WORLD METEOROLOGICAL ORGANIZATION

WEATHER, CLIMATE AND WATER

REPORT OF THE

EUROPEAN EXPERT MEETING ON

ENHANCED FLOODS FORECASTING

(Bratislava, Slovakia, 12 – 14 December 2005)

1. OPENING

At the kind invitation of the Slovak Hydrometeorological Institute (SHMU), the European Expert Meeting one Enhanced Floods Forecasting was held in the Hotel Tatra in Bratislava (Slovakia) from 12 to 14 December 2005. The meeting was attended by 60 experts in representation of 28 hydrological, meteorological and hydrometeorological services from the Regional Association VI Europe.

The meeting was opened by Dr Čubrík, representative of the Ministry of Environment of Slovakia. He welcomed the participants to Bratislava and appreciated WMO's initiative to organize this important event in Slovakia. He underlined the importance of the topic of the workshop, as flood prevention and flood forecasting is essential to save life and protect property. He also stressed the need for international cooperation to strengthen and ensure successful implementation of early warning systems.

Dr Čubrík underlined the primary interests of the countries should focus on reliable flood forecasting and warning system to protect the well being of their citizens. He added that WMO had a long tradition on flood activities and appreciated its support its Members in this field.

Mr M Tawfik, on behalf of Mr M. Jarraud, Secretary General of the World Meteorological Organization, added his words of welcome to the participants and thanked the SHMU for hosting the meeting. He highlighted the importance of the availability and proper use of accurate and timely meteorological and hydrological forecast products to effectively prepare and respond to the various flood related disasters and to assist the disaster management authorities in taking the appropriate response actions.

He informed the meeting about WMO plan to organize a series of regional workshops to bring national experts from meteorological and hydrological services to discuss problems and offer solutions in issues related to strengthening the flood forecasting in theirs countries. He added that the conclusions and recommendation of these regional workshops will provide an input to an international conference to be organized by WMO in 2006 / 2007. He thanked the participants and wished them a successful meeting.

Mr P. Rončák, Director General of SHMU and Permanent Representative of Slovakia with the WMO, added his words of welcome to the participants. He underlined the importance of integration of hydrological and meteorological techniques for improving timeliness and reliability of flood forecasts and optimising the use of resources. He also invited the participants to be provocative in their presentations, bringing in new topics to the discussion and presenting positive and negative aspects of new technologies. He expressed his expectation that the workshop would enlarge the horizons of participants and provide them with new ideas and suggestion for their work.

2. ORGANIZATION OF THE MEETING

The meeting agreed on its agenda and on the working hours. During the meeting country reports and technical/scientific contribution were presented and round table discussion were held.

3. TECHNICAL SESSIONS

3.1 First session (chair: Ms K. Hajtášová)

3.1.1 Existing Hydrological and Flood Forecasting Practices (Messrs P. Rončák and M. Benko,)

Floods and mainly flash floods are very important issue in the Slovak Republic, similarly to other countries in the region. There is a great need to receive the correct and fast flood forecasts by the flood management bodies. To fulfil such requirements a Flood Forecasting and Warning System has been established at the Slovak Hydrometeorological Institute. This system combines product and information from both meteorological and hydrological services. Different tools and methods are used to produce the flood forecasts and warnings as NWM, QPF, Remote sensing, hydrological and statistical models and other approaches.

Nowadays, there are activities to improve this Flood Forecasting and Warning System in such a way that the stakeholders should benefit in both flood management and risk management. Specifically, this will be done by implementing the following actions:

- completion of the telemetric terrestrial stations network
- completion of the weather radars network and lightening detection system
- commissioning of a new meteorological satellite receiving station
- upgrading of the communication system
- upgrading of the meteorological forecasting models
- development of the special hydrological forecasting systems (shells) for all 11 main catchments
- development of the flash floods warning methodology
- development of the new methods of the data processing and dissemination

3.1.2 Albania (Messrs M. Kolaneci and M. Marku)

Flooding is a frequent problem in Albania, due to the combination of sudden changes in river slope from the mountains to the plains, and heavy rains in wet period.

The hydrometeorological monitoring system is not in appropriate conditions to ensure sufficient amount of data necessary for hydrological forecasting. Only a simple warning system for the river water levels is presently operational, based on phone calls. Meteorological forecast is available for flood forecasting activities, most of the time as a support during emergency situations in form of 3-day forecast, especially 3 hours accumulated rainfall. The main numerical models in use are the Meteo-France model, Arpege, and its limited area version, Aladin/SI, which is run in Slovenia.

The Albanian Hydrometeorological Institute provides regularly to the Directorate for Civil Emergency Planning and Response under the Ministry of Interior informative reports on weather forecast and the water level of the main rivers when they reach critical values.

The most important problem in the frame of hydrological forecast is the improvement of hydrometeorological observation and transmission network.

3.1.3 Austria (Messrs R. Godina and T. Haiden)

Austria has a federal structure with nine provincial states. According to this structure the responsibility for the flood forecasting was assigned to the local Hydrological Services.

