

Report on the International Conference on Flood Estimation

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The International Conference on Flood Estimation was held in Berne, Switzerland, in March 6-8, 2002. Participants were 280, coming from 40 countries all over the world (with major participation of European countries). Eighty-one communications were scheduled during the 3 days : **Europe : 64** (Albania : 1; Austria : 3; Croatia : 1; France : 2; *Germany* : 12; Ireland : 1; Italy : 6; Netherlands : 3; Norway : 1; Romania : 1; Slovakia : 2; Spain : 1; Sweden : 1; *Switzerland*, 26; UK : 2); **Asia : 11** (Indonesia : 1; Iran : 3; Japan : 2; Malaysia : 1; Nepal; Russia : 2; Uzbekistan : 1), **Oceania : 4** (New Zealand : 4); **North America : 2** (Canada : 2), while 16 posters were exposed. In a general way, communications in all forms were of very good interest.

Objectives of the conference were to bring new solutions in flood estimation, and also to improve the links between scientists and practitioners. During the opening address, it was pointed out that in Switzerland, flooding damage has been increased by 8 in the last three decades, and has reached up to 8000 millions of CH francs (6 billions of euros) in 2000.

Conference was divided in 4 topics :

- Modelling and regionalisation (41 communications)
- Process analysis as a basis of flood modelling (28)
- Extreme value statistics (9)
- Flood measurement techniques (4)

However, many communications dealt in fact with two or more topics and will be reported according to a different classification. As both Prof. Weingartner and Prof. Schumann said during the final session, the conference gave an overview of both the method and the recent advances in flood estimation, whether it concerns flood design or flood forecasting. Concerning flood design, the method directly depends whether data are available or data are not available. In the first case, methods are directly based on flood statistics or/and rainfall-runoff modelling ; in the second, they are based on regionalisation of the statistics fractiles or the model parameters. In some cases, alternative or paleo-historical data should be considered in order to improve the estimations. Much attention was paid to flood forecasting, which received a lot of recent advances due to the development of atmospheric models and meteorological forecasting : experiences from different countries have been presented, and allowed to appreciate the results and the methodological problems as well. Some other aspects have also been considered, such as impact of climate change, remote sensing applications, analysis of uncertainties, economic losses.

Extreme values statistics is a very classical way in estimating design flood, provided discharge data are numerous enough. Communications have been dealing with improvement of the at-site distributions, influence of the seasonality, use of bivariate distributions of discharge-volume, relationship between precipitation and discharge distributions.

Concerning at-site distributions, improvement of parameters estimation can be brought through a Bayesian approach in order to use all available information (historical outstandings

and complete time-series) : an example is given for the river Rhine, where classical and bayesian approaches are compared (Chbab et al.). Using bivariate densities may be interesting to fit the distribution of floods downstream a confluence, whose two tributaries have uncorrelated or low-correlated regimes : this is the case of the french Loire-Allier confluence (Le Clerc and Lang). Two-Components Extreme Values (TCEV) statistical law has been used in New Zealand (Pearson).

Seasonal flood probabilities have been examined for several rivers of New Zealand, and differences with probabilities on annual basis may be operationnaly important (Painter). Seasonality of precipitation and floods was investigated in Southwest of Germany, and was found to be crucial for a more reliable estimation of design floods (Steinbrich et al.). In North Italy, indicators of seasonality should be considered in order to enhance subddivision in homogeneous areas initially based on topography and orography (Castellarin and Brath).

Design flood should not only account for peak flow, but runoff volume, which can be done by analysing and extrapolating bivariate densities : an example is given for estimating the design flood of El Infiernillo dam in Mexico (Ramirez and Aldama).

Flood quantiles may be derived directly from those of precipitation time-series. Examples are given using auto-regressive models in Switzerland (Capkun et al.), the so-called gradex method in Austria (Merz and Blöschl), POT analysis of daily data in Italy (Claps).

Rainfall-runoff modelling is widely used when discharge data are not numerous enough. Very different types of models have been presented, from almost all the participating countries : lumped or distributed, conceptual or physically-based models. Communications focused many aspects, like comparison between extreme statistics and rainfall-runoff modelling, recommendations in order to better calibrate the models, operational distributed models, improving modelling through processes study....

