FLOOD WARNING

RECENT FLOOD EVENTS ACROSS EUROPE HAVE RESULTED IN THE DEVELOPMENT OF NEW APPLICATIONS FOR HIGH WATER SITUATIONS. STEPHAN GOTTWALD OUTLINES A NEW APPLICATION FOR THIS PURPOSE.

During the past few years several high water situations occured in Europe, especially along the rivers Odra, Elbe and Danube. Germany, Austria, Poland, Czechia, Bulgaria and Romania were heavily hit by floods in the catchments of these rivers. Private houses and properties were flushed away, public infrastructure was damaged and took years to repair and even the loss of human life had to be mourned for.

High water situations are getting more and more threatening since they occur more and more frequently. It also has to be pointed out, that the public view is much more focussed on large rivers like those listed above and places which are more or less famous or publicly known. However, high water is much more dangerous along small river basins as the time span between an intense rain and the appearance of a flash flood amounts to just a few hours. Reviewing flood events over the last years then a lot of research has been triggered and new conclusions have been implemented such as,

- Research on impacts of global climate change regarding precipitation and snow and glacier smelt
- Research on and development of regional precipitation forecasts
- Investigation and implementation of physical flood protection like building or renewing dams, dikes, sluices or renaturation of river beds
- Build-up or redefinition of information processes and infrastructure
- Acceleration and automation of information processes
- Building public awarenes

Communication and Information Model Time to shelter –Time is Shelter

In case of a threatening flood time is the most important factor: the time span between the first knowledge that a flood will come and the arrival of the water is the time that can be used for additional measures against the water. To build up a communication infrastructure goes far beyond the normal realization of such a system in information technology. The question of "Who is going to be informed when and via which communication channel by whom" is not only highly political but also very difficult to answer. Where floods are threatening the time between alerting and the actually rising flood is decisive:

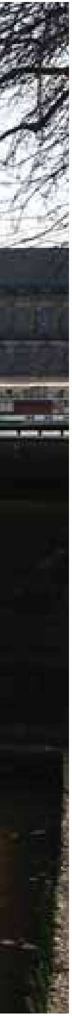
- How much time remains for additional flood prevention measures?
- How long is the information chain between recognition of a threatening flood and the last persons affected by it, the citizens?

Although the general information process is rather straightforward data collection - real-time monitoring - alerting – managing, however, there are quite a lot of partners involved with various responsibilities to supply measurements and prognosis or make decisions and carry out action plans and orders.

Data collection

At the start of this information chain weather services play an important part as they forecast precipitation, temperature and sunshine duration. The better the location and the rain intensity are predicted the earlier and more detailed can water levels be computed. In highlands local precipitation forecasts are a real challenge and their impacts can be immense – strong rain on the one or the other side of a hill causes floods in completely different valleys and river catchments. Therefore, precipitation measurements are necessary and decisive in such sensitive areas.