The Hydrological Service and the Central Institute for Meteorology and Geodynamics (ZAMG) are separated and organized in different form. The precipitation forecasts come exclusively from the Meteorological Service (ZAMG).

The severe flood events in spring and summer 2002 prompted activities regarding flood risk evaluation at country level and improvement and upgrading of flood forecasting models.

A new generation of flood - forecast models (conceptual water-balance rainfall-runoff models combined with flood routing models) was subsequently developed; and some of these are expected to become operational soon.

The Central Institute for Meteorology and Geodynamics (ZAMG) has improved the researches in the field of the precipitation forecast. An algorithmic synthesis (integrated nowcasting through comprehensive analysis) is applied for the nowcasting prediction. All available data sources (model results, observed precipitation data, radar- and satellite data and high resolution topografic – surface information) are used for this procedure. For longer-term forecasts a combination of the ALADIN-Vienna and the ECMWF model results with a different spatial-weighting is in operation.

For running these models, there are sufficient ground observations available, although the accessibility to these data during extreme events is still a problem. Furthermore improvement in quantitative precipitation forecast is necessary. To face these shortcomings the following activities are required:

- The radar system needs to be technically improved.
- There is need to improve the exchange of data.
- A reliable data transmission within a country, among institutions and agencies, and among countries is very important.
- Standardized approach for data management and visualisation and dissemination of data must be prepared.
- Sufficient financial (technical equipment) and personnel resources (trainings) must be provided for all these activities.

3.2 Second session (chair: Mr G. Balint)

3.2.1 Development of Hydrometeoroloogical And Hydrological Instruments For Flood Forecasting (B. Rudolf and A. Vogelbacher, Germany)

Since January 2005, gridded precipitation data sets of 1 km resolution are created in near real-time on an hourly routine basis for the territory of Germany based on the composit of 16 radar and 900 surface stations (RADOLAN = online adjusted radar).

The current NWP model system of DWD consists of the own global model (GME, ca. 40 km resolution, forecast up to 7 days) and the nested limited area "Local" model (LM, 7 km resolution, forecast up to 72 hours). In addition, ensemble predictions are used in a quasi-operational mode (ECMWF-EPS, COSMO-LEPS and SRNWP-PEPS). The model chain is in the process of being enhanced by the introduction of LME, offering a 7 km resolution for a larger model area covering most of Europe, and the LMK, designed for high resolution (2.8 km) shortest forecast (from 2 to 18 hours).

With respect of heavy precipitation, a radar-based now-casting has been developed to cover the first 120 forecast minutes with 1 km resolution. Finally, the hydrometeorological model "SNOW-3" is used to calculate the total water release from snow melt and rainfall for the next 48 hours.

Flood warning and flood forecasting is operated by the water management authorities of the federal states. Therefore organizational structures are not uniform across the country. In Bavaria a meteorological and hydrological information system and database with a fully automated data communication system has been created during the last five years. The measuring and communication systems have been equipped with redundancy.

Flood forecasting models based on precipitation-runoff models (LARSIM) and hydrodynamic flood routing models have been developed, verified and adopted. Operation of the forecast is done in five forecast centres corresponding to the basins of the main rivers, which operated successfully during the flood in August 2005. This flood also showed the necessity to improve the accuracy of the forecasts, the quantification of flood discharges, and the communication between the forecasting centres and the local authorities.

3.2.2 Azerbaijan (Mr S. Khalilov and A. Verdiyev)

Azerbaijan lies in the easternmost part of region RA-VI in the South Caucasus. The principal river systems are the Kura river and its tributaries, and Araz and Alazan (Qanich) rivers that flow directly into the Caspian Sea. There are overall more than 8300 rivers in the territory of Azerbaijan including small shallow rivers.

The government body responsible for issuing hydrological forecasts and warnings is the National Hydrometeorological Department (NHMD). NHMD issues daily, decadal, monthly and seasonal hydrological forecasts. There are no meteorological and hydrological models in use therefore simple statistical methods are in use for producing hydrological forecast. In 2003 nevertheless NHMD gave very effective and accurate forecast about spring floods, which caused seriously damages.

In 2004 the President of Azerbaijan Republic signed a Development Programme for Hydrometeorology in Azerbaijan until year 2010. In this Program hydrological forecast has important place.

3.2.3 Belarus (Ms V Fiadotava and M. Nahibina)

Belarus is located on the watershed of several river basins such as the Dnieper, the Neman, the Zapadnaya Dvina , the Bug, the Pripiat. In spring severe floods occur almost every year. The region most exposed to flood risk is the basin area in the middle and lower course of the river Pripiat, which is the most full-flowing tributary of the Dnieper.

The depth of flood on Pripiat is mainly 0.3-0.8 m, but sometimes it comes up to 2-2.5 m. The breadth of the inundated area varies from 5 to 15 km; the largest one comes up to 30 km in the Pinsk district. One of the most grievous floods on the Pripiat was in spring 1999.

In Belarus the National Department of Hydrometeorology carries out monitoring of meteorological and hydrological conditions.

