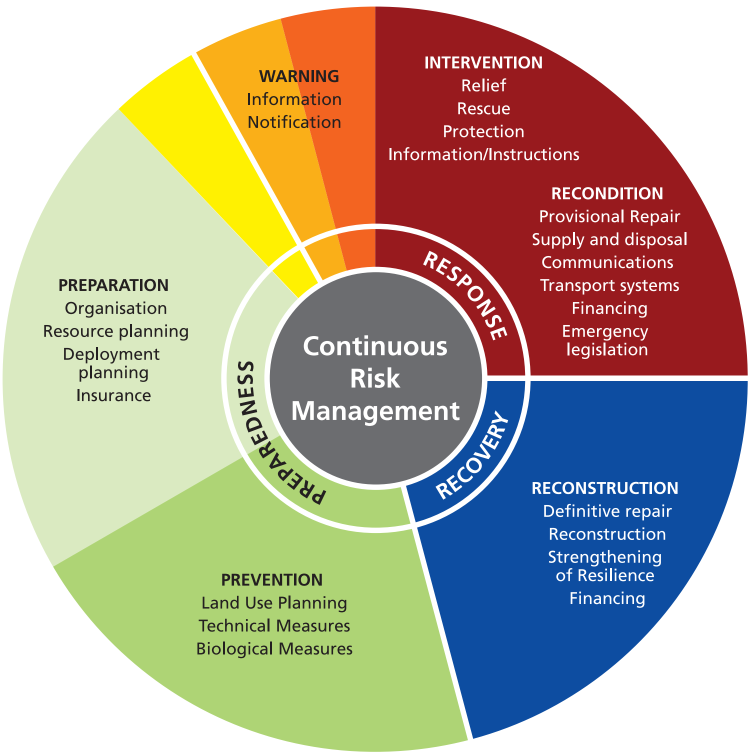


Figure 4: Risk management cycle (adapted from PLANALP)

The basic phases of disaster management are defined by their temporal relation to the occurance of hazard events:

PREPAREDNESS

Preparedness is the phase of planning activities with a long-term view on risk management. Activities within this phase aim at the reduction of vulnerability (to negative consequences from hazardous events) and at the reduction of hazard potential and exposure to hazards. WISNER et al. (2003[2]) have defined vulnerability as being dependent (inversely) on

- the capacity to anticipate
- the capacity to cope with
- the capacity to resist and
- the capacity to recover from

an extreme event.

RESPONSE

Response is the phase of reaction to an ongoing or impending (potential) disaster event with a short-term view on risk management. Activities within this phase comprise the emergency operation during the impact of a disaster and the short-term aftermath. The main emphasis is on the saving of human life but it also encompasses the protection of constructions, the supply of vital goods and services, as well as the protection of the environment.

RECOVERY

Recovery is the phase of restoring the affected area to its previous state, in terms of conditions of life, infrastructure, communication and social organisation. Activities of the recovery phase primarily comprise the rebuilding of destroyed property, re-employment, and the repair of other essential infrastructure.

Within each phase of risk management – and actually within almost each activity of risk management – a process from risk screening to risk treatment is being carried out.

Figure 5: Risk management overview (adapted from Australian / New Zealand Standard on Risk Management).

Situations and Measures

The identification and assessment of situations is a primary prerequisiste in risk management. In all phases of risk management situations have to be assessed with a maximum of reliability in order to identify the appropriate measures for risk management.

Situations are social objects, which are the setting for at least one event. Situations provide the link for both social regulations (norms) as well as for actions (measures).

Social norms aim at regulating situations, while measures are directly linked to situations.

Measures can be permanent even if the goal has been achieved. Measures have a goal as part and define roles and tasks necessary to reach the goal.

A scenario can be seen as a pre-defined course of situations, so measures can be attached to scenarios as well. The main scenarios and measures relevant for risk management are described in figure 6 below.

Within risk management situations can be categorized broadly into general risk related situations and those situations, to which predefined measures can be allocated (action related situations).

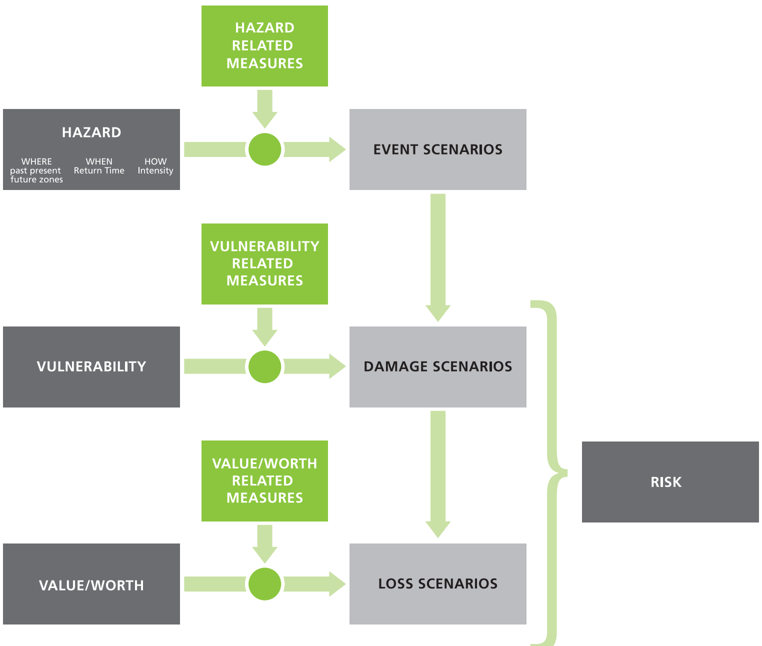


Figure 6: Linking risk and emergency terms (A. CORSINI)

ON TERMS

A situation describes the perceived part of reality which is the basis for action.

Measure is the final (event-like) plan, providing specific solutions for one known problem situation.

Hazards – floods and landslides

HAZARD PROCESSES

Knowledge about hazardous processes, especially about their existence/identification and their mechanisms, is the starting point of any risk management consideration. The terms processes and events in that context are often used in very heterogeneous ways.

Hazard processes are parts of events and define the mechanisms of event development.

RISK RELATED SITUATIONS

Security is a situation, which is the setting for risk classified as acceptable.

Danger is a situation which is the setting for an event classified as hazard

Threat is a situation, which is the setting for elements of the environment exposed to hazardous event.

Risk situation is a situation of threat where risk has been analysed and classified (quantified or at least qualified threat).

ACTION RELATED SITUATIONS

Nominal situation, where no hazardous events are ongoing or impending.

Alert situation is a situation of higher awareness of possible hazardous development.

Pre-alarm situation is a situation where dedicated observation on site becomes necessary.

Alarm situation is a situation where emergency forces are called into readiness for action.

Emergency is a situation, which is the setting for high immediate risk, so that urgent measures need to be taken in order to avoid damage. Emergency forces begin operation.

Damage situation is a situation, which is the setting for an impact, classified as damage.

Disaster is a situation, where the degree of damages is above an acceptable level.

More specifically, they define HOW (type of transportation or transformation) WHAT is changed (in terms of location or some other quality). When talking about natural hazards the HOW usually defines the transport-mode and the WHAT defines what kind of material ("amount-of-matter") is being transported. Process parts of an event can be related causally to each other in a multitude of ways, leading to different scenarios.

An event has an intensity (also called: magnitude) and a spatial location, where its processes take place. The temporal location of an event is usually defined as frequency (of reoccurrence) and describes the probability of the event taking place within a certain period of time.

Events are often causally dependend on other events, which are called triggers (or triggering events). Floods for example are usually caused by extreme weather events such as heavy rainfalls.

Within the broad range of hazards, MONITOR II specifically deals with floods and landslides.

Hazards – floods

The number of major flood events has increased within the European Union over the last decade. Therefore the EU water framework directive and the EU flood directive are aiming at improving the management of water resources as well as the security against floods and other hydrological threats by the implementation of river basin and flood risk management plans.

This shall include floods from rivers, mountain torrents, Mediterranean ephemeral water courses, and floods from the sea in costal areas.

According to the EU Floods directive a flood is defined as a temporary covering by water of land not normally covered by water can occur

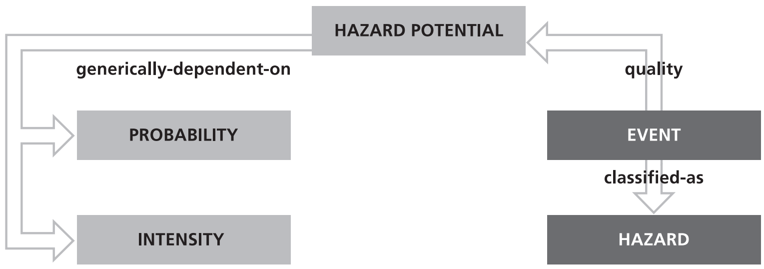


Figure 7: Defining hazard potential (S. KOLLARITS et al. 2007)

ON TERMS

Hazard potential is the quality of a hazardous event, which is generically dependent on the probability and the magnitude of the event.

Thus if both the probability and the magnitude of the (hazardous) event can be defined the hazard potential can also be defined.

TYPE OF FLOODING	CAUSE OF FLOODING	EFFECT OF FLOODING	RELEVANT PARAMETERS
River flooding in flood plains	• Intensive rainfall and/or snowmelt • Ice jam, clogging • Collapse of dikes or other protective structures	• Stagnant or flowing water outside of river channel	• Extent (according to probability) • Water depth • Water velocity • Propagation of flood
Sea water flooding	• Storm surge • Tsunami • High tide	• Stagnant or flowing water behind the shore line • Salinisation of agricultural land	• Same as above
Mountain torrent activity or rapid run-off from hills	• Cloud burst • Lake outburst • Slope instability in watershed • Debris flow	• Water and sediments outside the channel on alluvial fan; erosion along channel	• Same as above, • Sediment deposition
Flash floods in Mediterranean ephemeral water courses	• Cloud burst	• Water and sediments outside the channel on alluvial fan • Erosion along channel	• Same as above
Groundwater flooding	• High water level in adjacent water bodies	• Stagnant water in flood plain (long period of flooding)	• Extent (according to probability) • Water depth
Lake flooding	• Water level rise trough inflow or wind induced set up	• Stagnant water behind the shore line	• Same as above

Figure 8: Different types of floods according to "Handbook on good practices for flood mapping in Europe" (EXIMAP, 2007).

in different environments (large catchments in river plains, small watersheds in mountaineous terrain) the consequence of the process is the same. Large areas are covered by water and sediments.

An inevitable prerequisite for an effective flood risk management is a sound analysis of the hazards and risks existing in a river basin or a small watershed under investigation. The prevailing type of flood must be defined, comprising the probability of a particular flood event the flood magnitude represented by the flood extent, water depth or flow velocity, and finally the most likely magnitude of damage.

According to the "Handbook on good practices for flood mapping in Europe" (EXIMAP, 2007), different types of floods can be distinguished based on their general characteristics, the causes of flooding, the effect of flooding and on the flood-relevant parameters.

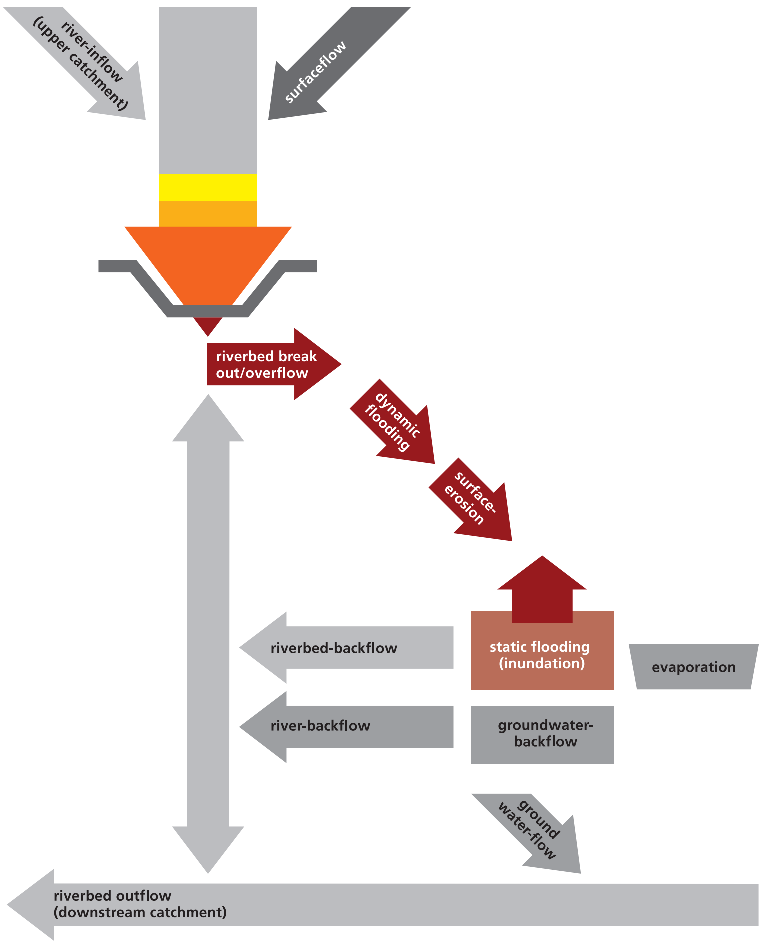


Figure 9: The process structure of flooding events (I. SCHNETZER)

According to the European Flood Directive flood risk is defined as the combination of the probability of a flood event and of the potential adverse consequences for human health, the environment, cultural heritage and economic activity associated with a flood event (DIRECTIVE 2007/60).

Flood hazard maps must contain information on flooding processes, at least for three given different scenarios of a low, medium and high probability of occurrence of the flooding. For each scenario the flood extent, the water depths or water levels, and where appropriate the flow velocities have to be presented in the maps.

Due to the fact that flooding processes can develop in a complex and often unpredictable way leading to different impact and damage scenarios which therefore must be considered within contingency planning procedure, a thourogh analysis and evaluation of the hazard process itself, and of the influence of structures or protective measures must be peformed.

From the point of view of the process structure of flooding in larger river basins, but also in smaller, alpine catchment areas, and their consequences for contingency planning, the following major elements can be defined (see figure 9 below). Torrential rainfall or steady rainfall events in the upper catchment leads to surface flow and river inflow depending the retention capacity of vegetation canopee, soil properties and material properties of bedrock and sedimentary cover. At certain locations, which can be modelled based on high-resolution topographic data (combination of Airborne Laserscanner Data with data from Echo sounding), the riverbed is too small to contain the water masses, or the river passage is blocked by objects or logs and a or the river passage is blocked by logs or other objects and a riverbed break out or overflow is happening, leading to a dynamic flooding of the flood plain itself. Surface erosion and static flooding (inundation) is caused, leading to damage scenarios. Depending on the magnitude of the flooding process, after quite some time, the initial state is reached through evaporation of the water column, groundwater backflow and riverbed backflow. Prevention measures installed in the catchment area, but also failure scenarios of these protective structures can have an influence on the time and magnitude dimension of flooding events.