Flood estimation using extreme value statistics or using rainfall-runoff modelling coupled with historical rainfall data was compared in France (Perrin et Michel). Similar studies, using a rainfall simulator, were made in Norway (Skaugen et al., 41), in Italy (Brath et al.), on the River Rhine (Eberle et al.). Comparisons are highly dependent on the duration of the time-series on the one hand, and on the reliability of the model on the other hand.

From a methodological point of view, it is known that conceptual models need to be calibrated. Some communications show that it does not guarantee the extrapolation towards the rare floods, or that interpretation of parameter can be greatly affected by equi-finality. Thus, calibration of the HBV model in Sweden is more reliable if trial/error procedure done in heterogeneous periods -"dry" and wet conditions (Seibert). In the same communication, the author recommend that alternative data, here groundwater levels, should be used. In UK, regionalisation of a rainfall-runoff model parameters is better performed if the calibration of the model is done step by step, through an iterative procedure starting from the most sensitive parameter (Lamb and Calver). Study of nested mountainous catchments shows the spatial variability of the flood characteristics at small scale in Switzerland (Liener et al.) and in Nepal (Dangol et al.).

Examples of modelling concepts were the lumped lag and route Clark-WSL, with application in small catchments of Switzerland (Vogt et al.), a storage model in Indonesia (Susilo and Prayogo), and overall semi-distributed or distributed GIS-based conceptual models (although some of them are titled "physically-based"). This kind of model, which accounts for the spatial variability of both rain and geographical characteristics of the catchment, was found to be able to improve a lot the quality of the results and the reliability of the extrapolation towards the rare frequencies. It remains easy to calibrate and might constitute a convenient tool in an

operational purpose. Examples were proposed in the alpine regions (Kuntner and Burlando), (Dubois et al.), in Nepal (Shrestha et al.), in Italy (Todini and Liu).

However, some fundamental processes should be better taken into account. Studies of such processes have been presented, and might greatly contribute to improve the conceptual rainfall-runoff model. Soil moisture evolution was characterized in time and space by TDR measurement in small swiss catchments (Joerin and Musy). In the same communication, contributions of rainfall, soil water and ground water to the floods were separated using silica-calcium environmental tracing. Other similar study is based on the isotopes of water molecules (Schotterer et al.). Infiltration data at the plot scale were obtained in Austria (Kohl and Markart) and in Switzerland (Scherrer), and show some tendency that infiltration rate grow with rainfall intensity. Non-linearity of discharge routing need further investigation : experimental simulations led to discuss accuracy of kinematic wave and diffusion for unsteady flood process in natural channels (Moramarco and Melone).

For large scale, physically-based models have also been presented. Applications of such models concern the effect of retention measure on the flood conditions of the river Rhine (Lammersen et al.; Herpertz et al.), flood forecasting or climatic change (see further).

Regionalisation studies were of course one of the predominant theme of the conference. Experiences were reported from a broad range of countries : Europe (Albany, Austria, Croatia, Germany, Hungria-Rumania, Slovakia, Switzerland, UK), Asia (Indonesia, Iran), Oceania (New Zealand), and gave a very large overview of what is or can be done today.

Methods of regionalisation may be different. Some are looking for homogeneous areas by using L-tests of the distributions of floods : examples were shown in Slovakia (Kohnova and Szolgay; Solin), in New Zealand (Pearson). Ability of geostatistical method (ordinary kriging without nugget or with nugget, ordinary kriging with uncertain data) for mapping flood index was studied in Austria (Merz and Blösch). Most of regionalisation studies are obtained through relationships between the basin characteristics and indicators of flood, like quantiles (Neff et al.; Ashkar and El-Jabi) or parameters of rainfall-runoff model (Niggli et al.; Lamb and Calver). SCS-curve number method has been adapted in Swizerland (Kuntner and Burlando), from measurement of infiltration on experimental spots.

Formulas and synthetic methods (rational formula, index flood, but many others) are still very popular for small and medium catchments and were adapted in a lot of local conditions, in Taiwan (Cheng and Lin), in Switzerland (Forster et al.). As mentionned by the authors, these methods remain very uncertain, and must be compared or combined in order to get some estimation of the reliability of the estimations. A weighted combination of both flood index method and rational method is suggested in Switzerland (Niggli et al.).

A regionalisation of the outstanding floods in Europa was also performed (Stanescu). The author recommends an international cooperation in order to make the data more exhaustive.