The observation network consists of :

- 49 meteorological stations;
- 2 upper-air stations;
- 3 radar meteorological stations.
- 132 hydrological stations and water gauges

The National Hydrometeorological Centre is the only agency in Belarus that provides meteorological and hydrological forecasts and warnings nationwide Weather and flood warnings and forecasts are prepared and issued by the Hydrological and Meteorological Forecasts Divisions under the Forecast Department

Warnings are communicated to Governmental Agencies, Ministry for Emergency situation (rescue services), companies, enterprises and populations. They are provided for the users via the Centre’s Internet site www.pogoda.by.

3.2.4 Recent Advances In Operational Flood Forecasting, Strength And Challenges (P.C. Røhr and J. Smits, Norway)

The Norwegian Snow Map System and the Dynamic Flood Forecasting Map (DFFM) are two recent advances in the national Flood Forecasting service.

Based on observed temperature and precipitation, the Norwegian Snow Maps system simulates the daily snow balance in a 1x1 km2 grid from 1971 up to date. Based on the simulation, thematic maps for snow water equivalent related to normal conditions, rank of years, change last week, runoff and others are calculated for each day. The maps are updated weekly based on observations. In between, daily maps are simulated based on daily weather forecasts.

The DFFM is a system coupling hydrological forecasting-, hydraulic- and digital terrain models producing daily maps forecasting inundated areas for selected sites the coming 6 days. It can also indicate the water level along levees and rivers. The system gives an overview and description of a flood situation before and during an event and improves the communication between the flood forecasting service, the local emergency services, press and public.

In Norway the meteorological and hydrological service forming the National Flood Forecasting Service is distributed between to different institutions under two different ministries. An agreement of co-operation exists between these two institutions.

The process of collecting meteorological and hydrological data, producing meteorological forecasts and producing hydrological forecasts is fully automatic. The meteorological data and forecasts from the Norwegian Meteorological Institute (met.no) are transferred automatically to the Norwegian Water Resources and Energy Department, NVE. NVE pay a fee to met.no for the additional work necessary for supplying NVE with the necessary data and forecasts.

The automatic processes are continuously supervised by qualified personnel who manually produce the actual warnings based on the results from the simulations. Beside, products for improving and facilitating the different operations are developed continuously.

3.2.5 Bosnia and Herzegovina (Ms E. Kupusović and Ms S. Hadžić)

The existing observation and data transmission networks in Bosnia and Herzegovina do not provide an adequate basis for carrying out flood forecasting and warning activities. Network coverage and data exchange is limited and the rehabilitation of hydrometeorological station network is necessary, especially on the upper parts of catchments; there is also need for installing of one or two meteorological radars to provide adequate coverage. The automation of the key meteorological and hydrological stations with real time data transmission and on the harmonization / standardization of the equipment and measuring methods are the highest priority actions together with the upgrading the existing telecommunication system, as well as of the computer facilities

Until present Bosnia and Herzegovina has not operated any hydrological forecasting model, nor does it have any practical experience in using such models. Inn order to achieve a satisfactory level in forecasting and warning there is need for development / improvement of hydrological and meteorological forecasting models supported by capacity building activities including staff training with particular emphasis on hydrological forecasting capabilities

3.2.6 Bulgaria (Mr D. Dimitrov and Ms P. Dimitrova)

The introduction gives short information about the National Institute of Meteorology and Hydrology (NIMH) as hydromet service and expert body. NIMH operates 40 Synoptic stations with professional staff and 100 climatic, 290 precipitation and 204 river stations with voluntary staff. Most of the stations are with manual observations, the precipitation totals are measured once, while the river levels twice per day.

The floods in 2005 were very intensive and affected about 80% of the rivers in Bulgaria. The crisis conditions according to [2] were concentrated mainly within the following four periods: 1. Intensive rainfalls hail and wind from 25 May to 12 June; 2. Continuous torrential rainfalls from 01 to 12 July, which at some places were up to 249l/daily; 3. Torrential rainfalls covering large territories from 04 to 07 August varying between 160 and 234 l/daily; 4. Very difficult situation was created from 19 to 25 September as a result of torrential flash floods and storms reaching 288l/daily.

The season of occurrence, the duration and the intensity of the event was quite extraordinary. By the use of different statistical methods is shown that the return periods of the peak rainfalls are higher than 1000 years.

NIMH is using nowadays rainfall forecasts of the German DWD – HRM and French Meteo France ALADIN HIRLA Models with 48 lead time, with spatial resolution 10 – 12 km. Based on that an indicative hydrological forecasts are isuued every day for 18 hydrometric stations.

To improve the performance and accuracy of its hydrological forecasting and flood warning system Bulgaria needs:

- Use of the ensemble rainfall forecasts of ECMWF with 8 – 10 days lead time. For that purpose Bulgaria need to become an ECMWF member;
- Investments in delivery and set-up of a modern rainfall and river level monitoring system with automatic telemetric data transmission;
- Introducing in the operational hydrological practices of up-to-date hydrological forecasting models.