Picture 2: Landslide of Valloria, Emilia-Romagna

Hazards – landslides

The term landslide, as defined by CRUDEN (1991) for the Working Party on World landslides, denotes "the movement of a mass of rock, debris or earth down a slope". More generally defined a landslide encompasses a wide variety of processes that result in the downward and outward movement of slope-forming materials including rock, soil, artificial fill, or a combination of these. The materials may move by falling, toppling, sliding, spreading, or flowing. Landslides can be initiated by rainfall, earthquakes, volcanic activity, changes in groundwater, disturbance and change of a slope by man-made construction activities, or any combination of these factors. Extreme weather conditions prevailing in the European mountain chains can lead to combined processes like rapidly evolving flooding events and rainfall triggered landslides of different types (sides, debris flows…) inflicting severe damage in the downstream areas.

Failure of a slope occurs when the force that is pulling the slope downward (gravity) exceeds the strength of the earth materials that compose the slope. They can move slowly (creeping) or can move quickly and disastrously, as is the case with debris-flows. Debris flow can travel down a hill with very high speeds, depending on the slope angle, water content, and type of earth and debris in the flow. These flows are initiated by heavy, usually sustained, periods of rainfall, but sometimes can happen as a result of short bursts of concentrated rainfall in susceptible areas.

ON TERMS

A landslide is the movement of a mass of rock, debris or earth down a slope.

The very frequent presence of different types of creeping processes or landslide remnants in mountainous or even hilly areas in itself does not form a threat to human activity. Only when landslides occur unexpectedly and very rapidly or when old landslides are reactivated they develop their "hazard characteristics". The prediction of a new active landslide or of the reactivation of older landslides is often difficult requiring a sound analysis of past events and the application of modern investigation methods (e.g. engineering geophysics; terrestrial or airborne Laser measurements; Synthetic Aperture Radar).

MONITOR II

Generally speaking a lot of different mass movements are termed "landslide", but they can be differentiated based on the type of movement, the type of material, morphology and the rate of movement. Detailed classifications were elaborated by VARNES (1978), and within the EU funded EPOCH project (EPOCH, 1993) and by the US Geological Survey.

TYPE OF MOVEMENT		TYPE OF MATERIAL		
	BEDROCK	ENGINEERING SOILS		
		Predominantly Coar	Predominantly Fine	
Falls	Rock fall	Debris fall	Earth fall	
Topples	Rock topple	Debris slide	Earth slide	
Slides	Rotational	Rock slide	Debris slide	Earth slide
Translational				
Lateral Spreads		Rock spread	Debris spread	Earth spread
Flows	Rock flow	Debris flow	Earth flow	
	(deep creep)	(soil creep)		
Complex		Combination of two or more principal types of movement		

Figure 10: Generalisation of slope movement types according to VARNES (1978).

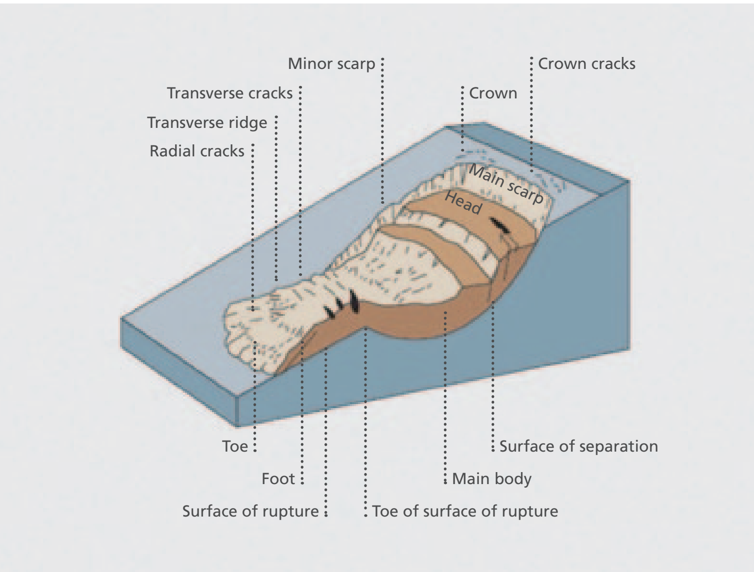


Figure: An idealized slump-earth flow showing commonly used nomenclature for labelling the parts of a landslide (courtesy USGS).

Landslide – sliding (rotational slide and translational slide)

More restrictively used the term landslide or slide should be used only for mass movements along a recognizable shear surface (zone of weakness separating the sliding material from the more stable underlying material). Two major types of slides can be distinguished – rotational slides and translational slides.

A rotational slide is a slide in which the surface of the rupture is curved concavely upward and the slide movement is roughly rotational about an axis that is parallel to the ground surface and transverse across the slide (circular or spoon-shaped shear surface).
In the case of a translational slide the landslide mass moves along a roughly planar surface with little rotation or backward tilting. A block slide is a special type of a translational slide where a single rock unit or a few closely related rock units move down slope as a relatively coherent mass.

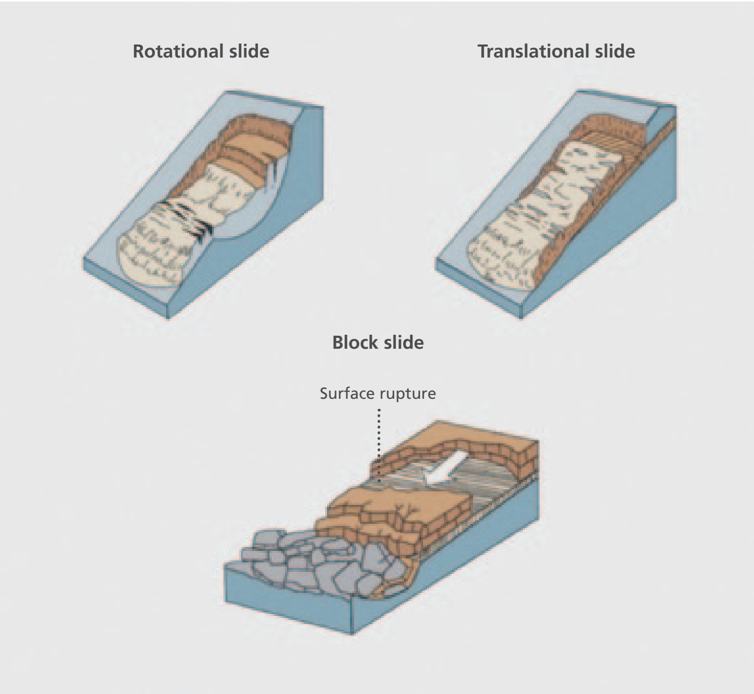


Figure 11: Different types of sliding processes (courtesy USGS).

Figure 12: Landslides – fall and topple (courtesy USGS).

Landslide – fall and topple

Falls are abrupt movements of masses of geologic materials, such as rocks and boulders, which become detached from steep slopes or cliffs (DICKAU et al. 1996). Separation occurs along discontinuities such as fractures, joints, and bedding planes and movement occurs by free-fall, bouncing, and rolling. Falls are strongly influenced by gravity, mechanical weathering, and the presence of interstitial water.

Toppling failures are distinguished by the forward rotation of a unit or units about some pivotal point, below or low in the unit, under the actions of gravity and forces exerted by adjacent units or by fluids in cracks.

Landslide – flows

There are different basic categories of flows that differ from one to another. A debris flow is a form of rapid mass movement in which a combination of loose soil, rock, organic matter, air, and water mobilize as slurry that flow down slope usually in surges induced by gravity and the sudden collapse of bank material. Debris flows include variable amounts of water and less than 50% fines. Debris flows are commonly caused by intense surface-water flow, due to heavy precipitation or rapid snowmelt, which erodes and mobilizes loose soil or rock on steep slopes. Debris flows also commonly mobilize from other types of landslides that occur on steep slopes, are nearly saturated, and consist of a large proportion of silt- and sand-sized material. Debris-flow source areas are often associated with steep gullies, and debris-flow deposits are usually indicated by the presence of debris fans at the mouths of gullies. A debris avalanche is a variety of very rapid to extremely rapid debris flow. Earthflows have a characteristic "hourglass" shape. The slope material liquefies and runs out, forming a bowl or depression at the head. The flow itself is elongate and usually occurs in fine-grained materials or clay-bearing rocks on moderate slopes and under saturated conditions. A mudflow is an earthflow consisting of material that is wet enough to flow rapidly and that contains at least 50 percent sand-, silt-, and clay-sized particles.

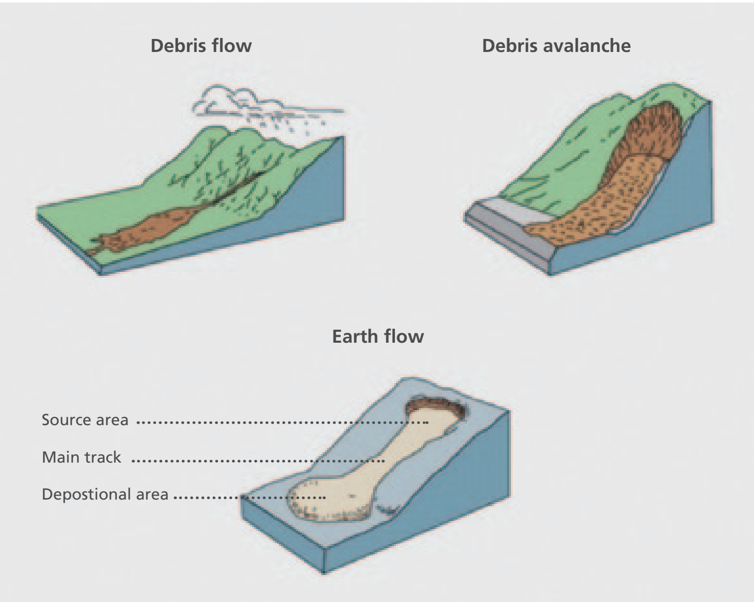


Figure 13: Landslides – flows (courtesy USGS).

Landslide – creep, lateral spread

Creep is the imperceptibly slow, steady, downward movement of slope-forming soil or rock. Movement is caused by shear stress sufficient to produce permanent deformation, but too small to produce shear failure. Creep is indicated by curved tree trunks, bent fences or retaining walls, tilted poles or fences, and small soil ripples or ridges. Lateral spreads are distinctive because they usually occur on very gentle slopes or flat terrain. The dominant mode of movement is lateral extension accompanied by shear or tensile fractures. The failure is caused by liquefaction, the process whereby saturated, loose, cohesion less sediments (usually sands and silts) are transformed from a solid into a liquefied state.

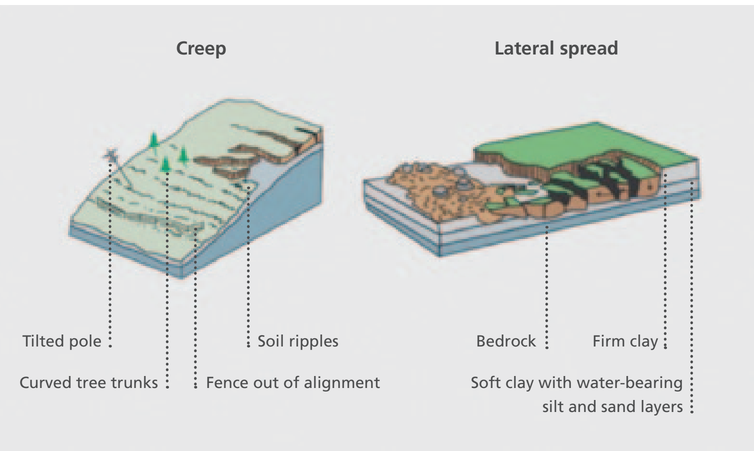


Figure 14: Landslides – creep and lateral spread (courtesy USGS).

The tools: state-of-the-art

A major goal of the MONITOR II project is to contribute to the definition of a harmonised methodology for hazard mapping and contingency planning within the EU-member states, based on the experiences of the organisations participating in MONITOR II. Based on the state-of-the-art analysis and evaluation of hazard mapping and contingency planning practices prevailing in the participating countries and organisations, recommendations for improvement, harmonisation and adaptation of existing hazard maps and contingency plans were worked out.

Be informed – hazard maps

THE PROCESS OF HAZARD ASSESSMENT

Starting point of hazard assessment is a situation of threat, for which hazard assessment is a recommended (or in some cases: a legally prescribed) measure. The goal of hazard assessment is to define hazard potential in qualitative as well as quantitative terms.

The assessment of hazards are carried out according to methods (rules, guidelines, practice…). These methods can be seen as a knowledge source necessary for successfully reaching the goal defined for a plan. Hazard inventory, hazard analysis and hazard evaluation are subplans of hazard assessment with each having a related goal.

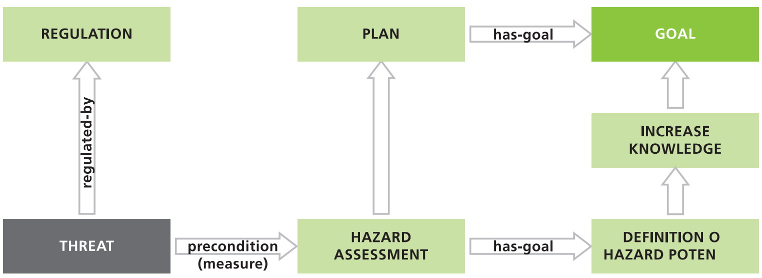


Figure 15: Hazard assessment and related goals (KOLLARITS, WERGLES et al. 2007)

Hazard maps can generally be described as major outputs of hazard assessment and constitute a decisive element in risk management. They assist the identification, evaluation and reduction of risks by using an optimal combination of measures. In a general definition the term hazard map encompasses both the proper map and the accumulated expertise.

Thus hazard assessment covers hazard inventory AND hazard analysis AND hazard evaluation.

Hazard inventory: Is the identification and description of existing and potential hazards and the general conditions (physical – meteorological – …) that determine them.

Hazard analysis: Is the (qualitative, semi-qualitative or quantitative) description of the probability of an event and its spatio-temporal location and magnitude (intensity). This involves measurements of parameters as well as estimation (by modeling approaches) and interpretation of data.

Within hazard analysis one (or more) likely scenarios of hazard process development are being considered. They serve as the central input to hazard evaluation.

Hazard evaluation: is the ranking and description of hazards in the area of interest, taking into consideration the findings of the inventory and analysis phases. It is based on pre-defined criteria, which classify parameters of the (most) likely scenarios of the process development. Usually this is done by classifying, the frequency and the intensity of hazard potential.

In the course of hazard evaluation the consequences of defined scenarios are evaluated, considering their (potentially) damaging impact. Finally one or more scenarios are chosen as reference scenarios, which together provide the basis for evaluation (esp. hazard zonation) and thus for further action to be taken.

