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# Flood Warnings at the Local Level: Tools and Experiences in Their Implementation

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**Abstract**

In recent years, we are observing a change in approach to natural disasters, including floods. It consists of a departure from actions focusing on protection from hazards, in the direction of actions focusing on risk management and on the behavior of inhabitants and crisis intervention forces in hazard situations. These changes mean that flood warning systems are becoming a tool more important than before in flood damage mitigation; their main aim should be to enable citizens to take effective action. In this article, we present experiences from the building of a local warning system in the Klodzko Valley, an area located in southwestern Poland, which is at risk for flash flooding.

## 1. Description of problem

In the case of flood hazards, the primary source of measurement and forecasting information for crisis intervention forces is the nationwide or regional meteorological and hydrological service. The information coming from there is not always satisfactory, especially for services and forces at the local level. In a particularly difficult situation are inhabitants of areas located in the upper reaches of rivers. Flood waves here are of violent character, and the nationwide hydrological and meteorological service is not in a position to provide suitably detailed measurement and forecasting information for such (on a nationwide scale) small areas. Consequently, there exists a strong need to expand the scope of available information, e.g. by building local flood monitoring networks.

For people responsible for flood protection action, measurement data and forecasts facilitate determination of what effects could be caused by a forecasted situation, and an important route to expansion of the scope of available information is to build a tool for the processing and interpretation of available data. Decision-making assistance tools should, as far as possible, make the forecasting information from the nationwide system more detailed, e.g. by building a local model providing river water level forecasting in a greater number of places. It is good for this tool to enable simulation of the development of the situation for different assumptions concerning future precipitation, giving an answer to the question 'What if…?' Equally essential is estimation of the risk, which could ensue from the forecasted hydrometeorological situation. This allows adequate action to be taken to mitigate the negative effects of a flood wave. A helpful solution is the creation of a common information base in collaboration with all interested institutions from the given area; basic information concerns amounts of precipitation, water levels and the speed of their rising, which have been determined by local forces to be dangerous, as well as actions which should be taken in such situations by crisis intervention forces.

Experiences from recent floods show also that often the weakest link in flood warning and response systems is the system for notification of the impending hazard. This concerns in particular areas characterized by flash flooding, where the time between maximum precipitation and flood wave culmination amounts to a few hours. In such situations, the flow path for information and warnings should be precisely

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thought-out. Also important are tools for rapid and effective warning of inhabitants. Implementation of such tools, as well as preparation of rules for notification of inhabitants, adapted to the character of the hazard and operationally available information, can provide essential assistance in mitigating the negative effects of flood waves.

## 2. Profile of support tools for the local flood warning system

Local flood warning systems (LFWS) are comprised of many elements, which should consequently permit attainment of the basic aim, namely, proper response of inhabitants to the hazard (EMA 1999). Below are described, in brief, prototypes for tools to assist in solving the above-mentioned problems. These tools were executed in part within the OSIRIS project[3], and are presently in the initial phase of exploitation in Klodzko County, in southwestern Poland. This is a foothill area at risk for flash flooding.

### 2.1 Analysis and interpretation of the hydrological situation

One application supporting the operational activities of the crisis management team is a tool permitting forecasting and analysis of a hydrological situation, as well as identification of potential hazards (cf. fig. 1).