3.3 Third session (Chair Mr M. Benko)

3.3.1 European Flood Alert System - EFAS (J. Thielen, JRC)

The European Flood Alert System (EFAS) is being developed and tested by the European Commission DG Joint Research Centre. EFAS is aimed at increasing preparedness for oncoming flood events both for the European Commission Services and the National Hydrological Services (NHS) by providing early flood warning information between 3-10 days in advance. EFAS forecasts are based on several medium-range weather forecasts as well as full sets of Ensemble Prediction System (EPS) from ECMWF and are aimed at complementing the short-term flood information from the NHS. How to extract the relevant information from the flood ensemble predictions and how to communicate it to the operational forecasters in the National Hydrological Services is part of the research activity which is conducted in close collaboration with the National Hydrological Services.

Since the beginning of 2005 the JRC has established a network of EFAS partners through Memoranda of Understanding. The network serves as a platform of information exchange on research and operational practices through the organisation of workshops and visiting researchers. Data exchange for research purposes remains one of the major challenges for the EFAS project. Flood information reports sent out by the JRC to the EFAS partners, so far for eight different flood events during 2005, have been perceived as useful early warning information by the NHS.

3.3.2 Croatia (Messrs K. Pandžić and D. Trninić)

Among the main tasks in Meteorological and Hydrological Service (DHZ) of Republic of Croatia is the provision of hydrological forecasts. At present DHZ doesn't have in operational practice advanced hydrological simulation and forecasting models. Only regression models are operational with which the peak of the water wave and approximate time of transit of the wave can be forecast. The model is using forecast or actual precipitation on the Sava near Zagreb and Kupa near Karlovac.

For identification and verification of forecasting models, their sensitivity, reliability and practical use, NMHS does not have much experience because it doesn't have developed service for hydrological forecasts.

With the Accident Emergency Warning System (AEWS), Principal International Alert Center (PIAC) in Zagreb, and by using the Danube Basin Alarm Model (DBAM) it is possible to predict the diffusion of polluted water wave along the stream flow, and other parameters such as concentration and time of arrival of pollution at some point of the stream flow.

Croatia has prepared entry data and it will become member of European Flood Alert System-EFAS [LISFLOOD ALERT] and in that way it will be able to gain results of the forecasting model.

3.3.3 Estonia (Ms I. Vahter)

Most of the Estonian rivers are short and present low flow rate. Estonia hasn't experienced any severe river flood, causing extensive damage, for a long time therefore there is no major interest in river flood forecasting. Daily hydrological real-time data, used for forecasts, contains: water level, precipitation, air and water temperatures, ice condition information (in winter). Forecasts produced regularly are: spring flow forecast and seasonal ice forecasts for the main rivers and lakes. Flood warnings and daily hydrological forecasts have not been made in recent years. Daily water level of main rivers can be found at the home page of Estonian Meteorological and Hydrological Institute (EMHI) (www.emhi.ee).

EMHI is responsible for surface water monitoring in Estonia. The duties of Hydrological Department are: data collection, processing, development and maintenance of hydrological database, also data analysis. Hydrological forecasting group issues forecasts using the operative data obtained from network. Official flood hazard maps are not available. There is a need for updating critical water levels (updated last time in 1989).

The main problems preventing flood forecasting are: a) lack of hydrological information in real-time format, b) low priority for hydrological activity, c) maintenance of data archive, fast data access, data availability d) lack of trained specialists in new technologies.

3.3.4 Finland (Mr M. Huttunen)

A watershed simulation and forecasting system is widely used in Finland for simulation of hydrological cycle and for making real-time forecasts. The system is based on watershed model, which is originally the HBV-model and simulates the hydrological cycle using standard meteorological data. The model simulates the whole land area of Finland, including cross-border watersheds, covering a total area of 390 000 km2 divided into 6200 sub-basins. The inputs of the model are precipitation and temperature and the simulated components of hydrological cycle are snow accumulation and melt, soil moisture, evaporation, ground water, runoff and discharges and water levels of main rivers and lakes. The input temperature and precipitation comes from 54 real time temperature observation station, 179 precipitation observation station and from the weather radar network, which covers almost all Finland.

The data assimilation algorithm of the model updates the simulation by assimilating real time water level and discharge observations from 487 stations together with snow water equivalent observations from 158 stations and satellite data of snow cover area and flood cover area. The model uses ensamble weather forecast from ECMWF. The hydrological forecast is made by simulating the model with 42 different 10 day weather forecasts after which is used historic weather data to make a 1 year long hydrological forecast. Out of 42 hydrological forecasts a mean forecast is selected and together with mean forecast the uncertainty limits of the forecast is shown. Hydrological forecasts for over 1300 rivers and lakes is updated several times a day and provided for the users via public www-pages at www.environment.fi/waterforecast. In the case of serious flood an automatic e-mail warning is sent to flood protection officers.