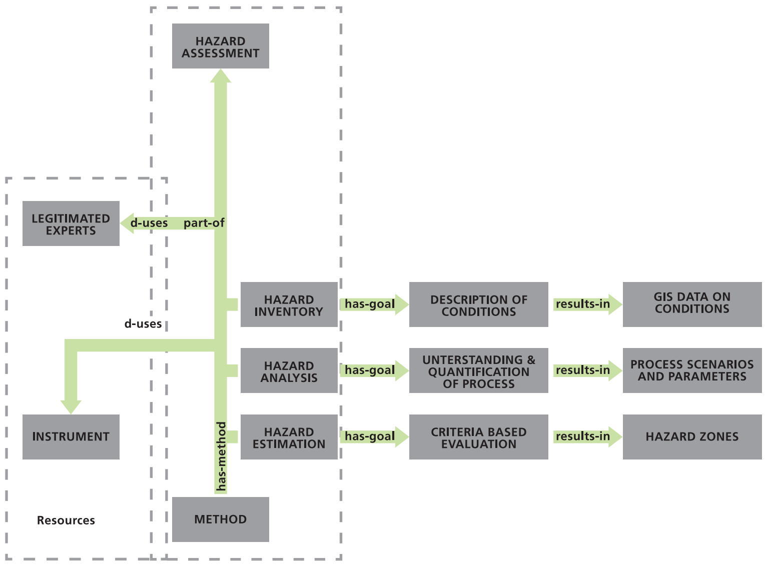


Figure 16: Hazard assessment procedure (KOLLARITS, WERGLES et al. 2007)

Hazard zonation: Is the delineation of areas which are possibly inflicted by hazard processes. The zonation is usually the (minimum) output of hazard evaluation. The zonation takes into account the possible damages, which depend on the intensity of the potential process and on standard assumptions about the vulnerability of the elements at risk.

Concerning the methods of hazard assessment available technical codes (which in some cases have normative caracter) have to be distinguished from the scientific state-of-the-art. Quite often detailed normative codes are not available but the "legitimated" experts are required to assess hazards based on the state-of-the-art.

The outputs of hazard assessment (description of the conditions, scenarios and parameters, hazard zones) can be directly used in the follow-up planning processes.

Used for prevention-related planning (land-use planning, protection measures and for preparation-related planning (contingency planning), the plans are differing concerning their need for detailed information. Land-use planning usually focuses only on hazard zonation whereas contingency planning needs more detailed information (scenario based) information, in order to allow the definition of sufficient countermeasures. Even more detailed information about the scenarios and their included process assumptions (dimensions of the process: time – intensity – frequency) is needed for the planning and design of technical protective measures.

ISSUES OF HAZARD AND RISK MAPPING

Hazard and risk maps have the goal to represent a criteria-based evaluation of the data, information and results obtained form inventory and analysis phases. Generally, these plans can be considered as 'pseudo-static' documents updated with an interval of 1 – 10 years (or even longer).

In the public sector hazard and risk maps are produced for land-use planning purposes and are not intended for contingency planning. Used as risk reduction tools, these maps are sustaining the efforts to reduce in future the exposure of buildings and residents to risks as well as also to support the planning and prioritizing of technical and non-technical measures.

Land-use planning requires maps to be used and interpreted by non-experts, allowing the incorporation of a dose of political-decisional subjectivity. For this reason a classes-based approach is fully justified, resulting in zonation maps having more a qualitative (pseudo-quantitative) than a quantitative character. These maps are thus not able to represent the full information gathered in the frame of the hazard assessment procedure. The full detail is usually available only as 'official expertise', but its interpretation requires expert knowledge.

In the private sector, for instance real estate insurance, the scope of hazard and risk maps is completely different, as in that case they are used as tools to calculate the probabilities of economic losses for the company. For this reason risk maps for the insurance sector need a truly quantitative scaling, in order to allow this calculation.

The project partners of MONITOR II are public institutions. The hazard maps developed by them are t used predominately for land-use planning and – as mentioned above – these maps have to be considered as pseudo-quantitative. The analysis of practices applied by the project partners has highlighted a number of commonalities between theses maps and the methods used to combine risk variables:

- **Frequency** of hazard processes is defined in classes by using return periods that are assessed on a statistical or an expert-opinion basis.

- **Intensity** of hazard processes is defined in classes that are determined on the basis of ranges of values of measurable physical variables.

- **Hazard potential** of hazard processes is derived by a heuristic matrix-based combination of frequency and intensity classes.

- **Vulnerability** of elements at risk is usually only defined on the basis of the function of structures, mainly buildings (with some regard to their socio-politic-strategic importance). There does not exist any 'true' information on the actual vulnerability of single structures concerning hazardous events. This means that the capacity of structures to resist the impact of an event is not taken into account.

  But vulnerability should not be restricted to the "resistance capacity" point of view, but must also include the dimensions of "anticipation capacity", "coping capacity" and recovery capacity as well.
  So far these aspects have not yet been considered in risk assessment procedures

- **Value** of exposed elements is usually not defined seperatly, as it is already somehow incorporated in the utilised notion of vulnerability ("function of structures").

The practice of vulnerability definition thus shows clear shortcomings and should be replaced by a transparent procedure for defining damage potential, calculated on the basis of vulnerability and value of elements at risk.

The general similarities described above contrast with great differences in details of approaches, which are summarised below.

RETURN PERIOD AND FREQUENCY

ON TERMS

A return period is a statistically defined recurrence interval between hazard events of the same type and intensity.

The theoretical return period is the inverse of the probability that a defined intensity of an event will be exceeded in any one year. For example, a 100-year flood has a 1% (1/100 = 0.01) chance of being exceeded in any one year and will on average occur once every 100 years.

Regarding the flood return period, it should be noticed that significant differences in the adopted boundaries can be observed reflecting the variety existing among national-regional legislations, spatial planning and design codes for protective structures.

FREQUENCY CLASS	AUSTRIA	SLOVENIA	AUSTRIA	SOUTH TYROL	SOUTH TYROL
	(PP1)	(PP3 & PP4)	(Hora maps)	(PP5)	(PP7)
High	< = 10 years	10 years	30 years	< = 30 years	< = 50 years
Medium	150 years	100 years	100 years	100 years	200 years
Low	n.d	500 years	300 years	300 years	500 years
Very Low	n.d	n.d	n.d	> 300 years	n.d.

Figure 17: Examples of frequency classes for floods based on the return period

INTENSITY CLASS	SLOVENIA (PP3 & PP4)		AUSTRIA (PP1)		SOUTH TYROL (PP5)
	Height of Water	Momentum	Height of Energy Line		Height of Water
		If velocity >1 m/s)	Recurrent events	Frequent events	
High	> 1.5 m	> 1,5 m²/s	> = 1,5 m	> = 0,5 m	>2 m
Medium	0.5–1.5 m	0.5–1,5 m²/s	< 1,5 m	< 0,25 m	0.5–2 m
Low	< 0.5 m	< 0,5 m²/s	n.d.	n.d.	< 0.5 m

Figure 19: Examples of intensity classes for floods

INTENSITY

Intensity of a natural hazard classifies measurable physical variables of the hazard processes.

The spatial extent of an event is calculated on basis of the frequency class. For example when assessing flood maps, the frequency class itself defines the spatial extent of the inundation zone. The intensity of the process is defined separately, by variables like water level, height of the energy line or flow velocities.

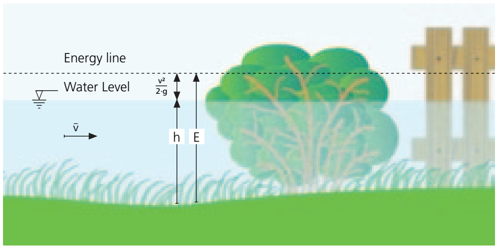


Figure 18: Intensity of a flood can be defined by different parameters (e.g. water height, height of energy line)

The comparison of the flood intensity variables used in three different countries reveals that South Tyrol uses only height of water while Slovenia and Austria indirectly also pay regard to flow velocities. Slovenia uses so called momentum (product of water height and velocity), Austria uses the height of energy line (the sum of water height and cinetic part).

HAZARD POTENTIAL

Hazard potential is derived by a heuristic matrix-based combination of return-period and intensity classes. This non-analytical approach results in various non-unified hazard classifications among countries. For example in hazard assessment for floods Austria distinguishes only high and low hazard while Italy knows four hazard classes. It should also be noticed that there are discrepancies among countries regarding the colour assigned to a specific hazard class when used in hazard maps.

		SLOVENIA (PP3 & PP4)			SOUTH TYROL (PP5)				AUSTRIA (PP1)	
HAZARD CLASS		FREQUENCY CLASS			FREQUENCY CLASS				FREQUENCY CLASS	
		High	Medium	Low	High	Medium	Low	Very Low	High	Medium
Intensity class	**High**	High	High	residual	Very High	Very High	Very High	residual	High	High
	Medium	High	Medium	residual	Very High	High	Medium	residual	Low	Low
	Low	High	Low	residual	High	Medium	Medium	residual		

Figure 20: Examples of hazard assessment matrices for floods

VULNERABILITY CLASSESS		SOUTH TYROL (PP5)				SLOVENIA (PP3 & PP4)			
		HIGH	MEDIUM	LOW	VERY LOW	HIGH	MEDIUM	LOW	VERY LOW
Population Density [per km²]	> 500	■				■			
	(=>101) & (=< 500)	■					■		
	(=>11) & (=<100)	■						■	
	=<10	■							■
Economic Buildings	businesses of national interest	■				■			
	businesses of regional interest	■					■		
	businesses of local interest	■						■	
	small businesses of local interest	■							■
Cultural Heritage	of national or world meaning	■				■			
	of regional meaning	■					■		
	of local importance		■					■	

Figure 21: Examples of vulnerability assessment

VULNERABILITY

Vulnerability classes are also obtained using a heuristic approach. For example the Autonomous Province of Bolzano defines vulnerability classes on the basis of functional land use classification and population density, and so does, with some differences, Slovenia.

This way of assessing vulnerability is very simplistic and, somehow, theoretically incorrect. As a matter of fact, it intrinsically encompasses an evaluation of the worth (or strategic value) of exposed elements.

This method does not consider the true structural vulnerability of the exposed elements. However, in this context it is important to note that the correlation between the intensity and degree of damage suffered by an element exposed to an specific risk is not linear. If we consider flood height as intensity, for example, we should have sharper damage increases when water reaches the next higher floor of a building.

Figure 22: Correlation between damage and water level defined as vulnerability curve

MONITOR II

RISK

Risk assessment of hazard processes is derived by a heuristic matrix-based combination of hazard potential and vulnerability classes. Significant differences are existing between the matrices used by the participating countries. It is difficult to compare the various national risk assessment methods. as the used approaches, classifications as well as illustrations are differing considerably.

Since hazardous processes t are not paying regard to national or other administrative border an improvement of international communication and understanding regarding hazard and risk assessment would facilitate transnational cooperation.

SOUTH TYROL (PP 5)

RISK CLASS	Hazard Potential Class: VERY HIGH	MEDIUM	LOW	RESIDUAL
VULNERABILITY CLASS: VERY HIGH	Very High risk	Very High risk	Medium risk	
HIGH	Very High risk	High risk	Medium risk	
MEDIUM	High risk	Medium risk	Moderate risk	
LOW	Medium risk	Moderate risk	Moderate risk	

SLOVENIA (PP 4)

RISK CLASS	Hazard Potential Class: HIGH	MEDIUM	LOW	RESIDUAL
VULNERABILITY CLASS: HIGH	High risk	High risk	Medium risk	Low risk
MEDIUM	High risk	High risk	Medium risk	Low risk
LOW	High risk	Medium risk	Low risk	Low risk
VERY LOW	Medium risk	Low risk	Low risk	Low risk

Figure 23: Examples of risk assessment classifications

Furthermore, in this context vulnerability classes should rather be defined as classes of damage potential (which includes both vulnerability and value).

HAZARD MAPPING ISSUES

Open issues regarding hazard and risk maps that have to addressed are in particular the harmonisation of documents at a European level and the usability of Hazard and Risk maps for contingency planning and management.

- As hazards are generally defined by a combination of Return Period and Intensity parameters, should these parameters be ranked in descriptive "qualitative" or "pseudo-quantitative" classes (as in landuse planning practice among PP), or should they rather be ranked on a continuous "quantitative" 0 to 1 basis (as in insurance practice)?
- Is it preferable to define Hazard levels combining Intensity and Return Period classes or values by using an heuristic "matrix-based" approach – so allowing the inclusion of some "political" decisions – or by using an objective "math-based" combination approach?
- If descriptive "qualitative" or "pseudo-quantitative" classes for Intensity and Return Period ranking are to be used, is standardization of classes possible and desirable?

- Should the vulnerability of elements at risk be ranked in descriptive "qualitative" or "pseudo-quantitative" classes based on its "strategic" or "social" value (as applied by project partners in landuse planning), or should vulnerability preferably be ranked on a continuous "quantitative" 0 to 1 basis taking into consideration the constructional characteristics with respect to the occurring hazard (as practiced in the insurance sector).

- If descriptive "qualitative" or "pseudo-quantitative" classes for ranking Vulnerability are to be used, is standardization of classes possible and desirable?

- Is it preferable to define the "Risk level" of an area by combination of Hazard and vulnerability classes or by values using a heuristic "matrix-based" – allowing the inclusion of some "political" decisions – or should these values be defined on the basis of an objective "math-based" combination of these parameters?

- Should codes for hazard processes and hazard-related risks as well as their illustration be standardized?

Be prepared – contingency plans

Contingency plans are important instruments necessary for an effective risk management.Their aim is to reduce the frequency of disasters and to reduce the number of casualties as well as other negative consequences caused by disasters.

Contingency plans usually have to be defined if threats have been identified at a certain administrative level. Contingency plans include specific strategies and measures (and related tasks) to deal with specific defined situations. They also include definition of monitoring processes and "triggers" for initiating these planned tasks.

The major goal of contingency planning is to provide decision makers in intervention phase with a clearly structured guideline of actions to be taken in case of extreme events (i.e. those events which are not covered by routine protective procedures). Contingency planning thus covers the phase of action from the beginning of an extreme event until the moment when the standard operation procedures (SOPs) for emergency can be applied. As part of contingency planning SOPs can be an essential supporting element through improving the quality and speed of decision making in disaster management.

Contingency plans are prepared in the preparedness phase of risk management and can be categorised as planning activities.

ON TERMS

A contingency plan is a plan to secure protection, rescue and relief in case of disasters or disaster forecast situations.

Standard operating procedures are a formalised structure to handle specific operational activities of emergency.

Contingency plans define necessary activities within disaster **preparation phase**.

- **Warning** includes notifying and warning the population in the event of disasters.

- **Human resource management** includes organising, equipping and training protection of rescue and relief forces as well as training of the population for individual and collective protection.

- **Provision of materials resources** includes provision of stocks of protective and rescue equipment as well as humanitarian aid equipment.

Contingency plans used in the intervention phase are defining protection, rescue and relief measures for specific disaster events. These plans are elaborated on the basis of the preceding hazard and risk assessments. In the frame of these plans the competent authorities and their tasks necessary to assure protection, rescue and relief are defined.

