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Decision Support System with Implementation in Natural Hazards Field Tests

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1 Intorduction

Between 2000 and 2005 Europe suffered more than 100 floods, including 9 major flood disasters. These major flood events caused 155 casualties and economic losses of more than €35 billion. Furthermore the material flood damage of 2002 is estimated to be higher than in any previous single year (Barredo, 2007). Indeed there is an increase in the frequency of years with very high damage produced by major flood disasters in Europe. Two years of the current decade, i.e. 2000 and 2002, are among the worst concerning losses in the last 36-year period (Barredo, 2007). Despite the relevance of the issue, there is a need for comprehensive, standardised and georeferenced information on floods. Relevant, accurate and up-to-date data is important for political and economic decision-making. In Europe, historical data on flood disasters are neither comprehensive nor standardised, thus making difficult long-term analyses at continental level. A map of the major flood disasters of the last 56 years in the European Union, has been created by the Emergency Events Database (EM-DAT1) and NATHAN2 of Munich. (Figure 1)
One way to approach the problem is by using risk management to reduce the danger to the people living in the potential flood areas. Risk management includes administrative decisions, organization, operational skills and abilities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental disasters. Hazard maps are an instrument of hazard assessment and constitute a decisive element in modern risk management. They assist the identification, evaluation and reduction of risks by using an optimal combination of measures. Hazard maps may also support decisions concerning preventive measures againstnatural hazards and mitigation measures to manage disaster events (Kienholz 2005). Thus hazard mapping is an important input for risk analysis. Due to the interdependencies between human action and natural disasters in respect to triggering such extreme events and determining the degree of vulnerability against natural hazards, solving the problem will be possible only by using interdisciplinary cooperation.

2 Main goal

Monitoring is a fundamental observation methodology in risk management, aimed at the continuous surveillance of known hazards or at the detection of previously unknown hazards. Monitoring systems consist of a complex combination of sensors and data processing procedures and software. Monitoring produces information, which