3.3.5 Enhanced Flood Forecasting Through the Use of Downscaling and Uncertainty Assessment (J. Høst-Madsen, Denmark)

A good flood forecasting practice requires forecasts to be: Accurate, reliable, provided fast, relevant and timely, easy to understand. Uncertainties are inherent in flood forecasting processes and therefore it is a challenge to quantify the uncertainties and evaluate the possible effects on decision making. DHI Water & Environment has developed an advanced Ensemble Kalman Filtering approach in MIKE 11 which allows for accurate estimation of forecasting uncertainty. A major source of uncertainty arrives from the meteorological inputs to flood forecasting models. Through the use of a flexible, low-cost and high-resolution operational weather forecasting system (THOR), the EU research project FLOOD RELIEF has tested the downscaling of meteorological information for use in operational flood forecasting systems like e.g. MIKE FLOOD WATCH. It is evident that the combined use of Ensemble Kalman Filtering together with downscaling of meteorological rainfall prediction can improve the quality of the flood forecasting information and assess the uncertainty related with the forecasts. The technologies are now being implemented in many MIKE FLOOD WATCH forecasting applications world-wide.

3.3.6 France (Ms F. Martini et A. Poyet)

In France law called “loi risques” sets the responsibility of the State for flood monitoring and forecasting on the largest rivers. In the framework of the new flood prevention policy of the Ministère de l’écologie et du développement durable (MEDD), a new system of organising the operations of flood forecasting is being progressively implemented since 2002. It consists of 22 flood forecasting centres (SPC) distributed all over the country. The SPCs are responsible for monitoring and forecasting floods on river basins. A national centre for hydrometeorology and flood forecasting (SCHAPI) has been set up in 2003. SCHAPI provides some technical support to the SPCs and is responsible for producing a flood vigilance map, together with the SPCs aiming at providing the level of risks of flood in largest watercourses in France.

Concerning the weather forecasting Meteo-France elaborates a meteorological vigilance map aiming at informing the civil security services and the public about the danger of meteorological phenomena that are foreseen.

These two procedures have the objectives to improve the anticipation of severe phenomena to allow the civil authorities to react in time, and also to largely inform on the danger associated to the event. The co-operation between the State (MEDD), and Meteo-France is organized through a framework agreement that sets the contribution of each organization for the flood forecasting improvement. Meteo-France and the SPCs and the SCHAPI have close co-operation for using and maintaining observation networks and data exchange, and for models improvement.

So far, this co-operation has proved its fruitfulness. For the future, a study is currently carried out on the opportunity and the possibility to elaborate a unique and unified vigilance procedure which would combine meteorological and hydrological information.

3.3.7 Hungary (Messrs G. Bálint and I. Bonta)

The existing practice and development of the system of flood forecasting is determined by the geographical situation of the country. The country ranks high on the world list of regions exposed to flooding, a substantial part of the country surface (24 000 km2 equal to 26%) being classified as flood plains, out of those 97% are protected by flood embankments. Namely less than 800 km2 remained for the streams and their active floodplains serving as flood berms or flood routes. Most of the Hungarian rivers originate outside of the country and 97% of the flow arrives from neighbouring countries. This makes international cooperation within the Danube Basin utmost important for Hungary and it is the basis for any operational hydrological activity especially for flood forecasting and warning.

The major task of the flood forecasting service maintained on a shared basis by VITUKI National Hydrological forecasting Unit and hydrological units of 12 water directorates to serve the management of the 4200 km long system of flood defence lines. The plain flood forecast and warning system utilises results of international hydrometeorological data collection, combined Hungarian Meteorological Service QPF products based on ECMWF, DWD, ALADIN-HU output and subjective analysis of the weather forecaster. The home developed GAPI – TAPI modelling and forecasting system serves 120 forecast points within Danube proper, Drava and Tisza sub-basins. The distributed version of the system is under installation. Experimental use and hydrological routing of meteorological EPS is on way. According to ongoing research and development COMOLEPS products and nowcasting output will be used for flash flood warning purposes within 3-4 years to cover hilly parts of the country.

3.4 Fourth Session (Co-chairs Ms F. Martini and Mr B. Ozga-Zielinski)

3.4.1 Flood Forecasting Dissemination - A Collaboration Between Meteo Swiss and the National Hydrological Survey (S. Vogt and D. Maurer, Switzerland)

The risk estimation of severe events at MeteoSwiss is mainly based on COSMO-LEPS, which uses ensembles downscaled from the global model of ECMWF. In the forecasting process the issue of severe weather warnings are discussed with the regional centres at least twice a day. The distribution of warning information to local authorities is done by fax or email via secure transmission. In the ideal case there is a “prewarning”, a “warning” (updated twice a day) and a “end of warning”. Unfortunately there is only partly little access to the public via main mass media. The warning includes the indication of the “level of danger”. The flooding event in august 2005 e.g. was a “level 3 event” (the highest level), with more than 160mm/72h over large areas.