- **Protection** includes organisational, technical and other measures as well as the use of technical and other means for immediate individual and collective protection of people, animals, property, cultural heritage and environment against the consequences of natural and other disasters.

- **Rescue** includes measures and procedures for rescuing people whose life or health is at risk, rescuing animals, property and cultural heritage from consequences of natural and other disasters.

- **Relief** includes measures and services of specialists, rescue units and services, the use of protection and rescue equipment as well as other means of relief.

Contingency plans are enforced in response phase, starting with warning stage and including intervention measures. The usability of contingency plans ends when standard operational procedures (SOP) of the intervention forces can take place and activities of recovery phase start.

The development of contingency plans has to be based on clearly defined event scenarios, which are the outcome of hazard assessment. The effectivity of measures defined in contingency plans strongly depends on the quality of the scenarios considered (i.e. on the level of detail of the scenario definition and how realistically they are defined).

For contingency planning the scenarios considered are transformed into a series of action relevant situations. These situation definitions both include a description of the likely event (and: the parameters how it can be identified) and the intervention resources available, but also the social (legal) conditions of action.

The measures defined in contingency plans relate to the situations of warning (pre-alert, alert and alarm) and disaster. For these situations contingency plans define

- what are the characteristics of these situations (parameters like water gauge levels, number of available staff resources)
- how can these situations be identified, e.g. by means of monitoring systems
- how and to whom shall these situations be communicated
- which measures shall be taken to counter the situation

The contents of contingency plans usually include

- general scope of the plan
- description of the administrative structure and responsibilities
- available resources and their roles
- hazards within the area concerned
- elements at risk and their vulnerability
- scenario-specific situations and measures (usually repeated for each relevant scenario):
  · monitoring
  · communication
  · protection, rescue and relief
  · evaluation and documentation

Despite its great importance for disaster management, contingency planning still shows high heterogeneity among the European countries This heterogeneity can be illustrated by comparing the legal basis and the specific issue of monitoring and warning.

THE LEGAL AND ADMINISTRATIVE FRAMEWORK

The European Commission is responsible for supporting and supplementing efforts at national, regional and local level with regard to disaster prevention, the preparedness of those responsible for civil protection and the intervention in the event of disaster. The legislative framework for European civil protection enabled the European Commission to to establish a framework for effective and rapid co-operation between national civil protection services when mutual assistance is needed:

- Civil protection financial instrument (adopted on 5 March 2007 (2007/162/EC, Euratom)
- Community civil protection mechanism (adopted on 8 November 2007 (2007/779/EC, Euratom)

The Community Civil Protection Mechanism and the Civil Protection Financial Instrument together cover three of the main aspects of the disaster management cycle – prevention, preparedness and response. The Mechanism itself covers response and some preparedness actions, whereas the Financial Instrument enables actions in all three fields. Moreover, these two legislative elements are complementary as the Financial Instrument finances the Mechanism.

This European framework has been incorporated into national and regional legislation. The resulting competences are allocated to different administrative domains (levels) as demonstrated by the analysis of the situation in Austria.

The implementation of the objectives of civil protection in Austria is effected mainly on the following two levels:

Since May 2003 the Austrian Federal Ministry of Interior (MoI) is responsible for the coordination in matters of disaster management on the federal level (SKKM – National Crisis and Disaster Management), including international disasters and disasters involving more than one federal province. As a central contact point, the federal warning and alarm center (BWZ) and the emergency coordination center (EKC) were established at the Federal Ministry of Interrior (MoI). In case of prolonged and complex crisis and disaster situations, the task of the SKKM is to ensure the rapid coordination of the federal authorities and the coordination and cooperation with those countries.

The disaster relief units of the 9 Federal Provinces are responsible for measures to avert, remove or alleviate the effects of imminent or past disasters (disaster relief, action planning) on a regional level. The legal basis is provided by the catastrophe aid acts of the Federal Provinces. Due to the lack of harmonisation these acts are showing remarkable differences. They define particularly the establishment of the disaster and the operational responsibilities on community, district and provincial level.

Depending on the extent of a disaster the implementation of intervention measures rests with the authority level, as described in the figure below.

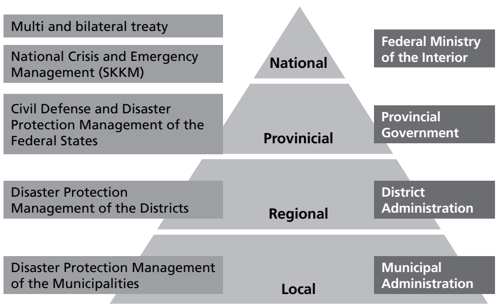


Figure 24: Competence levels of disaster management organisation in Austria

Concerning contingency planning, all partner countries of MONITOR II have legally defined responsibilities, but usually no guidelines are available. Contingency planning is generally done on a case by case basis, thus resulting contingency plans – if available at all – are not comparable and not standardised.

Specific progress has been made in South Tyrol, where guidelines for contingency planning are already available and communities have started implementation on this basis.

In Slovenia a Contingency plans are designed based on the assessment of threats, the analyses of conditions and possibilities, and the possible use of existing human and material resources to conduct protection, rescue and relief efforts in the event of individual disaster. Legislation act "Rules on the Elaboration of Threat Assessments for Natural and Other Disasters" from year 1995 is already in process of renovation by Administration of the Republic of Slovenia for Civil Protection and Disaster Relief (ACPDR) – a constituent body of the Ministry of Defence. Base for preparation of Contingency plans is "Decree on the contents and drawing up of protection and rescue plans". Both legalislation acts define the contents of the contingency plans, but there still exist possibilities to implement additional recommentadion for contingency planning from the point of view of best practises regarding scenarious and tools.

HAZARD TYPE	LEVEL OF PLANNING			
	COMPANY	LOCAL	REGIONAL	NATIONAL
Accident on sea	■		■	■
Earthquake		■	■	■
Flood		■	■	■
Heavy snow	■	■		
Forest fire		■	■	■
Nuclear accident	■	■	■	■
Terrorist attack			■	■
Accidents involving hazardous substances	■	■	■	
Air crashes	■	■	■	■
Railway accidents	■	■	■	■
Accidents in a tunnel	■		■	
Landslides or Avalanches		■	■	

Figure 25: Types of hazard and the related level of planning (Slovenia)

CONTINGENCY PLANNING ISSUES

Contingency planning is confronted with a quite large number of issues, some of which are related to the non-existence of transnational standards. For this reason

- Contingency plans are often not available in a harmonised form (if available at all).
- Contingency plans are usually not available in a structured digital form, thus links to GIS or hazard maps are not possible.
- The quality of Contingency plans is suffering from an inadequate consideration of the totality of potential hazards as well as from the considerable disparity regarding the involvement of institutions and their responsibilities hampering the development of integrated work-flows.
- Contingency plans need to be updated in the case of change related to hazards or the availability of protection, rescue and relief forces. Furthermore, new findings and experiences gained in disaster management have to be taken into account. So far standardised procedures are this important task (which determines the quality and thus usability of contingency plans) are not available.
- How can residual risk be dealt with in contingency plans?
- How can the public be integrated in a risk dialogue, particularly in terms of how to treat residual risks. Tthis should assure that all opportunities to manage and minimize residual risks are implemented (e.g. property protection measures, emerging planning and insurance…).
- How to avoid or at least minimise risk aversion? Examples have shown that people tend to ignore (avert) risk, especially if "it has never happened before" (which means: in my remembrance), but even in case of previous disaster events the rate of ignorance is high.

SITUATION	DESCRIPTION
Nominal situation	Use of standard monitoring systems (e.g. gauging station, weather forecasts).
Alert situation	Increased awareness of possible hazardous development. Intensify use of standard monitoring systems.
Pre-alarm situation	Start dedicated observation on site. Stand-by for emergency duties (24 x 7).
Alarm situation	Emergency services are called into readiness for action.
Emergency situation	Start action and measure implementation. Can be subdivided into different phases of escalation.

Figure 26: Typical situations during warning and related escalation procedures

SLOVENIA		
H1 (Q1) – elevated water stage	information	regular monitoring
H2 (Q2) – continuous monitoring of ongoing situation	detailed information	limited to hazard areas only
H3 (Q3) – state of readiness for action	notifying	preparedness
H4 (Q4) – taking action	alerting	initiation of on-site interventions
H5 (Q5) – catastrophic flooding	alarming	relief, rescue, protection
AUSTRIA LOWER AUSTRIA		
Warning level	(e.g. 50 cm beneath the alarm level)	notifying
Critical water level	(e.g. 30 cm beneath the alarm level)	alerting
Alarm level	(water level at first flooding)	alarming
SOUTH TYROL		
zero	information	regular monitoring activity
alfa	notifying	higher awareness, intensified use of monitoring, stand by for emergency services, preparedness
bravo	alarm	alerting, on-site intervention begins, relief rescue, protection, public awareness
charlie	emergency situation	Escalated situation, measure implementation, need of coordination by the civil protection authorities in a crisis management group.

Figure 27: Comparison of different definitions of warning phases and related parameters

MONITORING AND WARNING

Warning is based on monitoring information and on the complementary use of forecast models for projecting monitored information into the (near) future. Both monitoring and forecasting are important for all types of hazards and are directly used in the implementation of contingency plans. This mutual influence between monitoring and action can be seen in figures 28 and 27.

For the purpose of monitoring and early warning many countries have set up national warning centres, with regional subsidiaries. In **Italy** the national system of the "Centri Funzionali", which has been promoted by the National Civil Protection department and by the regions, provides a network of monitoring and warning centers for the national "Altering system", distributed all over the territory. The operational centre is previewing, monitoring and controlling events and their effects on the territory in real-time It also provides decision support for the authorities during the various emergency management phases. In the Autonompus Province of Bolzano – South Tyrol one of these Warning centres is active (LWZ – Landeswarnzentrale). The directive of the president of the Italian Council of Ministriers of 27th February 2004 regulates tasks and operational functions of these centres.

Standards concerning the reaction to monitoring information show significant differences between countries (warning levels and related action).

ON TERMS

MONITORING is the process-like method of checking, observing and tracking processes in a defined area, with the purpose of evaluating system threshold values.

FORECEAST denotes methods to estimate or calculate in advance, especially to predict future conditions by analysis of available data.

Connecting the tools: scenarios

In **Austria**, the federal states and the municipalities are responsible for flood warning. The monitoring is performed by the hydrographic service, cooperating closely with the Provincial Warning and Alarm Centres (LWZ). For each monitoring station three gauge levels are defined. In case of an imminent flood event the Provincial Warning and Alarm Centre (LWZ) is informed automatically by the monitoring systems. After checking the correctness of the values, the LWZ initiates the necessary measures and informs the population through the warning and alarm system.

In **Slovenia** the monitoring and flood forecasting is provided by the Environmental Agency of the Republic of Slovenia (ARSO). The forecasting system was established for the main rivers of Slovenia, covering a threshold for forecast of one day. Prevention and operational notification and warning on risks posed by natural and other disasters is prepared by national notification center in cooperation with the ARSO. Slovenia has 1 national (NCRS) and 13 regional notificatiuon centres. On the basis of the real-time monitoring results (discharges, levels) and forecasts the ACPDR activates the civil protection forces on the designated areas. Information on water levels, river flow and water temperature is sent to the notification centre every 30 minutes. For the management of flood hazards the contingency plan prescribes a five-stage intervention scheme governed by the cross-section flow of the watercourses. The early-warning (alarm) system is organised as an uniform system, deployed on national, regional and local levels.

In **Greece**, the major rivers have a series of monitoring stations measuring among other parameters flow and speed. For each station there have been established "alert" and "alarm" levels triggering the respective administrative and emergency services responses. In Evros river, the stations transfer their wirelessly their data on a real time basis to the Department of Hydraulic Works of the REMTH.

The missing link: scenarios

Hazard maps indicate for defined return periods of the considered design events (e.g. 100-years flooding event), the spatial distribution of areas which are possibly inflicted by natural hazard processes of a certain intensity. Based on the assessment of potential damages and the existing standard assumptions about the vulnerability of elements at risk, a risk zonation is carried out. In assessing hazards a very detailed standard procedure based on technical codes and and regulations has to be followed by the hazard mapping experts, leading to the definition of probable scenarios for the design events and to the delineation of related hazard zones. Although high quality information is available during the hazard assessment procedure, the information on hazard processes, process development and potential event scenarios is generally summarized in reports hardly readable by contingency planners and "condensed" in more or less simple hazard maps. During this process of this somehow necessary "simplification" of complex processes and process interactions, key information, required by contingency planners might end up being hidden or lost.

BASIS QUESTIONS ABOUT HAZARD PROCESSES	INFORMATION REQUIRED
WHAT CAN HAPPEN?	Standardized process description including simplified scenario models.
WHERE CAN IT HAPPEN?	Standardized description of source, transport and impact area of the process.
HOW OFTEN CAN IT HAPPEN?	Description of the expected frequency (recurrence interval) of an event
HOW FAST WILL IT HAPPEN?	Standardized description of process development in time scale
HOW SUDDENLY WILL IT HAPPEN?	Standardized description of process initiation in time scale
ARE PROTECTION MEASURES INSTALLED AND ARE THEY FUNCTIONAL?	Standardized description of protection measures and functionality including information on protection, failure conditions and residual risk.
EXPECTED IMPACT OF HAZARD EVENT AND AREA AFFECTED?	Description of key impact parameters like flow velocity or impact energy, and of area affected.
IS IT POSSIBLE TO FORECAST EVENT'S INITIATION AND EVOLUTION?	Standardized description of possible triggers and process activation. Definition of warning stages.
IS IT POSSIBLE TO OBSERVE OR MONITOR EVENT'S INITIATION AND EVOLUTION?	Definition of observation points and of standard operation procedure.
IS IT POSSIBLE TO OBSERVE / MONITOR KEY PROTECTION STRUCTURES AND OBSTACLES POSSIBLE?	Description of key protection structures, their function and of failure conditions. Description of obstacles. Standard operation procedures for observation.
IS IT POSSIBLE TO UNDERTAKE ANY INTERVENTION BEFORE AND / OR DURING FULL PROCESS DEVELOPMENT?	Definition of intervention points and appropriate measures to be defined in standard operation procedures.

Figure 28: Basic information about hazard processes required by contingency planners

A more **"process oriented approach" of contingency planning** requires as input from advanced hazard mapping, answers to very basic questions about the development of hazard processes and about actions and measures necessary to be taken (see Tab. 1).

In order to fulfill these requirements, **reference scenarios** must be defined and included in the hazard maps and in tools like a "hazard manager" being part of Continuous Situation Awareness (CSA) systems to allow the establishment of links between hazard mapping and contingency planning procedure.

Reference Event Scenarios refer exclusively to the evolution in space and time of the hazardous process. Reference Risk Scenarios (divided into Damage Scenarios and Loss Scenarios) refer to the evolution in space and time of the reference event and of its effects, also considering eventual mitigation or response actions.

Reference scenarios should be structured according to **simplified scenario models** i.e. as a standardized description of a course of future hazard events and of their impacts, based on a consistent and plausible set of assumptions about future conditions. Within contingency planning, scenario models can be used to describe reference scenarios both in the preparedness phase and the response phase.

