OPERATIONAL FLOOD FORECASTING FOR THE SWISS RIVER RHINE BASIN

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The Swiss Hydrological Survey of the Federal Office for the Environment (FOEN) has been drawing up operational water level and runoff forecasts for the River Rhine at Rheinfelden since the 1980s. These forecasts cover the following 72-hour period and provide information for each hour. This offers customers such as shipping companies that use the Rhine, hydro-electric power stations on the river and forecasting centres downstream an additional tool for planning their daily work. During flood situations these forecasts are of fundamental importance for local authorities in the planning of flood protection and emergency measures. The normal interval of one forecast per day can then be reduced to 2-hourly forecasts depending on the water level of the river.

The presentation will set out experiences of flood forecasting in the Alpine region of Switzerland with the illustration of recent events. Challenges within a complex hydrological system will be shown, possibilities and limits of hydrological forecasts as well as their quality and requirements for an operational service with respect to warnings and alerts will be discussed. The presentation is based on the experiences gained with the flood forecast system for the Swiss river Rhine basin, the water level forecasts for the Lake of Constance – an international collaboration with Baden-Württemberg and Vorarlberg. The FOEN elaborates hydrological forecast for the river Rhine basin which covers several Kantons and some tributaries. Consequently the local authorities of the whole region have one contact office and a consolidated forecast for that region. For the river Rhone and Ticino the corresponding cantons maintain their own forecasting systems.
For the meteorology new numerical forecasting models were developed in the recent past. These can be tested within the MAP D-Phase project, the presentation will therefore include the first results gained during the FOEN participation of that project.

FLOOD FORECASTS FOR THE RIVER RHINE

FOEN is today working with the third generation of forecasting systems, with the **F**lood **E**arly **W**arning **S**ystem – **FEWS-CH**. The system was developed by Delft|Hydraulics, responsible for the data handling with respect to editing, visualizing and database and the Swedish Meteorological and Hydrological Institute, responsible for the hydrological model HBV. The model is set up for an hourly time step and uses measured meteorological and hydrological data as well as the parameters obtained from deterministic numerical weather forecasting model COSMO7 from the Swiss Meteorological Institute.
FEWS-CH covers the entire area of the river Rhine basin until Basel including tributaries from Austria and Germany. The basin is divided into about 60 sub-basins. It covers areas subject to a high level of human influence (hydro power and reservoirs) and mountain areas partly covered by glaciers. It can also be used to calculate and therefore predict the volume of water flowing into Alpine lakes.

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Flood waves in Alpine regions are characterised by short forecast periods, rapid rises in water levels and sudden, marked flood peaks. The hydrological conditions in the Swiss Alpine areas like glacier cover, hydro-electric power stations, the transfer of water between different river basins and the regulation of runoff from Alpine lakes present special challenges for the precipitation runoff model.

INTERNATIONALLY COORDINATED WATER LEVEL FORECASTS FOR LAKE CONSTANCE

Since the spring of 2006, a system for forecasting Lake Constance water levels has been jointly operated by the FOEN, the Baden-Württemberg flood forecasting centre (HVZ) in Karlsruhe and the Water Management department of the Vorarlberg state government. This means that lakeside communities in all three countries are equally well informed about water level trends.
When water levels are low to medium, 7-day bulletins are issued daily by the forecasting centres: these comprise a forecast for the first day and an outlook for the remaining days.
In critical situations, the development of water levels can only be predicted for a 48-hour period. Because weather forecasts are less reliable under heavy precipitation conditions, water level forecasts are also less accurate. During these situations, a status report is issued jointly by the three countries. This includes current measurement and forecast data and information on weather conditions and snowmelt. A status report is also issued during extremely low water levels, as in the winter of 2005/2006.

RESULTS OF THE PARTICIPATION IN THE MAP D-PHASE PROJECT

With the input of deterministic numerical weather forecasts models into their hydrological forecasts models hydrologists come to limits. Local authorities that have to take measures against flood require information regarding uncertainty and probability. Hydrological forecasts are more and more required also for smaller catchments. For both requirements deterministic forecasts deliver insufficient information.
The FOEN therefore participates in the MAP D-Phase project. D-PHASE stands for "Demonstration of Probabilistic Hydrological and Atmospheric Simulation of flood Events in the Alpine region" and is a Forecast Demonstration Project (FDP) of the World Weather Research Programme (WWRP) of WMO. The MAP FPD takes place from June 2007 to November 2007.
It will address the entire forecasting chain ranging from limited-area ensemble forecasting, high-resolution atmospheric modelling (km-scale), hydrological modelling, and now casting to decision making by the end users, i.e., it is foreseen to set up an end-to-end forecasting system.
For the FOEN the main reasons to participate in that project are the given opportunity to test the newest meteorological numerical forecasts and win experiences with them and especially with the probabilistic forecasts. Additionally the FOEN aims at searching for new approaches to deal with the uncertainty of hydrological forecasts. Together with the end users – local authorities responsible for short term flood protection measures - solutions for the communication of probabilistic forecasts and uncertainty should be developed.

Keywords: flood forecast, warning, hydrological model