The National Hydrological Survey (which is integrated in the new Federal Office for the Environment FOEN since January 1, 2006) has no explicit legal duty to issue flood warnings to local authorities and to the public. Flood protection is a duty of the cantons (provinces). As consequence, the elaboration of water level and runoff forecasts for 7 gauging stations in the Rhine catchment below the prealpine lakes has to be regarded as a service. Forecasts are issued on working days in the morning; the interval is increased up to every two hours during severe flood situations. The forecasting system bases on the HBV-model and uses data from the meteorological stations and the numerical weather model aLMo from MeteoSwiss as well as from the gauging stations from FOEN. Customers are local authorities, shipping agencies, power stations and downstream forecasting centres in Germany and France.

MeteoSwiss as well as FOEN are in progress for more effective working environments in the production of forecasts and warnings in their institutes (MeteoSwiss → NinJo; FOEN → FEWS)

From the operational view, the present organization in the two different institutions (in two different ministeries) doesn’t provide a closer collaboration. The delivery of meteorological data from MeteoSwiss to FOEN works without problem and FOEN has direct access to the meteorologist in duty at MeteoSwiss for the discussion of the weather situation. Nevertheless the collaboration needs to be improved (Consequence of the August flood).

An important point is to create the legal framework for disseminating meteorological and hydrological warnings directly to the public via mass media.

3.4.2 Latvia (L. Kurpniece and L. Karklina)

The Latvian Environment, geology and meteorology agency (LEGMA) provides both hydrological and meteorological forecasts. Hydrological and meteorological forecast divisions are under Forecast department; together with aviation forecast division and methodology division thus ensuring a good level of cooperation among the various experts The State Fire and Rescue Service which is responsible for the dissemination of warnings and coordination of the activities during and after the flood. Civil defence plan describes each organization duties, responsibilities, besides there are named rivers and territories, which are endangered by flooding.

There are 49 stations on river (mostly on biggest rivers and their tributaries), 2 on reservoir, 1 on lake and 9 stations for sea observations. Only 4 stations are still served by observes. The implementation of WFD in Latvia will increase the amount of hydrological observation stations. There are also 4 automatic meteorological observation stations and a number of rain gauges. Basic NWP data are provided by DWD and the Met Office. Shortly are expected to be commissioned a EUMETSAT satellite data receiving station and radar in the capital Riga. Nowadays software program HYDRAS 3 allows receiving water level data and temperature data in real-time regime if necessary.

The HBV model is used for Latvian part of the Daugava River. Everyday forecast is made for water inflow into Plavinas hydropower plant for next 7 days. For all large rivers – Daugava, Gauja, Lielupe, Venta – seasonal forecasts of ice development, onset of maximum spring flooding and discharge are issued.

3.4.3 Lithuania

Lithuanian Hydrometeorological Service operates a network of hydrometeorological stations which observational data are used for flood forecasting and information for local population and rescue services. The network is comprised of 18 meteorological and 65 hydrological stations. It is a sparse network, however sufficient to satisfy basic flood forecasting and warning needs. Forecasters receive their information over the GTS network.

Since in Lithuania the floodwater breaks river banks during the icebreak period because of ice jams, the most important task is to predict the icebreak date. For this purpose empirical methods elaborated by local hydrologists and based on correlation between the daily sum of positive temperatures and the icebreak are used. Forecasts originated using this methodology have poor validity rate and their quality has been decreasing in recent decades due to global warming and unsteady course of winter weather, often splitting the flood into several waves. More accurate are maximum water discharge forecasts based on well-established link between the water equivalent of snow and weather conditions during the snowmelt period and other parameters.. The forecasts and information on actual conditions in the flood zone are provided for general public as well as for rescue services and state authorities.

3.4.4 FORECASTING PROCESS (I. Karro and C. Edlund, Sweden)

In Sweden, SMHI (Swedish Meteorological and Hydrological Institute) is responsible for both the meteorological and the hydrological forecasting. The forecasting process is integrated and starts with the meteorological work with creating a forecast database. The database is gridpointbased and contains meteorological parameters up to ten days ahead. The information in the database is then used by the hydrological forecaster in order to issue hydrological forecasts and warnings. The most important thing is that the warning information must reach the relevant end-users. In Sweden there is a well defined dissemination process for hydrological warnings. The process is well known also by the end-users and includes an early contact between the forecasters and local actors dealing with flood prevention. To ensure the quality of the hydrological forecasts and warnings there are special training and also certification of the forecasters who take part in the forecasting process. During

a flooding event a special organisation can be set up, where special roles are defined, i.e. flood manager, forecaster, and media responsible. At present hydrological EPS forecasts are operational and further development is being done. There is also a webbased information system which is used both at SMHI and by the rescue services. Work is being done in close co-operation with the hydropower industry. It is important to continuously work with improvements in all parts of the forecasting chain and to remember that if the warning does not reach the relevant decision makers the warning is useless and it doesn't matter how good your forecasting process is.·

3.4.5 Macedonia

The observing network managed by the Hydrometeorologicsal Service is formed by 262 meteorological stations (including 2 automatic stations, and 200 precipitation gauges) and 225 hydrological stations (110 for surface water and 115 for groundwater). The observation are complemented by three meteorological radars covering the territory of the country. Data on discharge and water temperature are centralized through RIMSYS.