This leads to the next complex task – data collection. Water gauges



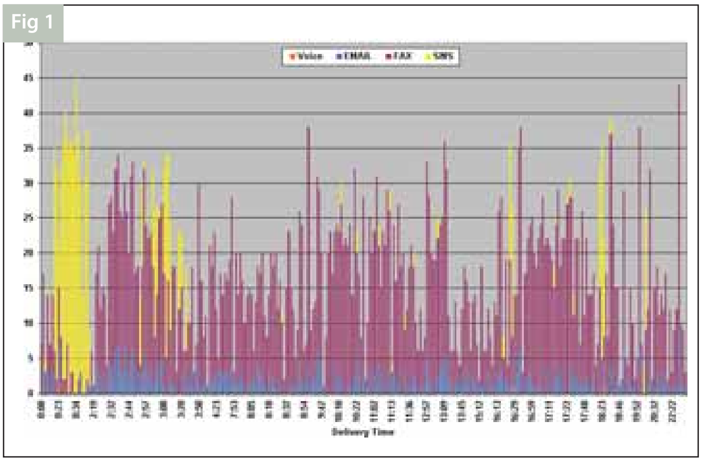


FIG. 1: Delivery log channel

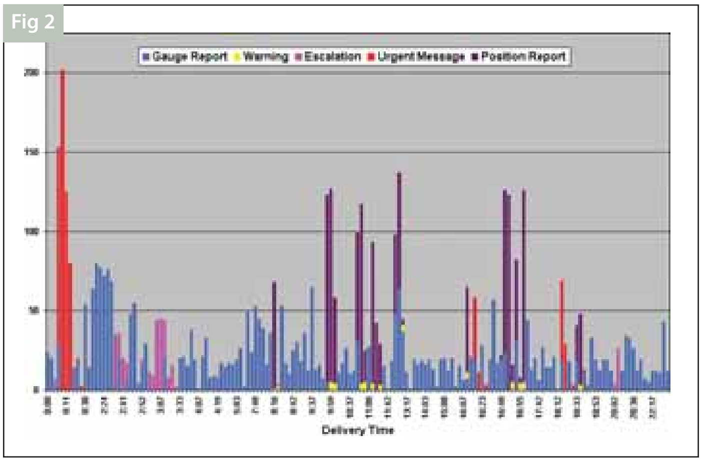


FIG. 2: Delivery log messages

were installed or rebuild after the last flood measuring water levels and in some cases also water discharge. These measurements have to be collected automatically at short time intervals, e.g. every 15 minutes and runoff data have to be computed. As rivers and river systems usually pass different administrative borders a quick and comprehensive cross border data exchange has to be established. In some areas additional human observers are integrated into the information process. These observers look after a water pole and take additional measurements to ensure the quality of all electronic measurements. During past flood events in some cases human observers had to take over completely and provide the measurements since whole measuring stations were flushed away. They can also provide additional observations on water discharge like icing or flotsam washed ashore.

In an early high water warning system all these aspects have to be integrated into a fully automated data collection process so that no manual maintenance is required.

Monitoring

All measurements and observations from all stations have to be checked for measuring or data transmission errors so that only feasible data are stored and used for further processing and actions. A real-time monitoring system is used to check for limiting values, to trigger automatic alarm events and to visualize all necessary data. Based on actual precipitation and runoff data and time series of past days or weeks prognosis of future water levels can be computed.

In case of a threatening or genuine disaster it is important that the hydrologist on duty is provided with general overviews of complete river catchments as well as detailed views of the development of a flood in a specified area. He needs this information to enable him to compile a position report integrating the meteorological and hydrological situation and further developments.

Alerting and information delivery

As far as the information and communication process is concerned all data and information are available at this point. Now the decisive steps have to be taken: the information must be delivered to all persons concerned. As pointed out in the introduction an information and communication model has to be

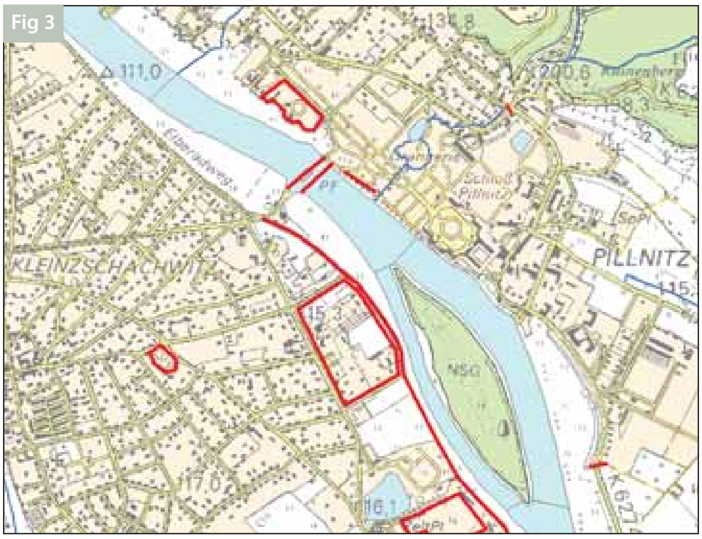


FIG. 3: Pillnitz, Germany

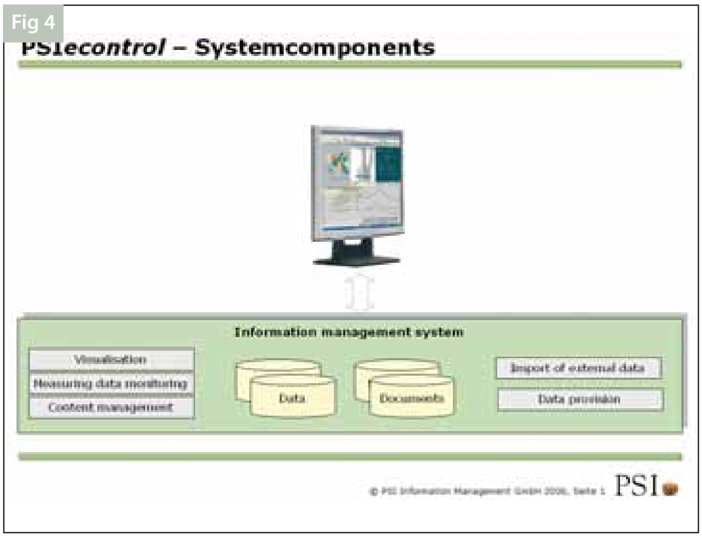


FIG. 4: System Control Components

established stating which information has to be delivered to whom.

