An Integrated Systems Approach for Early Warning and Risk Management Systems

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ABSTRACT

An integrated and interdisciplinary approach to Early Warning and Risk Management is described in this paper as well as the general technical implementation of Early Warning and Risk Management Systems. Based on this systems approach, a concept has been developed for the design of an Integrated System for Coastal Protection. In addition to this, as a prototype implementation of a modern environmental monitoring and surveillance system, a system for the Remote Monitoring of Nuclear Power Plants is presented here in more detail, including a Web Portal to allow for public access. The concept, the architectural design and the user interface of Early Warning and Risk Management Systems have to meet high demands. It is shown that only a close cooperation of all related disciplines and an integrated systems approach is able to fulfill the catalogue of requirements and to provide a suitable solution for environmental monitoring and surveillance, for early warning and for emergency management.

Keywords: Communications Infrastructure, Environmental Impact Assessment, Environmental Informatics, Environmental Modeling, Human/Computer Interaction, Remote Sensing, Risk Management

INTRODUCTION

With the upcoming global warming and resulting climate changes, it can be observed that the frequency and the severity of environmental disasters are increasing continuously, although not all of them are due to global warming. Hurricanes, heavy thunderstorms, floods and landslides, earthquakes, tsunamis, volcanic eruptions and wildfires alternate with tanker collisions, oil spills, coastal pollution and accidents in chemical or nuclear plants (accompanied by the emission of toxic gases or radioactive nuclides). Independent of the originating causes, natural or anthropogenic, the latter ones ranging from careless passivity over targeted misuse up to terrorist attacks, these disasters affect human and animal populations, surface infrastructures, atmosphere and oceans in a harmful way.

The loss of human life and the tremendous damages caused by those catastrophes as well as the increasing sensitivity of the general public...
make it reasonable to protect the population and the environment by means of a new generation of intelligent surveillance, information, early warning and emergency management systems. This includes a highly sensitive monitoring, fast and reliable prognostic calculations, but also a timely dissemination of the relevant information to the general public within the endangered area and in adjacent regions. This challenge calls for a cooperation of academia, industry and public administration, for interdisciplinary approaches involving physicists, chemists, biologists, computer scientists, application engineers and medical staff.

INTERDISCIPLINARY COOPERATION AND INTEGRATED APPROACH

In a first step, the relevant stakeholders and experts from all related disciplines and organizations will have to meet and to produce a catalogue of requirements, as a prerequisite for a more detailed functional specification and for the technical design of the solution, including the specification of the communication links with the corresponding interfaces. Not only the technical problems but also the amalgamation of informational and communicational aspects with the organizational ones will add to the complexity of such a system. Organizational implications tend to have a serious impact on the design of the system.

Facing the complexity of the challenge, it is obvious that only a network of computers with dedicated individual tasks and appropriate communication structures can provide a promising approach to solve the problem of monitoring, surveillance, threat prediction, decision support, early warning and emergency management. However, defining an adequate logical structure for those networks, a variety of subtasks and prerequisites have to be fulfilled in each case in order to include intelligence in various ways and to reach the goal of an integrated operational system:

- Development/integration of adequate sensor systems and sensor networks (autonomous or remotely controlled) providing data and background information. This may include mobile sensory platforms and remote sensing systems (air space surveillance and satellite systems). Figure 1 shows an example for the integration of remote sensing systems (radiological surveillance / area scan by helicopter). The variety of sensor types to be used clearly depends on the disaster type and the involved scientific disciplines. Synergy effects can be obtained by interdisciplinary cooperation, e.g. by upgrading radiological measuring stations with meteorological equipment or by using already existing meteorological stations and installing additional sensors for pollution, air quality and so on.

The subsequent tasks are:

- Advanced modelling, i.e., development/improvement of scientific prediction models for prognostic calculations of each disaster type supporting interpretation and extrapolation of data, e.g. calculation of the atmospheric dispersion in case of NBC releases, taking into account the current meteorological situation and the expected forecast values. Similar examples are the prognostic calculation of tsunami waves based on seismological data, on hydrodynamics and 3D models of the seaground and of the coastal environment, or the formation and propagation of a flood wave in a river basin, using the actual cross section of the river, the precipitation forecast for its catchment area and the saturation of the soil, the latter depending on the precipitation in the recent past and other parameters.

- Integration of these scientific prediction modules into operational systems and definition of adequate interfaces to allow for fast response actions even under critical conditions. This implies the online availability of all relevant data and reasonable processing times for the scientific models.
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