Flood forecasting activities are operationally carried out:

- Prediction of the floods with new high-resolution (2km) numerical weather prediction models (NWP), and public information;
- Real time estimation of the precipitation on the catchments with radars and meteorological stations network;
- Floods forecasting and their propagation with classical methods.

The main problems facing the hydrometeorological service are poor condition of the hydrological and meteorological network stations, limiting the flow of data for forecasting purposes, and the lack of appropriate hardware and software for running more sophisticated and performing forecasting models.

3.4.6 Romania

Romanian Meteorological and Hydrological Forecasting Services are during a transition period, towards a modern integrated system, based on nine Doppler radars, eight lightning detectors, meteorological and hydrological automatic stations, meteorological and hydrological models, warning dissemination systems, named SIMIN (National Integrated Meteorological System) and DESWAT (DEStructive WATers Abatement and Control of Water Disasters).

Despite the fact that meteorological and hydrological services are managed by two different institutions, the cooperation and integration of data and methods are at the base of the SIMIN-DESWAT systems.

The huge financial effort accomplished by Romania for these systems is justified by the climatologic risk of severe weather, especially FLASH-FLOODS, as it could be seen during the year 2005, when historical floods were recorded in Romania.

3.5 Fifth session (Chair Mr P Rončák)

3.5.1 Hydrological and Meteorological Aspects of Flood Monitoring and Forecasting (B. Ozga-Zielinski, Poland)

Monitoring of hydrological and meteorological conditions are carried out continuously using a network of 61 hydrological and meteorological stations, 8 weather radars, 9 sensors for thunderstorm and lightning detection and location, 885 water gauges (on rivers, lakes and at the Baltic Sea coastal area), about 1000 rain posts and 50 groundwater posts. At present, a telemetry system is installed, which will enable tracking hydrometeorological situation development continuously. Satellite images are also regularly acquired from EUMETSAT. Meteorological Forecasting Offices monitor the situation 24 hours a day. ALADIN and LM-COSMO models are used for meteorological forecast, while various modes (HBV, MIKE 11, etc.) are used for hydrological forecast. At seven Hydrological Forecasting Offices existing in Poland, when there is no emergency or flood alert state, hydrological conditions are monitored currently every day over 8 hours. The situation is analysed and assessed once a day every day during the whole year. When hazard occurrence is expected, irrespective of day time (also in free days and holidays), observation and measurement data are transmitted to forecasting offices immediately upon their observation or measurement, so that, within about 1 hour from observation time, current analysis and situation assessment can be prepared and meteorological and hydrological warnings are issued.

Information is provided free of charge to the users at all levels listed in the distribution list, resulted from IMGW tasks, while it is delivered priced to commercial customers, who order hydrological protection. All hydrological forecasting offices transmit information, messages and forecasts to regional authorities at the area of their responsibility, providing at the same time all information to the Central Hydrological Forecasting Office (CBPH) located in the Headquarters of IMGW, where information for central authorities is prepared.

3.5.2 Russian Federation

In the Russian Federation the tasks of monitoring and forecasting of a condition of the natural environment, including the rivers, lakes and water basins, is assigned to Federal Hydrometeorology and Environmental Monitoring Service. The basic source of the information on the status of superficial waters and development of hydrological processes in the Russian Federation is the state hydrometeorological network of Federal Hydrometeorology and

Environmental Monitoring Service. At present the network is formed by 3086 hydrological stations.

At hydrological stations and posts daily hydrological observations are carried out and data transmitted to the relevant regional centers on hydrometeorology. Their tasks consist in data acquisition, carrying out primary data processing and transferring these data to the territorial centers on hydrometeorology. Some regional centers on hydrometeorology also perform some short-term hydrological forecasts. The territorial centers on hydrometeorology acquire data from the regional centers, release long-term, mid-term and short-term hydrological forecasts. At national level, the Hydrometeorological Centre of Russia undertakes the development of new methods and technologies for hydrological forecasting, methodical management of the territorial centers on hydrometeorology, the issue of long-term, mid-term and short-term hydrological forecasts. Hydrometeorological Center of Russia provides also the analytical information and forecasts to Federal Hydrometeorology and Environmental Monitoring Service, the Government of the country, the various ministries and companies. The general-purpose information and forecasts are transferred users free-of-charge while the specialized information is given on the basis of bilateral agreements with users and at cost

3.5.3 Serbia and Montenegro

Hydrometeorological Service meteorological and hydrological information, forecasts and warnings against hazardous events, support flood protection and defence actions. Existing information products are: daily briefing, daily bulletins for hydrological department, weather forecast for entire river basin and detail analysis of meteorological aspects of flood in past (synoptic situations). The Service issues hydrological forecasts at the time of flood events when water stages reading overcome established thresholds (warning water level determined for each station). The network of hydrological stations on the territory of Serbia (excluding Kosovo) consists of 185 stations and 56 of them collect data in real time. On 44 of these stations data are collected by phone or radio communication and on 12 by the automatic acquisition (digital registering with the GSM connection). Weather forecast is based on observations (39 meteorological stations, satellite data, radar data, synoptic weather charts), products of numerical weather prediction (ECMWF, DWD, Eta) and EPS (chart of extreme forecast index).