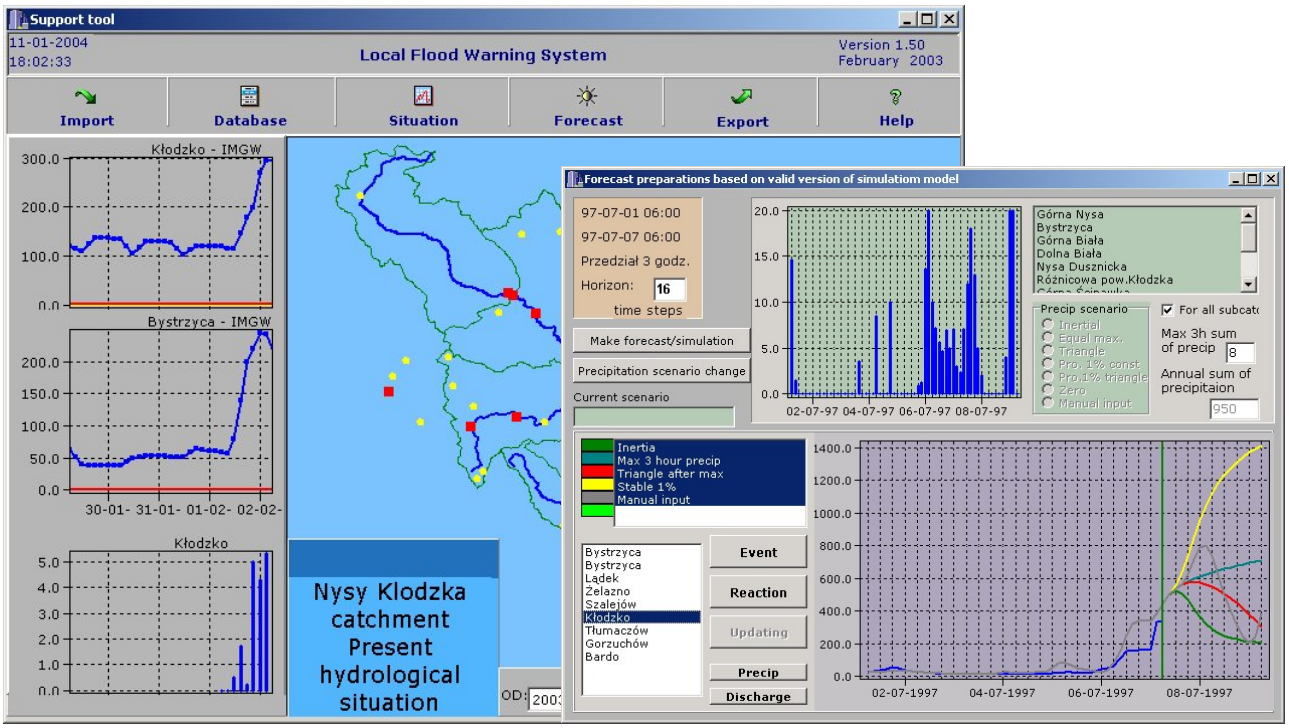


Fig. 1: Flo-Info—application supporting actions of crisis intervention forces

[3]Operational Solutions for the management of Inundation Risks in the Information Society, a project executed as part of the Fifth Framework Program of the European Union (contract IST-1999-11598)

The main functions of this module include:

- *Access to measurement data*. This function has the task of communicating with operational databases, checking whether new information has appeared, and downloading it. It is also possible to input data manually.
- *Preparation of a local hydrological forecast*. The essence of this function is to enable the user to carry out simulation analyses for several simple hypotheses concerning the distribution of precipitation over time and space. The aim is to prepare a local forecast of water levels on the basis of a selected precipitation scenario.
- *Analysis of measurement and forecasting information*. Analysis is based on an events database, in which are defined threshold values (of water levels, precipitation, etc.), as well as the hazards associated with them. The aforementioned threshold values are compared with the measured and forecast values, which permits 'awakening' of crisis response structures and forecasting of hazards (as well as the time and place of their occurrence).
- *Dissemination of messages and warnings*. This function encompasses servicing for lines of alarm communication with members of crisis intervention structures, for transmission of warnings (fax, e-mail), on the basis of analysis of the catchment status and of results from flood forecast interpretation.

The application requires a user acquainted with issues in hydrological forecasting and crisis response.