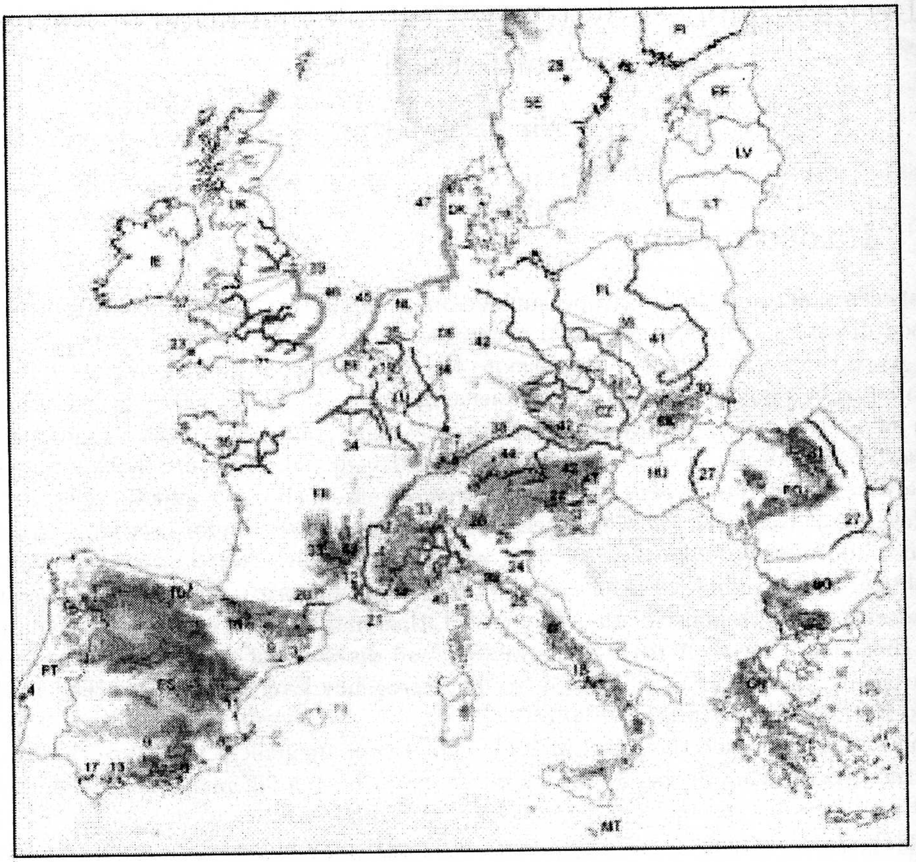

Figure 1: Major flood disasters in Europe: 1950-2005. Numbers from 1 to 23: flash floods, 24 to 44: river floods, 45 to 47 storm surge floods. A triangle feature represents very large regional events.

is valuable for depecting risk scenarios. Monitoring helps to assess hazard scenarios, where, how and when a specific disaster process will take place. From a methodological point of view monitoring can be seen as a complement to simulation models. From a practical point of view monitoring provides the information source of risk management instruments like hazard zonation or early warning systems. As such it serves as an important complement to active risk management measures like protective measures. In comparison to these benefits of monitoring include: the relative cost efficiency, the fast technological development and its positive impact for capacity building. These obvious advantages of monitoring have to be contrasted with some pitfalls: Many new monitoring methods are primarily research oriented and cannot yet offer the complete set of tools needed for practical application. Of these new technologies the potential is often theoretically known but not yet tested in practise.

In addition to that some techniques are often highly innovative but require a high level of expert knowledge. The main goal of project MONITOR II (funded by SEE program) is improvement of the methodology of risk evaluation and communication by applying these innovative methods into a Continuous Situation Awareness system (MONITOR II CSA). This project is the second stage of a project called MONITOR, where a wide range of the methods have been implemented in various test-beds with focus on different types of natural hazards. The suitability of methods was shown to be adequate but related risk communication difficult (short time period of warning). Risk communication procedures were developed as a participatory process in alarm plan development. A regional hazard response has been generated to show the relation between hazard potential and actual land use activities, where risk combinations between several hazards processes and exposition structures is displayed.

2.1 Monitoring methods used into the CSA system

A broad variety of heterogenous monitoring methods exist, that is why we organized criteria which we have used to evaluate their applicability and practical use.

2.1.1 By data acquisition platform

- Remote sensing systems: Remote sensing systems do not require the operation of active sensors directly in the area of interest. A further distinction can be made concerning the operational location of the sensor between spaceborne, aerial and terrestrial systems.
- In-situ sensing systems: In situ sensing systems require the operation of active sensors directly in the area of interest. A further distinction can be made between surface and sub-surface systems.

2.1.2 By data acquisition frequency

- Continuous monitoring: This applies to systems in which data acquisition is automated and the frequency can be varied depending on the user needs, up to a sampling frequency of a few minutes or seconds;
- Discontinuos monitoring: This applies to systems in which data acquisition is not-automated and the frequency depends upon the availability of personnel to carry out the measurements, or on systems in which data acquisition is automated but the frequency cannot be varied depending on the user needs and sampling frequency is in the order of days or weeks.

2.1.3 By data availability timing

- Real-time monitoring: Real time monitoring means acquiring, transmitting and processing data automatically, and reacting to results in an unsupervised manner - e.g. by automatically raising an alarm. This timing is mainly used in forecast, response and recovery phases.

- Near-real-time monitonng: This implies acquiring, transmitting and processing data automatically, and to react quickly to results in a supervised manner. E.g. given by the way of experts who will decide if, for example, an alarm must be raised and/or if decision makers and stakeholders must be informed. This timing is mainly used in forecast, response and recovery phases.
- Non-real-time monitoring: This means acquiring, transmitting and processing data automatically or manually, and to react to results at some point in time in a supervised manner by way of experts who will decide if and when, for example, decision makers and stakeholders must be informed. This timing is mainly used in prevention and only rarely used in forecast, response and recovery.

2.1.4 By spatial extent of data

- locallsed monltormg: e.g. data is collected at specific point-like locations
- distributed monitoring: e.g. data is collected over a more or less large area

Each of the monitoring methods is applicable for one or two of the project partners, but there is no method applicable for all of them. That is why the system architecture is giving opportunity to the user to pick a model incorporating methods applicable for the specific area depending on the hazard maps and hazard analysis provided as an input data.