Based on the definitions and experiences made in the German Free State of Saxony the following model is feasible, useful and approved. There are three main types of information or document:

- Management or position reports for each river catchment which cover the meteorological and hydrological situation and include recommendations for action.
- Water level reports which consist of a form containing actual measurements, trends and alarm levels on which to calculate the position.
- Urgent short messages which signal the first-time overrun of the alarm threshold and are replicated in case of transgression of further alarm levels.

The communication model in Saxony is based on the principles, that

- All local partners with responsibilities like mayors, fire or water brigades, police and other safety or rescue organisations receive directly the above mentioned documents where they cover their field of responsibility
- The receipt of an urgent short message has to be confirmed manually so it can be assumed that the content has really been read.
- In case an urgent short message is not confirmed within a defined time span escalation reports are generated and delivered to the supervisory authority.
- All information can be delivered via different and redundant communication channels like fax, email, SMS and voice.
- The public is informed by internet, fax, teletext and vocal announcements

This complex information and communication model can only be implemented when using a powerful and flexible software system which allows an adequate mapping of the defined processes. And complete automation of the information processes is the key to significantly speeding up the process of warning and alerting citizens and it is the basis of an early warning system.

Managing the flood – Emergency plans

The last step of the introduced information process consists of the assistance of locals responsible to manage the flood. In each area potentially affected by a flood action and emergency plans are compiled. These plans usually refer to alarm or water levels of a nearby water level gauge.

Having a communication infrastructure as mentioned above it is only a small step to store and maintain these action plans within a software system which automatically alerts recipient groups to execute predefined actions, e.g. road blocks or evacuation of vulnerable places at a certain water level. Again, actions can be monitored and controlled and manual feedback can be integrated into an information process.

Practice report in the German Free State of Saxony

The flood in 2002 did not only leave much damage behind in cities and the countryside in Saxony, it also destroyed the existing infrastructure used for flood warning. The flood warning system was literally flooded away. Up to that time Saxony had 3 flood warning centres that were responsible for different river basins. The need for a new technical infrastructure was a chance to renew the organisational structure and to introduce an absolutely new technical approach.

The Berlin based company PSI, one of the large independent software companies in Germany, implemented a completely new high water management system, called PSIecontrol. It consists of three components: a control unit, an information management system and a communication platform. The control unit polls all available control points automatically. Data can be exchanged via voice, web or WAP with enablers on site. The information management system is the core of the whole system where all data and documents are stored in redundant and fail safe systems. Here analysis, plausibility checks and monitoring of data from all control points are automatically carried out. The communication platform is responsible for informing, and when appropriate, initiating an alarm to the appropriate person(s) dependent upon the detected values. Manual intervention is also possible if, for example, the operator can anticipate a hazard. Extensive configuration parameters enable very flexible choices as to which information should be conveyed when and to whom and whether it should be passed via fax, email, SMS or voice.

The system has been running since 2005 without any problems. In March and April 2006 there was another large flood in Saxony caused by snowmelt and additional precipitation. Within a few hours the water levels of many usually very small rivers rose and flooded streets, villages and landscapes. PSIecontrol managed to issue up to 120 parallel alarms and to deliver up to 8.000 documents within 24 hours.

With the use of a system like PSIecontrol the time span can be fully utilized: at the time the flood forecast recognizes an upcoming flood situation on account of river levels and precipitation the information process is set off automatically without any human interaction regardless of the time of day: all relevant persons are informed via their preferred communication channels. Thus the remaining time until the water arrives can be optimized.

Conclusion

The introduction of systems like PSIecontrol is less complex than defining the organisational boundary conditions. Building up a complete information and communication model is the key to introducing an early warning system and a prerequisite to implementing these conditions in a powerful software system. PSIecontrol is rather independent of these questions: due to its adaptability and upgrading functions it can be configured rather easily.

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