## 2.2 Flood hazard and response database

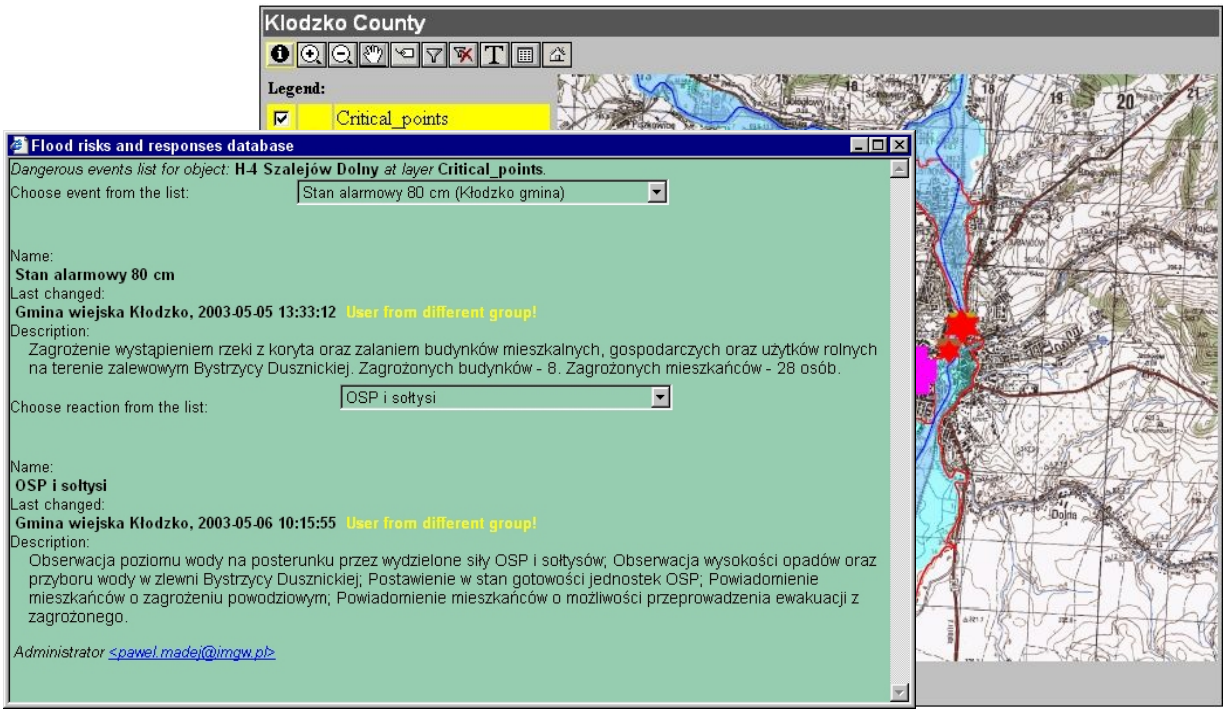


Fig. 2: Flood hazard and crisis response database

This is a tool, which enables sharing of information, executed in the form of web pages based in part on a digital map (Madej 2002). The software enables appending of information about hazards and crisis response to structures from selected layers of the map, as well as presentation of the collected information (cf. fig. 2). Its main functions are:

- *Input/modification of information.* The text portion of the database, containing descriptions of hazards and crisis response at the local level, can be filled in and updated by specialists from municipal crisis intervention centers.
- *Presentation of information concerning identified hazards.* This function enables viewing of the flood hazard and crisis response database. Its essence is to, in an effective manner, provide the local decision-maker with the maximum information concerning possible consequences of a flood.

The tool enables local crisis intervention forces to input into the database elements of crisis response plans associated with the aforementioned threshold values, as well as make cooperative use of this database. The information contained in the database can also be made available to the public.