In Prevention, several realistic reference scenarios (considering hazard or risk) can be defined, each characterized by a different temporal probability of occurrence. In Warning, one or a few highly probable scenarios can be identified for a short- to mid-term time window in

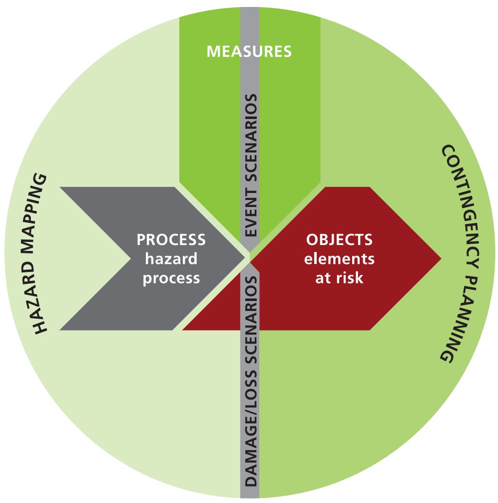


Figure 29: Simplified scenario models as a link between hazard mapping and contingency planning (I. SCHNETZER).

future, on the basis of the ongoing or forecasted evolution of triggering causes and of the hazardous process. In Intervention the actual scenario is appraised, which might change rapidly under changing boundary conditions. A synthesis of information flow between hazard mapping and contingency planning in preparedness phase is absolutely necessary.

Due to the fact that the classical hazard/risk zonation is based on very rough standard assumptions regarding the vulnerability of elements at risk and possible damages, a comprehensive evaluation of all parameters for every object (exposure, resistance, and vulnerability and regeneration capacity) or critical infrastructure is not possible. Therefore contingency planners must be involved in the evaluation of damage and loss scenarios. Furthermore, it has to be ensured that critical infrastructure playing a crucial role during the interventions of the response phase (e.g. bridges, fire-fighter buildings fire stations, hospitals) will be included in the damage and loss scenarios.

Simplified scenarios models (used for "event" or "damage"/"loss" scenarios) should comprise the following key elements:

- Definition/Description of possible – eventually multiple – "reference" scenarios (mainly process oriented).
- Evaluation of the efficiency of existing countermeasures ("protected" or "failure" scenario").
- Definition of forecasting, observation, alert and intervention options.
- Indication of the main elements and key situations regarding processes and countermeasures/interventions (using "critical", "observation", and "intervention" points – see below).
- Comparison of the expected effects of these situations for endangered objects (i.e. damage and loss scenarios) (i.e. "basic", "protected" and – as worst case – a "total failure-of-countermeasures" scenarios)

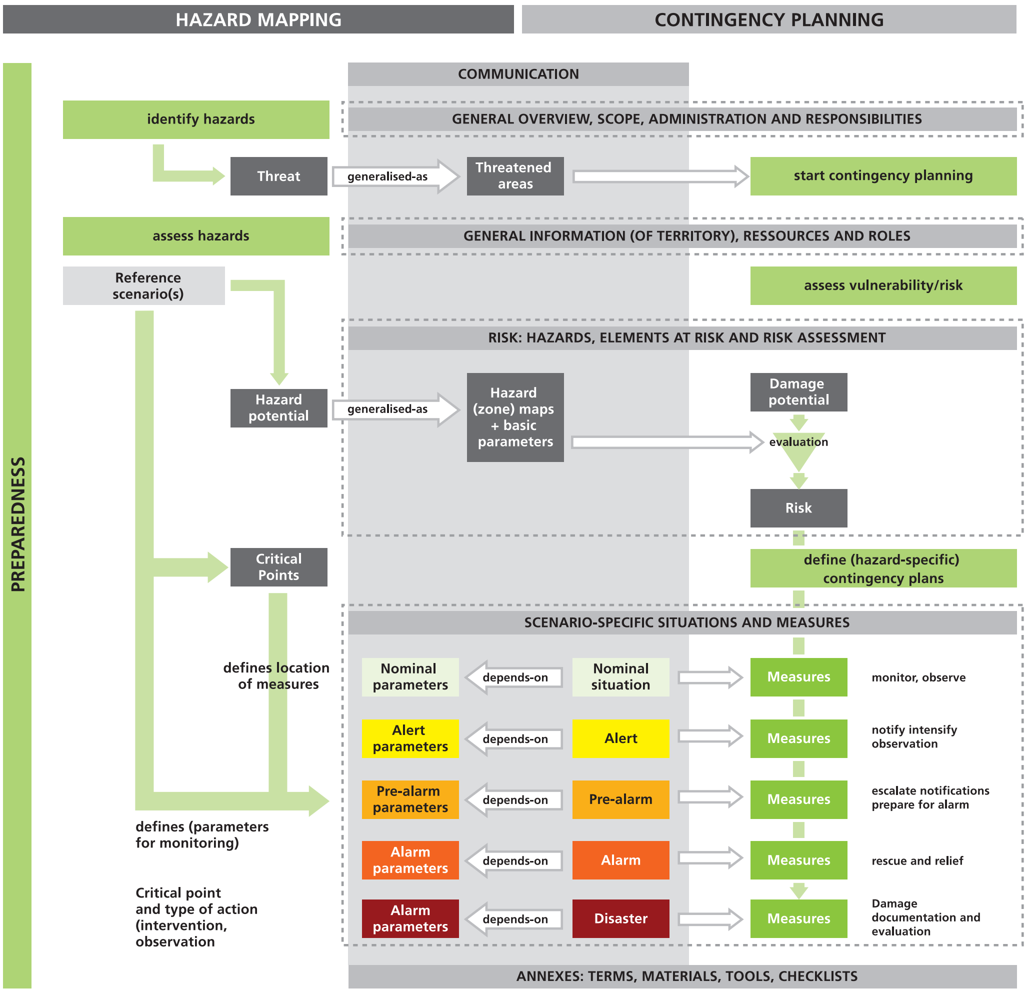


Figure 30: Interfacing hazard mapping and contingency planning (S. KOLLARITS)

HAZARDS ARE NOT EQUAL

Considering the required communication and interaction between hazard experts and contingency planners it is useful to distinguish between two types of hazards, as described below. In contingency planning most emergency scenarios are generally categorized as resulting from "sudden-onset" or "stepwise-onset" hazards. Any process that is developing in a time span shorter than the required intervention time must be considered to be "sudden" from the point of view of contingency planning or crisis management.

- **STEPWISE ONSET HAZARDS:**
  Stepwise-onset hazards are those whose effects take a long time to evolve into emergency conditions (for instance, natural hazards, such as big river flooding or long-term drought, that over a long time may contribute to severe food scarcity conditions, malnutrition and eventually famine conditions).

- **SUDDEN-ONSET HAZARDS:**
  Sudden-onset hazards include both natural hazards (e.g. earthquakes, hurricanes, flash floods in smaller catchments) and man-made or "complex" hazards (e.g. sudden conflict situations arising from varied political factors).
  Relating this concept to the "process domain" of natural hazards the following characterization of the two hazard types can be given:

SLOWLY AND REGULARLY EVOLVING REGULAR EVENTS (SLOW STEPWISE-ONSET HAZARDS)

This natural hazard type is characterized by the fact that on the one hand historic information and "forecasting" information (gauges, meteorological network, established threshold values) is available allowing longer forewarning times and leading to well established warning and alert stages in the hazard management cycle. On the other hand the evolution of the scenario/event is following a regular sequence of process development stages which are quite well known due to the detailed analysis of historical events, using validated models and real time monitoring data, the consequences of such events can be predicted rather precisely.

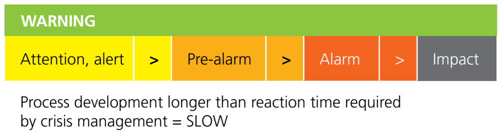


Figure 31: Warning and impact in the case of a slowly evolving regular event (slow-onset hazards)

From a more general point of view these regular events like e.g. flooding scenarios in larger catchment areas are characterized by a more "frozen" situation with only a few changing variables.

RAPIDLY AND IRREGULARLY EVOLVING EVENTS (SUDDEN-ONSET HAZARDS)

This hazard type is characterized by a dynamic/composite evolution of event scenario and by a limited reaction time. Especially smaller catchment areas in the Alps are very frequently inflicted by rapidly evolving irregular events. Extreme meteorological conditions causing torrential rains within a very short time span in a local watershed can trigger various processes like landslides, rockslides, rock fall, debris flows and flash-flooding leading to complex multihazard scenario combinations. Additionally existing technical prevention measures like e.g. retention dams have to be considered with respect to their operational and failure conditions (mitigation/prevention failed). Even if forewarning systems are installed in such small catchment areas, the warning time is very short. After alert phase a pre-alarm or a very short alarm is often immediately succeeded by the event and its impacts.

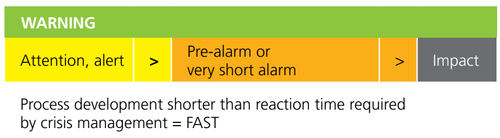


Figure 32: Warning and impact in the case of a fast evolving irregular event (sudden-onset hazards)

Due to the more complex nature of sudden onet hazards more information on the scenario, relevant for contingency planning, should be directly be indicated in the hazard maps

SCENARIO DESCRIPTION

To increase the usability of hazard maps for contingency planners during preparedness and response phase additionally to the delineation of zones indicated in hazard maps, the course of events and event scenarios must be described in a condensed, standardized and formalized manner using pre-defined ontology rules and syntax. When using analogue hazard maps the required process information can be printed directly on the hazard maps. If a map is thereby "overloaded", the text information can be included in a separate manual. When hazard maps are available in digital form or if a Continuous Situation Awareness (CSA) tool is available, the required process information can be made available to the contingency planners in form of simple map symbols providing the opportunity to open "pop-up windows (e.g. "hot spots" like information points, critical points, and observation and intervention points – see below). Additionally to the description of the course of events and of event scenarios, situations and identification parameters (e.g. threshold values etc.) must be indicated in the scenario description. Thereby contingency planners must be enabled to decide which scenario/situation is actually evolving. Furthermore links to alternative scenarios (or sub-scenarios) which can be activated interactively should be offered.

Besides the information indicated in hazard maps and the event scenario information given in a separate manual, additionally short guidelines, using a clear ontology must be worked out and provided to contingency planners. In these guidelines simple and short descriptions of basic process parameters have to be given including references to the relevant process models. E.g. What is a debris flow? How can a landslide be triggered? What is clogging ("Verklausung")?
Depending on the process type (e.g. flow/flooding; rock fall; landslide) and event development different information must be included in the scenario description.

SCENARIO DESCRIPTION

FLOW – FLOODING (STEPWISE ONSET) E.G. RIVER FLOODING IN FLOOD PLAINS				
Cause and triggers	Intensive rainfall and/or snowmelt	Ice jam or clogging, lake outbursts	Collapse of dykes or other protective structures	
Process type	Clear water discharge	Suspended load/bed load transport		
Relevant parameters	Water depth	Water velocity	Extent of flooded area	Flood propagation
Forecasting/ monitoring options	Weather forecast	Rain fall, water depth at gauging stations	Linkage of defined threshold values with expected flood extend	
Expected time to impact	With forecasting	Without forecasting	Considering existing protection measures	Considering the failure of protection measures
"Hot spots" in the process domain	Critical points (e.g. natural dam)	Observation points (e.g. gauging stations)	Intervention points (e.g. weirs to be opened to use natural retention capacity in flood plains)	

FLOW – FLOODING (SUDDEN ONSET) E.G. MOUNTAIN TORRENTS				
Cause and triggers	Cloud burst	Ice jam or clogging, lake outbursts, landslides	Collapse of natural dams (e.g. landslide dams) or protective structures	
Process type	Clear water discharge	Suspended load/bed load transport	Debris flow	
Relevant parameters	Volume	Depth	Velocity	Sediment load
Forecasting/ monitoring options	Weather forecast	Rain fall and duration, water depth at gauging stations	Water depth, bed, bank and slope erosion at defined observation stations.	
Expected time to impact	With forecasting	Without forecasting	Considering existing protection measures	Considering the failure of protection measures
"Hot spots" in the process domain	Critical points (e.g. reactivated landslide)	Observation points (e.g. water level at bridges)	Intervention points (e.g. clogged gorge or bridge)	

Figure 33: Scenario description and necessary parameters for flow/flooding events (stepwise and sudden onset).

ROCK (FALL, TOPPLE, SPREAD, SLIDE) – STEPWISE ONSET AND SUDDEN ONSET				
Cause and triggers	Weathering	Erosion	Induction by shock (e.g. earthquakes)	
Process type	Fall	Topple	Spread	Slide
Relevant parameters	Block size	Volume	Bounce height	Impact force
Forecasting / monitoring options	Extensometers measuring opening of fissures	Remote sensing methods measuring displacement	Manual measurements of displacement	
Expected time to impact	With forecasting	Without forecasting	Considering existing protection measures	Considering failure of protection measures
"Hot spots" in the process domain	Critical points (source area)	Observation points (measurement/monitoring of displacement)	Intervention points (removal of unstable parts; permanent and mobile protection measures)	

LANDSLIDE (SLIDING, CREEPING, FLOWING) – STEPWISE ONSET AND SUDDEN ONSET						
Cause and triggers	Sediment composition	Existing sliding plane	Hydrostatic pressure and moisture	Slope		
Process type	Translational sliding	Rotational sliding	Flowing	Creeping		
Relevant parameters	Activation	Volume	Depth	Speed	Run out length	Impact force
Forecasting / monitoring options	Weather forecast and measurement of precipitation	Sensors measuring displacement and moisture	Remote Sensing methods to measure displacement	Manual measurements of displacement		
Expected time to impact	Below reaction time (=FAST) Above reaction time (=SLOW)	With forecasting	Without forecasting	Considering existing protection measures	Considering failure of protection measures	
"Hot spots" in the process domain	Critical points (source area)	Observation points (measurement/monitoring of displacement)	Intervention points (drainage of sliding mass; lowering of groundwater table by pumping wells, auger piles, anchor walls etc.)			

Figure 34: Scenario description and necessary parameters for rock movement and landslide events (stepwise and sudden onset).

DEFINITION OF HOT SPOTS IN THE PROCESS AND INTERVENTION DOMAIN

Within the co-operation of hazard experts and contingency planners "hot spots" can be defined in the process (p), damage/loss (d) and intervention (i) domains. These "hot spots" are indicators for information linking the hazard/process- and the contingency/intervention fields by providing key process information or indications for required measures. These "hot spots" comprise information points, critical points, observation points and intervention points.

THE PROCESS ORIENTED DOMAIN:

Process-oriented information points are providing general information on the hazard process/event scenario. Depending on the event scenarios the main information is provided in a condensed form based on a clear ontology (see above).

Process oriented critical point (p-CP): A process orientated critical point is defined by hazard mapping experts based on historic information and a sound. This point can indicate the area where a process is starting (e.g. the detachment zone of a landslide or a rock fall), where a process is transformed (e.g. sediment input from the river flanks leading to debris flow), or diverted (e.g. clogged bride) in different directions – possibly leading to sub-scenarios.