3 The system

The primary goal of the MONITOR II CSA (Continuous Situation Awareness) is to improve situation awareness and knowledge about those situations, which are relevant for disaster management. This goal has to be achieved for different stakeholders in different phases of the disaster management cycle. This will integrate communication between hazard experts, decision makers and civil protection services with improved flow of information.

3.1 CSA technology

The MONITOR II CSA is a series of software components, which allows the easy integration, presentation and use of disaster management information. The CSA supports the information needs of different phases of the Disaster 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 where ever feasible; they define open service oriented interfaces, allowing to integrate them with other components; their functionality is encapsulated so that they function indepently of specific other components and/or

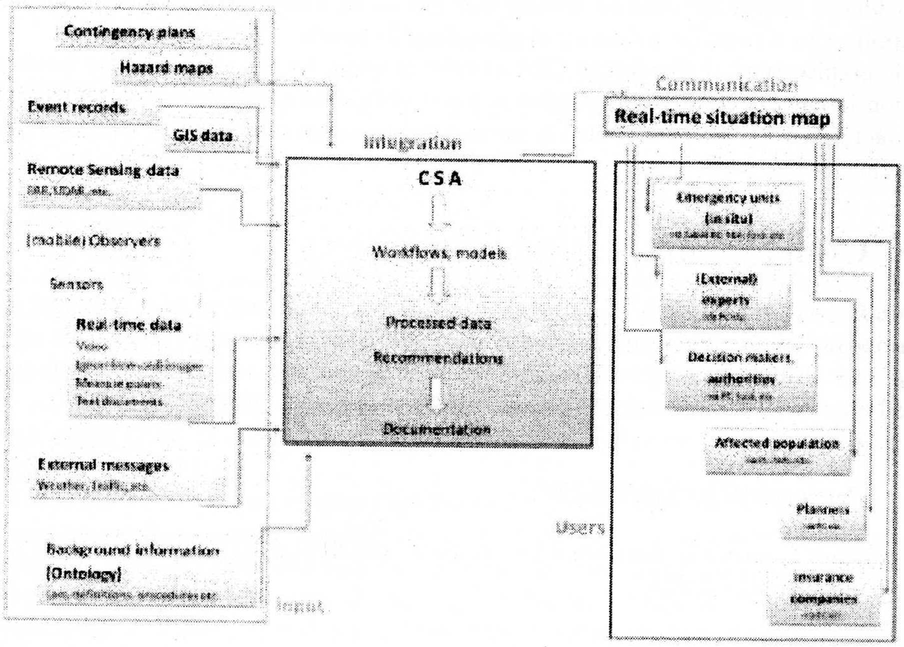

Figure 2: The CSA – Continuous Situation Awareness System architecture

information sources; their modular design is defined on thematic and interoperable units (figure 2).
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 they conform to the thematically corresponding INSPIRE implementation rules. Otherwise a transformation of data is necessary. The CSA defines different levels of information integration: visual integration by overlaying information sources into one common image (hazad map); functional integration by using external functions (like simulation models) and integrating only the results of this; full integration of data and data processing within CSA.

3.1.1 Scenario modeler

A scenario modeller will be defined and will represent work-flows. It will use the following elements as "process nodes": natural processes; measures (and – depending on the measures defined – the possible processes, which are influenced/changed by these measures); damages. Endangered objects will be linked to processes (exposition). The scenario modeller is intended to describe general models of natural (disaster) processes and shows the resulting damages depending on the measures taken. It

provides a means for communicating the results of hazard assessment (e.g. hazard mapping) to a broad community of non-hazard-experts.
This architecture of the future CSA system is going to be developed for implementation in each partner country, after a series of field test planed in the MONITORII project schedule, prove that this is the correct sequence of measures, which in case of emergency has to be taken.

4 Conclusion

A unified system for early warning concentrated on flood events does not exist in the European Union. Thus the project idea of MONITORII is very innovative and the field test results together with successful development of working CSA system will be the best formula for better Civil Protection measures in future.

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