## 2.3 Mass telephone notification system

A system intended for automatic, rapid notification of large groups of people about an occurring or potential hazard, making use of land and mobile telephone systems. The main functions of the tool are:

- *Input and modification of information* enabling definition of distribution lists encompassing people at risk and rescue forces (grouped according to a territorial and functional key), as well as pre-defined voice messages.
- *Dissemination of notifications and warnings*. The process of notification can be started from the operator's console, or remotely (by telephone) and comprises the following actions: selection of distribution lists, selection of the type of alarm, selection or recording of a message, as well as sending of information.
- *Compilation of reports* on the effectiveness of the notification on the basis of analysis of the effects of the system's action (telephone answered, busy signal, damaged line), and of information recipients' responses (no response, confirmation of receipt of information).
- *Provision of information about flood hazards.* Inhabitants and users of flood plain areas notified or warned with a short message transmitted by telephone can obtain further information via a telephone hotline.

The telephone system for alarm dissemination described here is a commercial tool, adapted by the authors to the needs of local warning systems according to the suggestions of IMGW and the Klodzko County Government. During testing, the system purchased by the Klodzko County Government, which utilizes 32 telephone lines simultaneously, achieved an efficiency of approx. 800 notifications per hour; it is also easily expandable (by multiples of 32 lines).

# 3. Experience in exploitation

The flood warning system for Klodzko County was built on the basis of the local hydrological and meteorological monitoring network which came into being on the initiative of county authorities after the great flood in 1997. In preparing the concept and tools to support the action of the LFWS, a large role was played by specialists with the Institute of Meteorology and Water Management (IMGW). This made it possible to link the capacities of the nationwide and local systems for effective warning of inhabitants.

The action of the system requires close collaboration of county authorities with municipal governments, as well as with local forces and services, the fire brigade, and IMGW. This concerns in particular issues of organization, as well as division of roles and competency areas, which cannot be based only on legal regulations, but require agreements to be reached at the local level. Because the building of a local monitoring network was an independent initiative of the county, the second phase of action—encompassing, among other things, design and implementation of the tools described above—required intensive contacts with the chief stakeholders, with the aim of obtaining their favor for the idea of a local flood warning system. As it turned out, the greatest difficulty was to convince the authorities of the 14 municipalities of Klodzko County to collaborate in the area of implementation and exploitation of the warning system. This required an array of meetings, presentations of the aims and potential benefits of building the system, as well as discussions of the assumptions and capabilities of the tools, but it bore fruit in closer collaboration among specialists in the area of crisis response within the county. On the basis of information from municipal crisis intervention centers, based on experiences from recent floods, lists of inhabitants at risk were prepared, and local leaders were designated whose task would be to warn specific groups of inhabitants. Representatives of municipalities obtained the ability to remotely activate the telephone alarm dissemination system. The municipalities participate in the costs of exploitation, incurring at this time 23% of the costs resulting from the annual operation of the system (77% is borne by the county).

The LFWS is well-perceived by inhabitants. Surveys carried out after test activations of the system (since installation of the system, there has not been any major flood yet) showed that the continuity of operation of such a system will fulfill not only a practical warning function. Also essential appears to be the psychological aspect of the undertaking, because it increases the feeling of safety, gives support and is perceived as evidence of the authorities' interest in the welfare of inhabitants. However, it should be remembered that the warning system requires strong educational and informational support (Cunge/Konieczny 2003) both to secure its acceptance by inhabitants, and to ensure its effectiveness. Educational actions in this direction are being undertaken by Klodzko County in close collaboration with IMGW.

## Bibliography


Cunge, J.A., Konieczny, R. (2003): Educational Strategy for Risk Awareness: from exposed population to education of decision-makers, Proceedings of the final workshop on the OSIRIS Project, Berlin, Germany, March 2003

EMA (1999): Flood warning, second edition, Emergency Management Australia

Madej, P. (2002): Map-based Internet information services—examples of GIS utilization in off-line mode, in: W. Pillman, K. Tochtermann (eds.), Environmental Communication in the Information Society, Proc. of 16th Conference "Environmental Informatics 2002", Vienna, September 25–27, 2002, vol. 2, pp.325–328.