Process oriented observation point (p-OP): A process-oriented observation point indicates a location where the process can best/most significantly be observed or monitored. An observation point can e.g. indicate the location of a sensor installed in the preparedness phase to monitor a process. In the warning phase additional technical devices may be installed or "observers" may be sent to the defined locations to observe the process development according to a pre-defined Standard Operation Procedure (SOP).

Process oriented intervention point (p-IP): Process oriented intervention points used during the preparedness phase designate all technical and non-technical prevention measures installed. During the warning phase, at a process oriented intervention point an action may be taken to influence directly the process or event development itself. In the case of a flooding in a lager river (slow-onset), typical intervention points are e.g. retention basins with manual or automatic steering of the weir, structures to divert the flood into natural retention areas, or locations where river blockage may occur and must be averted (clogging, blockage by side erosion or landslides). In mountain torrents (fast-onset) these process oriented intervention measures are mainly depending on the given warning time. Possible measures at intervention points are e.g. the removal of clogging, the opening or widening of discharge channels after riverbed blockage caused by sliding and bank erosion, or by rapidly constructed reflection or retention dams.

According to the definition of "hot spots" in the process domain, they can also be defined in the "damage/loss" and "intervention" domain by contingency planners. E.g. a "damage-oriented" critical point is defining a location where the damage is likely to take place. An "intervention oriented" critical point is indicating a location where activities have to be taken to reduce risk.

	PROCESS ORIENTED DOMAIN	DAMAGE/LOSS ORIENTED DOMAIN	INTER-VENTION ORIENTED DOMAIN
information point	p_INFO	d_INFO	i_INFO
critical point	p_CP	d_CP	i_CP
observation point	p_OP	d_OP	i_OP
intervention point	p_IP	d_IP	i_IP

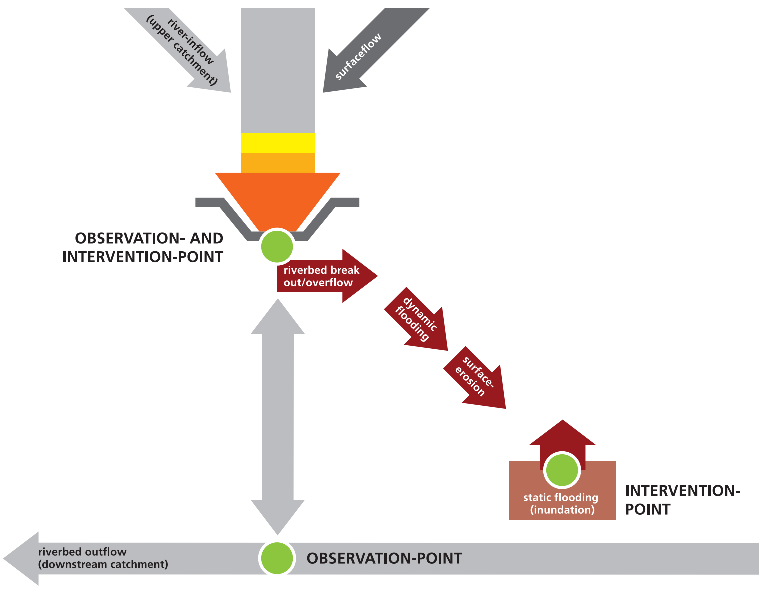


Figure 35: The concept of scenario models and "hot spots" shown for a flooding event (I. SCHNETZER)

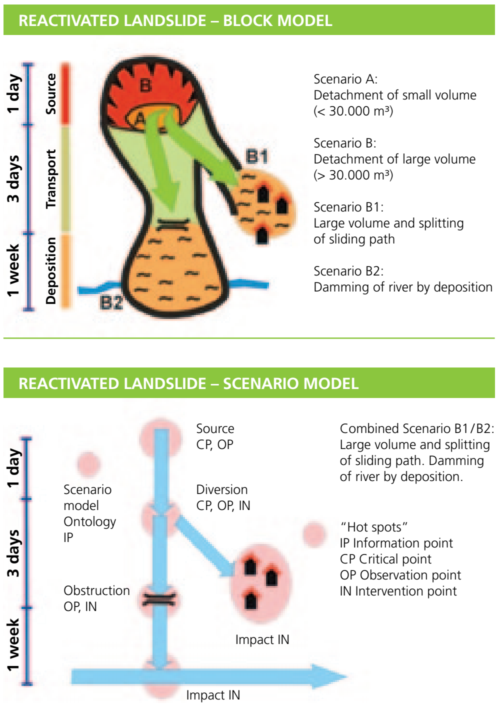


Figure 36: The concept of scenario models and "hot spots" shown for a sliding event (D. LEBER, A. CORSINI).

SCENARIO MAPS

Based on the classical approach of hazard assessment and mapping as well as the concept of hazard scenarios, scenario maps can be worked out. These maps show different zones and provide additional detailed information on hazard processes and possible mitigation or intervention strategies, using the "hot spot" concept lined out above. Information points are used to provide general event details, critical points designate important process-related information; observation points as well as intervention points provide information on possible actions to be taken by contingency planning or crisis management.

ADVANTAGES OF SCENARIO USE

The invention of simplified scenario models and “hot spot information” included in hazard maps (in addition to the zonation information) sustains the contingency planner in the preparedness and and intervention phase to gain a fast overview about principle process information in a standardized form and thus helps to improve process understanding.

Contingency planners can consult hot spots in order to access information In addition to the static information as defined in standard hazard maps. Thus they are informed about monitoring the process and its activation and about the principles of process development in the process area.

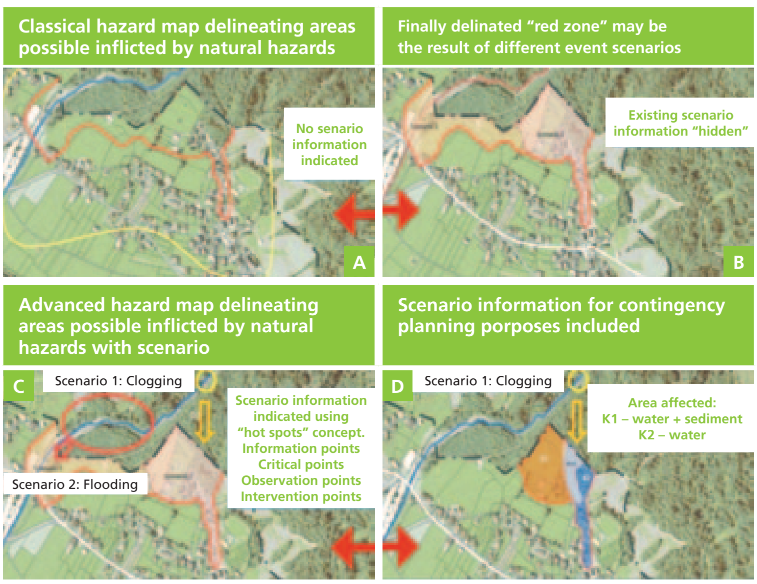


Figure 37: Example for the improvement of the quality of hazard mapping information for contingency planning by the integration of simplified scenario-models into hazard maps (modified after I. SCHNETZER).

Critical points are informing about important parameters in the source (initiation) area of the hazard processes or about changes of the process.

The consideration of observation points already in the early warning phase allows to take action at an early stage of the process development, thus improving the anticipation capacity (= early warning capacities) and increasing the time span between the first action (intervention) and the occurrence of the disaster.

In classical disaster management intervention actions are started after the occurrence of the event causing damages. Using the information provided by the process oriented intervention points, the process development can (at least in some cases) directly be influenced by process related intervention action, thus increasing the coping capacity and sometimes even preventing the hazard at all.

MONITOR II

A synoptical example: flood at river Morava

BASIC GEOGRAPHICAL DATA

The Morava river is a left-sided tributary of Danube river and is the border river between Austrian and Slovak Republic over a length of about 70 km. The catchment area exceeds 25.000 km². Flooding at the Morava river typically occurs between March and May as a result of the snow melt in the mountainous part of the catchment area in Czech Republic. However, flood events with shorter duration also occur during summer and winter periods. Consequently an extensive system of flood protection dykes was constructed almost along the whole Slovak-Austrian river reach.

MORAVA FLOOD EVENT 2006

The extreme discharge situation in spring 2006 was mainly caused by above-average snow packs being stored in the catchment area (150–200 mm water equivalent). The water level of the river Morava started to raise abruptly on 27 March reaching a maximum on 2–4 April corresponding to an occurrence probability of hundred years.

On 3 April the flood protection dyke close to Jedenspeigen was over-topped and subsequently destroyed over a length of 100 meters within a few hours. The fire brigades had to evacuate 400 inhabitants in Dürnkrut. Another dyke failure occurred few kilometers downstream, close to Mannersdorf on April 4th.

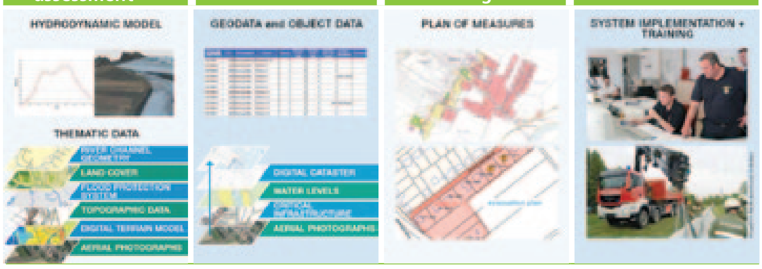
All in all, about 890 individuals had to leave their homes and about 600 households were affected by the flood disaster. Private households and the Austrian railway track to Czech Republic were heavily damaged between Anger and Dürnkrut, the area where the larger part of the damages occurred.

The experiences of the flood event 2006 showed major shortcomings with previously existing contingency plans, especially the lack of sufficient knowledge

- on potential hazards deriving from dyke failure,
- on the temporal aspects of the hazard scenarios and
- on the details of feasible relief measures.

As a reaction Lower Austria developed comprehensive and homogenous basis for flood emergency measures for the municipalities (co-financed by ERDF within project MONITOR), focussing on:

- Definition of different hazard scenarios, including residual risk scenarios.
- Identification of potentially affected areas, based on numeric modelling of dyke break and overtopping scenarios.
- Classification of the potentially endangered buildings based on their use and degree of exposure; designing of evacuation zones. Collection of all relevant spatial data within the evacuation zones.
- Actual situation classification of the dyke (geotechnical, design-elevation, logistic).
- Development of possible defense measures at the flood protection system and of emergency measures in residential areas.



1 Hazard assessment	2 Risk assessment	3 Contingency Planning	4 Implementation
Evaluation of the hazard documentation and of geotechnical survey of the dykes	Comprehensive overview and classification of damage potential: persons, cultural and economic values.	Information, communication summary of hazard assessment, determination of warning and alert values for parameters, display the chain of information, register of contact data.	Contingency plan comes into force.
Identification and definition of hazard scenarios.	Definition of vulnerability (based on mobility of people, handling time, logistic framework conditions, situation on supply and disposal).	Tasks and responsibilities of the authorities at communal, district and regional, level, of operators of protection systems and of the relief units	Introduction of contingency plan to emergency forces (fire brigades) and training courses.
Definition of model parameters for dyke breaks (width of breach, temporal development).	Assessment of indirect damage potential by environmentally endangering substances.	Catalogue of measures: list of all emergency management measures, temporally ordered by phases WARNING-ALERT-DISASTER- "ALL-CLEAR".	Training with technical experts of authorities.
Modelling of 6 dyke break scenarios (HQ30 and HQ100) and 1 overload event (HQ300).		Description of measures, which are listed in the catalogue.	Joint disaster control exercise.
Identification of critical scenarios.		Supporting plans: survey map, plan of measures, evacuation plans, data sheets and tables	Periodic activities for the update and maintenance of data.
Summary as hazard maps.			

Figure 38: Workflow of hazard / risk mapping and in contingency planning in case of Morava river (A. SCHWINGSHANDL)

BEST PRACTICE WORK-FLOW FOR FLOOD RELATED CONTINGENCY PLANNING

The work-flow used for the comprehensive hazard assessment – including definition of critical scenarios, and the subsequent risk assessment and contingency plan development can be regarded as a best practise example for flooding.

According to feasibility of measures and to the computed water depths in the flooded areas, different kinds of barriers for flood defense in residential areas were designed. The most crucial criteria for the application of measures is the fact that the fire brigades and other emergency management forces have to be able to build up these barriers within a short period. Stability and the safety of the construction in conjunction with the dimensions of the barriers were relevant planning criteria. The same is essential for defence measures designed for flood protection dykes. Limited access to the dykes because of the lack of drivable roads makes it difficult to defend them over the whole length.

The flood contingency plan was developed in close cooperation with the municipalities, the local and district fire brigades, the responsible expert for civil protection of the district, the Austrian waterway company and the regional government of Lower Austria.

MONITOR II

Risk management needs information

Information needs and information generation

Information collection is essential in all risk management phases (Preparedness – Response – Recovery). Information collection produces supporting datasets that are used to meet information needs. Different information needs arise in different risk management tasks, such as, for instance, Prevention, Warning and Intervention.

	PREPAREDNESS	RESPONSE	
INFORMATION NEEDS	P) PREVENTION Planning – Technical measures (non-real-time information)	F) WARNING Alert – Pre-Alaram – Alarm (real-time information)	R) INTERVENTION Rescue – Damage mitigation (real-time information)
	InfoNeeds: to Assess – Define	InfoNeeds: to Forecast – Identify	InfoNeeds: to Appraise – Control
H) HAZARD	P.H.1) Hazard processes spatial distibution and extent P.H.2) Hazard processes long-term evolution-dynamic P.H.3) Triggering Conditions P.H.4) Predicted Event Scenarios P.H.5) Hazard Mitigation Alternatives	F.H.1) Hazard processes on going evolution-dynamic F.H.2) Hazard processes expected evolution-dynamic F.H.3) Triggering causes situation F.H.4) Triggering causes expected trends F.H.5) Expected Event scenarios F.H.6) Urgent – Contingent hazard mitigation measures	R.H.1) Hazard processes on going evolution-dynamic R.H.2) Status-efficacy of ongoing hazard mitigation measures R.H.3) Ongoing Event scenarios
V) VULNERABILITY	P.V.1) Exposure P.V.2) Vulnerability P.V.3) Value or Worth P.V.4) Vulnerability and/or Cost-worth Reduction Alternatives	F.V.1) Urgent-Contingent Vulnerability and/or cost reduction measures	R.V.1) Status-Efficacy of ongoing vulnerability and/or cost reduction measures
R) RISK	P.R.1) Predicted Damage Scenarios P.R.2) Predicted Loss Scenarios	F.R.1) Expected Damage Scenarios F.R.2) Expected Loss Scenarios	R.R.1) Ongoing Damage Scenarios R.R.2) Ongoing Loss Scenarios
Main information flow direction During an Emergency Event		Update	Update
Main information flow direction After an Emergency Event	Update		

Figure 39: Information needs by disaster management phase (A. CORSINI)

Definitions needed: ASSESS-DEFINE-FORECAST-IDENTIFY-APPRAISE-CONTROL

Supporting datasets are the result of the combined application of different data collection methods. **Observation methods** generate basic supporting geographical data, archives of past events, outputs of hazard (Rechtschreibfehler in hazard) process surveys and mapping, results of monitoring of hazard processes (non-real time/real time) and causes (non-real time/realtime); outputs of mapping elements at risk, databases of past damages; description and assessment of structural characteristics of elements at risk; damage potential curves, economic (value) assessments, strategic (worth/importance) assessments; output of heuristic expert-based models (to simulate hazard processes and their evolution/dynamics with respect to triggering conditions and – eventually – mitigation measures).