When discharge time-series are not available, **alternative data** should be better considered to improve flood estimation. Paleo-historical flood data were shown to perform well in a small spanish catchment (Rico and Benito). Prediction of flood occurrence based on rainfall erosivity was analysed in Malaysia (Roslan and Janmaizatulriah).

A lot of communications reported on experiences in **flood forecasting**, coming from Bangladesh , Canada , UK, Switzerland, Germany. In some cases, forecasting is made at very large scale, like the EFFF European Flood Forecasting System.

If not using meteorological forecasting, flood forecasting may be effective at the catchment lag time duration, as it was presented for large catchments in Asia (Herath and Dutta).

Most of the forecasting systems make use of the mesoscale weather forecasting systems. Those are for example ECWCF (Swiss), MC2 (Canada), MESO-Nh (France), BOLAM3 (Italy), which have spatial resolution varying from 1x1 km² up to 14x14 km². They are then coupled with distributed physically-based catchment models, like LISFLOOD, WATFLOOD (Canada), WaSim-ETH (Suisse), FGMOD (Germany). Performances of forecasting systems were analysed in Canada (Kouwen and Benoit), in Switzerland (Jasper et al.), in Germany (Frei et al.). Influence of the resolution grid and interpolation method was discussed (Gerlinger et al.).

Long-term forecasting for snowmelt prevailing processes was carried out using model of snow cover formation and scenarios of temperature. Examples were shown in Uzbekistan (Baumgartner et al.) and in Germany (Kleinn et al.).

Stationarity of flood time-series has been analysed in regard with **climatic fluctuations** : one communication links flood occurrences since 1947 in New Zealand to the relative frequency of El Nino and La Nina (McKerchar), other one shows a decadal scale variability from historical data during 1500-2000 in Central Europe (Wanner)

Impact of temperature elevation on flood estimation was simulated for the Rhine basin. Change in snowmelt and shift from snowfall to rain were considered using a coupled climate-runoff model (Kleinn et al.).

Remote sensing data applications were presented : flooding zones can be readily estimated by using SAR and InSAR data (Wiesman et al.); ERS, RADARSAT or NOAA-AVHRR may help to measure spatially soil moisture and snow cover, with the temporal frequency required (Schulz et al.). In both communications, improvement is expected when ENVISAT will be operative. Light Detection And Ranging (LIDAR) technology has proved to provide accurate DEM, and to be an efficient support for developing flood risk map in the Llobregat River, Spain (Ruiz et al.).

To deal with **uncertainties**, complex deterministic models should be represented by equivalent stochastic simple model, in order to reduce computational effort. After appropriate calibration, the simple stochastic approach allows a large number of simulations in a Monte Carlo framework, as it was shown for the Rhine river (Merz et al). Other study compared predictive uncertainties on flood inundation modelling using 1D or 2D model, through the GLUE procedure (Werner). Application of GLUE was also shown on both small and large catchments in Czech Republic (Blazkova and Beven). In UK, approximate confidence intervals of the floods derived from the regional estimates of rainfall-runoff parameters can be constructed by Monte-Carlo methods (Lamb and Calver).

Some studies have reported about **economic losses** in UK (Rodda et al.), in Germany (Kron and Willems), in Austria (Merz et al.). **Aspects of education and information** were shown in Sri Lanka (Seneviratne).

Conclusions :

Recommendations at the end of the conference were the following :

- Choose or develop accurate measurement of floods among classical (moulinet, dilution) and modern (radar, doppler) methods
- Improve calibration of the rainfall-runoff model, accounting for dependence and multi-collinearity of the parameters
- Combine different models in order to estimate uncertainties.
- Develop uncertainty analysis in a Monte-Carlo framework
- Use historical or alternative data
- Develop process study, in order to define more accurate conceptual models
- Use bivariate distributions for design flood: discharge, but also shape, volume
- Analyse the stationarity of the time-series; does climatic change affect flood extreme values ?
- Develop data bases in order to guarantee free and holistic data access

Proceedings of the Conference will be available in November 2002. Further information can be found on the web site : <http://hydrant.unibe.ch/veranstaltungen/flood/flood01.htm>

List of prospective institutions/contact persons who could reinforce the implementation of FRIEND (please apologize if they already do !):

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