Statistical or deterministic methods serve as basis for numerical models capable to simulate the spatial and temporal evolution of hazard processes with respect to triggering conditions and other causal factors.

When one or more of the above mentioned methods are used to derive a dataset representing expert knowledge, these datasets are **called composite datasets**. Typical examples of composite datasets are hazard and scenario maps.

One key distinguishing characteristic of datasets is their update/availability timing. During the prevention phase, an update of the datasets is only needed when developments have occurred in the territory modifying the conditions described by the datasets. Real-time information is usually not necessary, so that static (pseudo-static) data and informations are used. During warning tasks datasets update must be carried out in the shortest time possible, and data availability must be between near-real-time to real-time, so that dynamic informations can be derived.

Onother key characteristic is the **spatial dimension**: datasets can be spatial (e.g. maps) or non-spatial (e.g. raw monitoring data). Spatial data can be classified in different categories according to the INSPIRE directive of the European Union. However, such standards have no reference to the functional usage of data in risk management. To ensure that the spatial data infrastructures of the Member States are compatible and usable in a Community and transboundary context, the Directive requires that common implementing rules are adopted in a number of specific areas (metadata, data specifications, network services, data and service sharing and monitoring and reporting). These implementing rules are adopted as Commission Decisions or Regulations, and are binding in their entirety. The Commission is assisted in the process of adopting such rules the European Commission is assisted by a regulatory committee composed of representatives of the Member States and chaired by a representative of the Commission (this is known as the Comitology procedure). An INSPIRE metadata editor has been made available through the INSPIRE Community Geoportal. The INSPIRE Metadata editor allows to create INSPIRE compliant metadata and to download them as an xml file. The main metadata categories are: metadata on metadata; identification; classification; keywords; geographic; temporal; quality and validity; conformity; constraints; organization.

The INSPIRE directive of the EC requires the public authorities of member states to build and document GIS data according to specified implementation rules.

INSPIRE conformity of GIS data assures the comparability of data on structural and semantical level. It thus allows to build GIS-based models and applications once, but re-use them in the other countries and regions of Euopean Union.

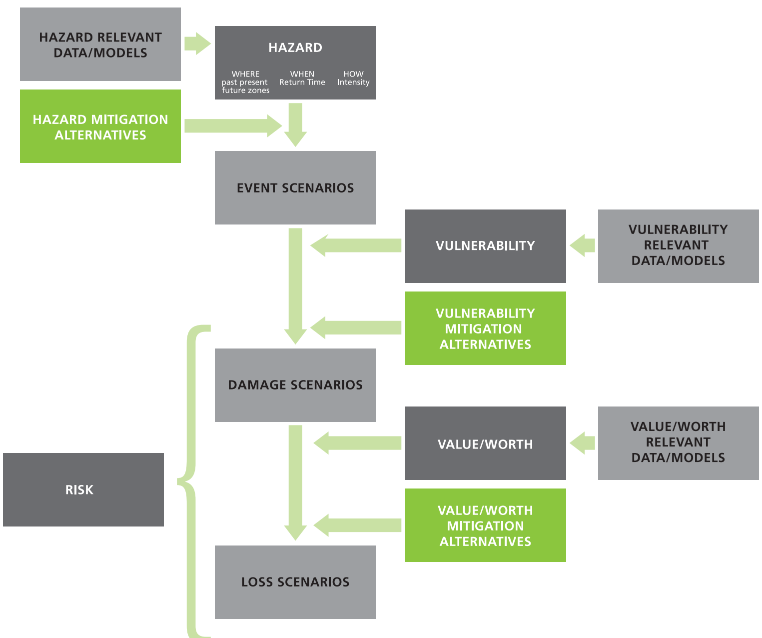


Figure 40: Risk and emergency basics with relevant data input (A. CORSINI)

Information flows

Information flows are defined by the way in which datasets are used in a harmonised integrated manner in order to meet information needs. Information flows vary depending on the risk management task.

The general framework linking risk-related terms (hazard-vulnerability-value-risk) to emergency-related terms (event-damage-loss scenarios) has been presented above. Based on these general schemes, flowcharts for the information flows during prevention, warning and intervention phases can be defined. These flowcharts are directly related to the main information needs of the risk management phases defined and take into account the review of practices among MONITOR II project partners.

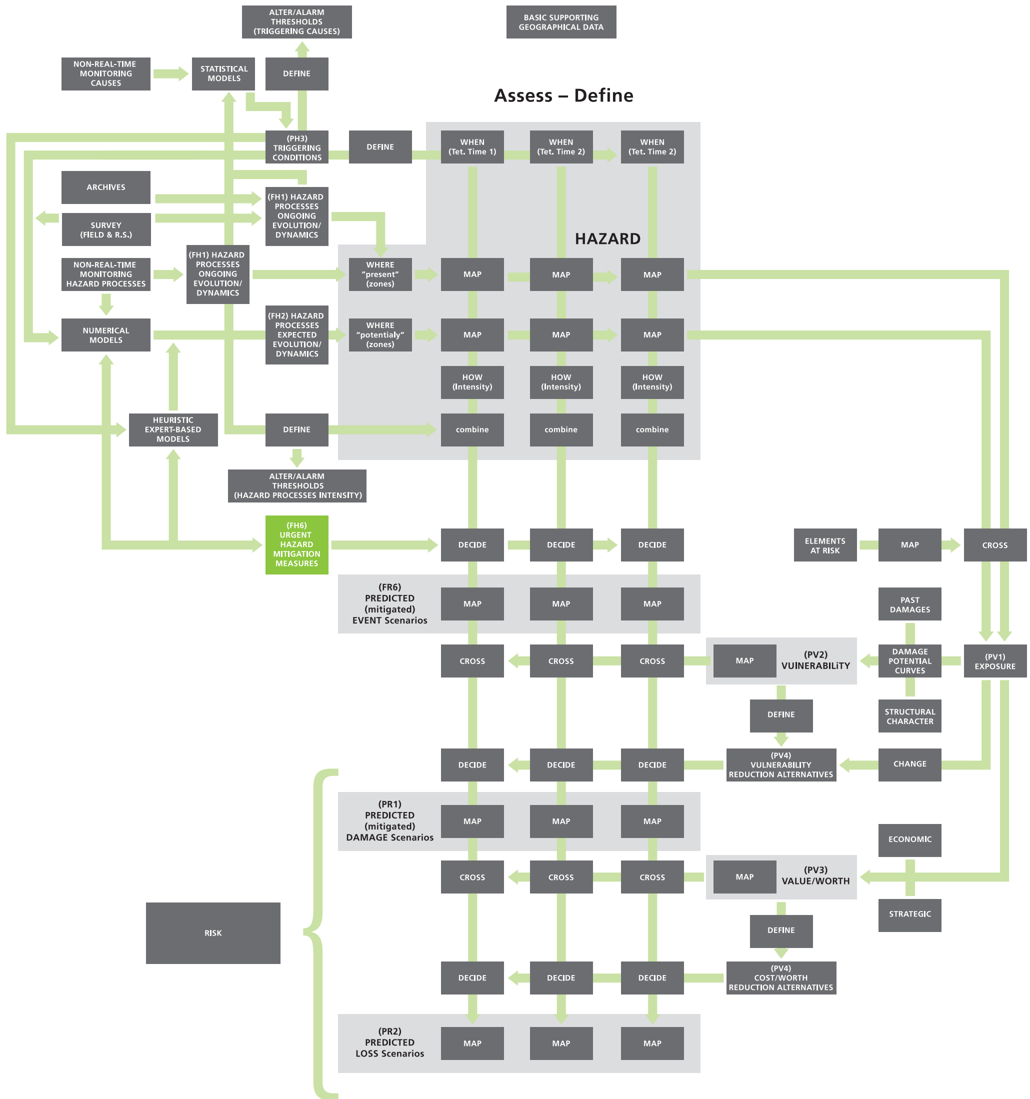


Figure 41: Information flows during prevention phase (A. CORSINI)

During prevention task, hazard-related data and models (among which monitoring data) are aimed at defining – in non-real time and with reference to long term conditions relevant chareacteristics of hazard processes; triggering conditions and thresholds (either related to causes or intensity of the hazard processes); possible hazard mitigation alternatives.

On such basis, hazards with various occurrence probabilities (i.e. return periods) can be outlined in terms of areas involved and expected intensity. By using this information in conjunction with mitigation alternatives that eventually have been undertaken, predicted event scenarios can be defined. Vulnerability related data and models must be used to define vulnerability characteristics of elements at risk, and to identify possible vulnerability mitigation alternatives. By combing this information with damage scenarios, the predicted damage scenarios are obtained with reference to different probability of occurrence. Value and/or strategic worth relevant data allows assesing the different predicted loss scenarios, that must be computed by identifying and eventually implementing value-worth reduction-mitigation alternatives.

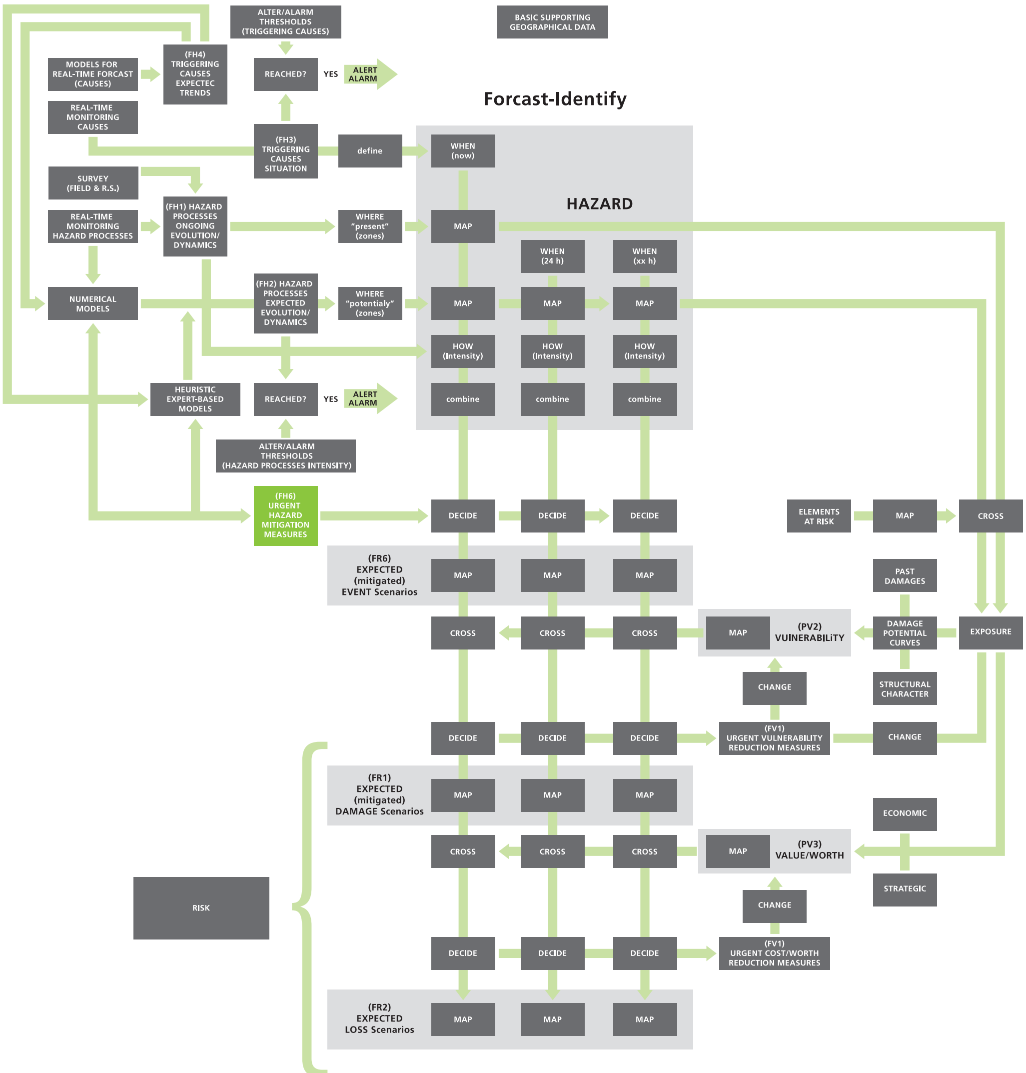


Figure 42: Information flows during preparedness phase (A. CORSINI)

During warning phase, hazard-related monitoring is primarily aiming to verify in real time and with reference to short-mid term conditions, if the thresholds defined during prevention (regarding causes and hazard processes) are likely to be reached or have already been exceeded. Models are used to forecast the future short to mid–term trends of triggering causes and also the possible evolution of the expected hazard processes. On such basis, nowcasting of hazards and forecasting of hazards in the short-mid term can be obtained. Information regarding hazard mitigation measures undertaken to prevent or to control hazard processes, are used in conjunction with hazard information in order to depict the predicted event scenario in the short and mid-term.

All the information and data on vulnerability that where acquired, processed and synthesised in the prevention phase, is useful as they allow the nowcasting and forecasting of expected damage scenarios necessary for the preparation of the implementation of urgent vulnerability reduction measures.

Subsequently, all the information and data on exposed elements (with their specific value and

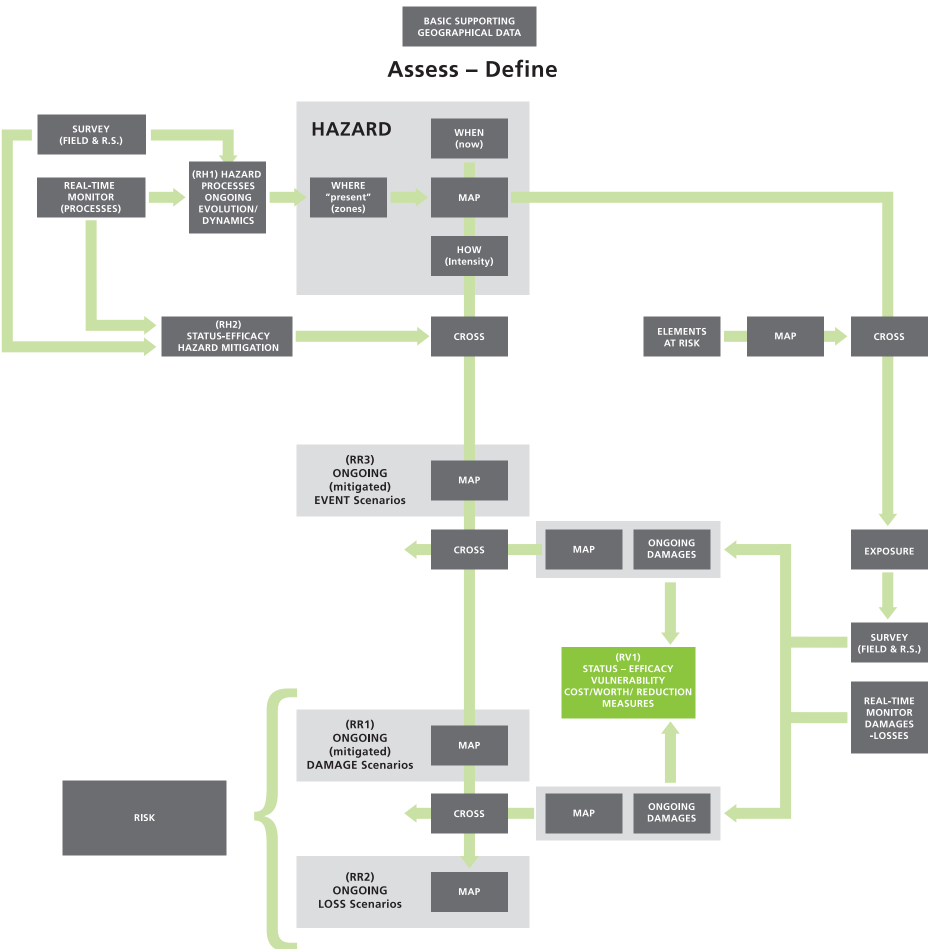


Figure 43: Information flows during response phase (A. CORSINI)

worth) must be analysed and updated, to outline the expected loss scenarios and to evaluate possible urgent damage reduction measures (e.g. evacuation measures). During response, a timely update on the ongoing situation is essential. Response is carried out while forecasting is still ongoing, so to have a clear picture of what is actually going on and of what can happen next in the short term. Evaluation of the ongoing hazard processes and of the performance/efficacy of hazard mitigation measures implemented in prevention and forecast is essential for assessing the hazard scenario as well as the ongoing event scenario. In this phase, the feedbafrom the field is essential an can be carried out by different means.

At the same time, the direct observation-measurement of the efficacy of vulnerability and/or cost-worth reduction measures that have been set up during prevention and forecast, is fundamental in order to define and continously update ongoing damage and loss scenarios.

How to keep (information) control: CSA

Goals

The primary goal of the MONITOR II CSA (Continuous Situation Awareness) is to improve situation awareness and knowledge about situations, 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 depends on the integration of a (large) number of information from different sources and their evaluation at different levels of detail. This process iusually called information fusion is at the heart of the CSA.

ON TERMS

Situation awareness is "knowing what is going on around oneself."

CSA vision

The CSA supports disaster management processes with information provision

- relevant for the current situation and the corresponding tasks of the user
- integrated into a seamless view
- communicated in an easily understandable manner.

The MONITOR II CSA tool will consist of several components and modules for supporting users in planning tasks, situation assessment, decision making and communication/documentation. These modules can be used in a flexible combination and extended according to region specific needs.

CSA technology

OPEN STANDARDS

The MONITOR II CSA consists of a series of software components, which allows the easy integration, presentation and use of disaster management information. The CSA supports the information needs of the concerned stakeholders at different phases of the risk management cycle.

The system architecture of the CSA takes into account the existence and well established use of legacy systems. This means that the components of the CSA follow some design rules:

- they are standards based, supporting OGC standard (like WMS, WFS or Sensor Web) and INSPIRE whereever feasible;
- they define open service oriented interfaces, allowing the integration of other components;
- providing an encapsulated functionality ensuring a functioning independent of specific other components and/or information sources;
- modular design building on thematic and interoperable units.

The CSA is designed to store event data in a special CSA database. Object data – like buildings or roads – are assumed to be stored in the local, regional or national GIS. The CSA can use these object data directly if conforming to the thematically corrspeonding INSPIRE implementation rules. Otherwise a transformation of data is necessary.

INTERACTION WITH OTHER SYSTEMS

MONITOR II project is well aware of the fact that partners and potential users have developed a number of well established systems. These systems have been built with considerable costs and many users are accustomed to using them. Consequently MONITOR II CSA

- provides solutions only as a complement to existing systems
- strongly builds upon and is dependent upon interactions with existing and planned systems

MONITOR II

CSA modules

The CSA and its moduls aim at supporting all concerned stakeholders in all phases of the risk management cycle:

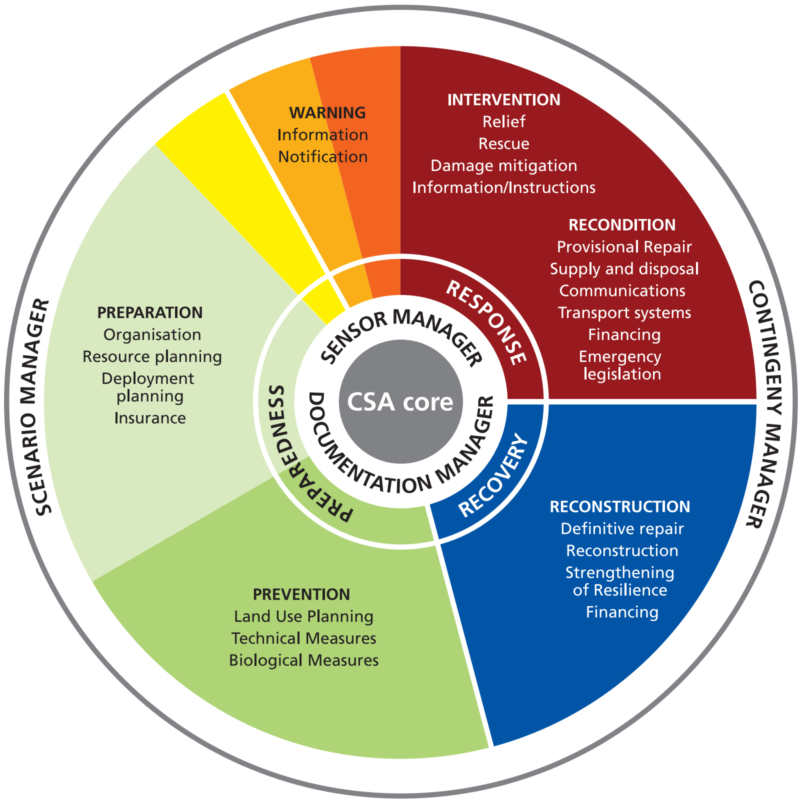


Figure 43: MONITOR II CSA modules within the risk management cycle

The **CSA core module** promotes services integration, by serving as rule engine and providing visualisation features. It includes all basic administration functionality (user administration, authorisation and security management, service configuration) and allows to interface to GIS integration services (WMS, WFS, …). Basic user interaction – like mapping, querying and filtering and searching is provided via a user-friendly web client.

The **sensor manager** supports the integration of sensor information of various sources (by using standards like sensor web) as well as the configuration and monitoring of sensors. Sensor generated information can be visualised (on maps, in charts) and analysed – together with other information sources provided by the CSA core module.

Figure 44: MONITOR II scenario manager supports the definition of observation points for further use in contingency planning

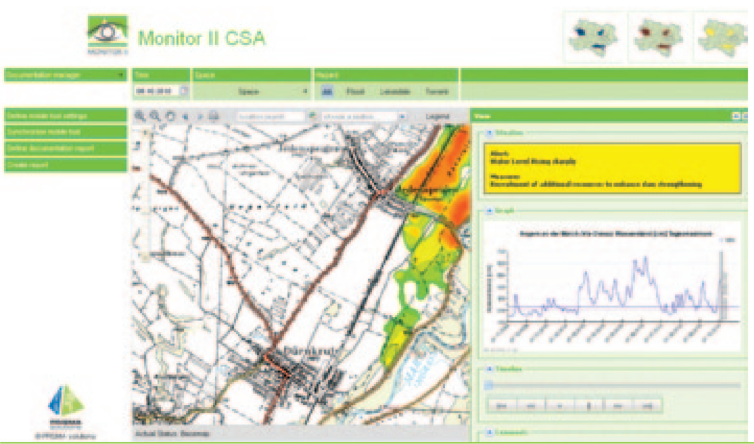


Figure 45: MONITOR II documentation manager visualized all relevant parameters of an event in its development over time

The **scenario manager** supports the definition of hazard scenarios and their linking to hazard maps. This approach facilitates the communication of scenarios and provides an information base for contingency plans.

The **contingency manager** supports the definition of contingency plans (conforming to contingency plans as defined in MONITOR II) using a digital, GIS based. decision support system. In response phase these digital contingency plans supportthe monitoring and execution of contingency plans (the workflow of measures) and after an event to evaluate the contingency plan and update the contingency plan.

The **documentation manager** provides mobile information viewing and mobile information. On platforms like smartphones or tablets the user is supported in mobile observation (with the help of augmented reality), reporting and information collection. All information can be interfaced with the core system and used for reporting as well as documentation purposes.

MONITOR II

Authors contacts

MAIN AUTHORS:

Stefan Kollarits
PRISMA solutions
stefan.kollarits@prisma-solutions.at

Didi Leber
Geoexpert
leber@geoexpert.at

Kathrin Plunger
Lead Partner BMLFUW, Austria
Kathrin.Plunger@bfw.gv.at

Martina Stefani
Partner 05 BZ-CP, Italy
martina.stefani@provinz.bz.it

WITH VALUABLE INPUTS FROM:

Alessandro Corsini
Partner 07 UNIMORE, Italy
allecors@unimore.it

Joze Papez
Partner 03 PUH, Slovenia
joze.papez@puh.si

Tanja Preseren
Partner 04 UL-FGG, Slovenia
Tanja.preseren@fgg.uni-lj.si

Ingo Schnetzer
BMLFUW, Austria
ingo.schnetzer@die-wildbach.at

Albert Schwingshandl
External Expert RIOCOM, Austria
albert.schwingshandl@riocom.at

Stefan Kreuzer
Amt der NÖ Landesregierung,
Zivil- und Katastrophenschutz, Austria
stefan.kreuzer@noel.gv.at

Daniel Kozelj
Partner 04 UL-FGG, Slovenia
daniel.kozelj@fgg.uni-lj.si

Franci Steinman
Partner 04 UL-FGG, Slovenia
franci.steinman@fgg.uni-lj.si

Nina Dobrinkova
Partner 11 IMI-BAS, Bulgaria
ninabox2002@gmail.com

Christian Rachoy
Partner 02 OEBB, Austria
Christian.Rachoy@oebb.at

Petrisor Vica
Partner 06 ROMSILVA, Romania
petrisor.vica@gmail.com

Francesco Ronchetti
Partner 07 UNIMORE, Italy
francesco.ronchetti@unimore.it

Matteo Vischi
Partner 05 BZ-CP, Italy
matteo.vischi@provincia.bz.it

Literature

CRUDEN, D. M., 1991. A simple definition of landslide. Bulletin International Association for Engineering Geology, 43: 27–29. **DICKAU, R., BRUNDSDEN, D., SCHROTT, L., IBSEN, M.-L. (Eds.), 1996,** Landslide Recognition – Identification, Movement and Courses, 251 p., Wiley. **Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007** on the assessment and management of flood risks. **EPOCH (European Community Programme), 1993.** Temporal Occurrence and Forecasting of Landslides in the European Community, (Ed. J.-C. Flageollet), 3 Volumes, Contract No. 900025. **EUROPEAN COMMISSION ENVIRONMENT 2011.** A European Flood Action Programme, Floods and their impacts, Article in the Internet: URL: http://ec.europa.eu/environment/water/flood_risk/impacts.htm. **EXIMAP, 2007.** Handbook on good practices for flood mapping in Europe. (http://ec.europa.eu/environment/water/flood_risk/flood_atlas/pdf/handbook_goodpractice.pdf). **KOLLARITS, S., N. WERGLES et al. 2007.** MONITOR – an ontological basis for risk management. (http://www.monitor-cadses.org/documents/MONITOR_BaseOntology_Report_1_0.pdf). **VARNES, D. J., 1978.** Slope movement types and processes. In: Special Report 176: Landslides: Analysis and Control (Eds: Schuster, R. L. & Krizek, R. J.). Transportation and Road Research Board, National Academy of Science, Washington D. C., 11–33. **WISNER, B., BLAIKIE, P., CANNON, T., DAVIS, I. et al., 2003.** At risk. Natural hazards, people`s vulnerability and disaster. London, New York.

MONITOR II Partners

Lead Partner

BMLFUW
Federal Ministry of Agriculture, Forestry, Environment and Water Management, Forest Department
Vienna, Austria
www.lebensministerium.at

Project Partners

02 OEBB
Federal Railways Railnet Austria Inc.
Railway Services
Natural Hazards Management
Vienna, Austria
www.oebb.at

03 PUH
Torrent and Erosion Control Service
Ljubljana, Slovenia
www.puh.si

04 UL-FGG
University of Ljubljana
Faculty of Civil and Geodetic Engineering
Ljubljana, Slovenia
www.fgg.uni-lj.si/kmte

05 BZ-CP
Autonomous Province of Bolzano South Tyrol
Department of Fire Control and Civil Protection
Bolzano, Italy
www.provinz.bz.it/zivilschutz

06 ROMSILVA
National Forest Administration
Development Department
Bucharest, Romania
www.rosilva.ro

07 UNIMORE
University of Modena and Reggio Emilia
Department of Earth Sciences
Modena, Italy
www.terra.unimore.it

08 DAG
State Forestry Agency
Sofia, Bulgaria
www.dag.bg

11 IMIBAS
Institute of Mathematics and Informatics at the Bulgarian academy of Sciences
Sofia, Bulgaria
www.math.bas.bg/index.html

12 REMTH
The Hellenic Republic
Region of East Macedonia – Thrace
Komotini, Greece
www.remth.gr

13 OTRG
Office of the Tyrolean Regional Government
Regional Forestry commission (public)
Innsbruck, Austria
www.tirol.gv.at/wald

10% Project Partner

UNIBG
(financed by Lead Partner)
Belgrade University
Faculty of Forestry
Department of Ecological Engineering in Soil and Water resources Protection
Belgrade, Serbia
www.sfb.bg.ac.yu

MONITOR II within the South East Europe programme

The South East Europe programme (SEE) is a unique instrument which, in the framework of the Regional Policy's Territorial Cooperation Objective, aims to improve integration and competitiveness in an area which is as complex as it is diverse.

The programme is supporting projects developed within four Priority Axes: Innovation, Environment, Accessibility, and Sustainable Growth Areas - in line with the Lisbon and Gothenburg priorities, and is also contributing to the integration process of the non-EU member states.

More information about MONITOR II and SEE:

www.monitor2.org, monitorii@prisma-solutions.at
www.southeast-europe.net