For big rivers (Danube, Sava, Morava), forecasts are made few days ahead applying models for water waves propagation (flood routing). For smaller rivers, applying models modeling precipitation-runoff process are used and early warnings are issued on the basis of radar observations and weather forecasting.

Before and during flood, acquired data, hydrological forecasts and warnings are distributed in real-time to: Ministry for agriculture, forestry and water management, Water management centers at the rivers Danube, Sava and Morava, Republic information center, Civil Defense Administration, Belgrade information center, Media, Public.

3.5.4 Operational Radar Products for Meteorological and Hydrological Forecasting (J. Danhelka, Czech Republic)

Meteorological radar network is very powerful tool for the identification of precipitation, its quantity estimation and nowcasting. First of all radars provide meteorologists and hydrologists with the spatially distributed information about the precipitation occurrence. There are some more steps necessary to gain the quantitative precipitation estimate from radar reflectivity field – the practice shows that the combination of different information (radar – raingauge) is necessary in stratiform precipitation events especially.

To ensure the fast flash flood warning the radars and radar based nowcasting procedures are the most reliable way from the nowadays point of view. However soil moisture and hydrological aspects must be implemented to build useful flash flood warning system.

Hydrological use of the radars brings many possibilities to enhance the forecasting process and results of the forecast. Hydrologists using radars has to be educated in the field of radar meteorology to understand the advantages and weak points of the radar data to avoid misunderstanding. Very crucial is the research on the behaving of the hydrological systems if move from raingauge inputs to radar or combined information (radar – raingauges).

3.5.5 Turkey

Flooding is second important natural hazard after earthquakes. On the average 18 flood events occur in a year and they take about 23 lives. Almost after each flood, the government has paid a large proportion of the damage, in addition to losing significant revenues due to the consequences of economic disruption. For example the flood disaster in West Black Sea Region in May 1998 affected four cities, 10 towns, 110 villages, and 25 000 ha agricultural land.

Experience indicates that structural measures implemented at basin scale are effective in reducing the risk of flood damages, but that more importance should be given to other non-structural measures. This change of policy is reflected in the implementation of the TEFER (Turkey Earthquake and Flood Emergency Recovery) Project initiated after 1998. With this Project the establishment of all kinds of structural and non-structural measures as flood control alternatives is being undertaken. The infrastructure of TEFER has been completed, but its meteorological and hydrological calibration procedures have not been completed yet. The complete system is consisting of 3 Meteorological Doppler Radars and 206 automatic meteorological stations for meteorological service (DMI) and 129 real-time hydrological stations for hydrological service (DSI). For the coordination and online data exchange between meteorological side and hydrological side, an agreement was signed between two governmental organisation in 2004.

3.5.6 Ukraine

The State Hydrometeorological Service of Ukraine mandate is to implement the state policy in the field of hydrometeorology, in particular: carrying out observation and evaluation of the state of the environment, supplying the state administration, industry and agriculture, defense, and population with information and forecasts on meteorological conditions and in the environment.

The State Hydrometeorological Service runs 23 regional hydrometeorological centers, including 8 zonal centers and the Hydrometeorological center of the Black Sea and the Sea of Azov; 6 hydrometeorological observatories; 203 meteorological, aeronautical meteorological, aerological, hydrological and specialized stations; 650 hydrological, meteorological and other posts, including 530 posts for monitoring pollution of the environment; and 2 stations for reception of satellite information. The State Hydrometeorological Service also manages a research and development hydrometeorological institute with two experimental bases and a marine department, with scientific research ships.

Starting from 2002 Ukraine has been developing a regional synoptic-statistical model, taking into account microclimate and orography of the various regions of the country in the results of calculations made by the global model of meteorological center Offenbach 48 hours in advance. This model will allow obtaining results of the calculations of precipitation and other weather parameters in grid format and with a resolution of 10x10 km. The work is expected to be completed in 2006. At present the Ukrainian weather forecasters use calculations of foreign centers (MRF, AVN, DWD, MM5, Bracknell, NOA), reports on current weather in Europe and satellite information. The basic hydrological models used by Hydrometeorological service for forecasting of processes in rivers are conceptual box models of rainfall-runoff transformation (models of the Ukrainian Research Hydrometeorological Institute and MIKE11), flood routing, different versions of “unit hydrograph” method.

The main problems with which the Service is presently confronted are the need for the modernization and automation of the monitoring networks; the need to produce reliable forecast of the extent of the flooded areas, the insufficient availability of digital data on channel morphology and flood prone areas, the lack of NWP and quantitative meteorological forecasts.

3.5.7 Republic of Moldova

The geographical situation of the Republic of Moldova, namely the proximity of the Black Sea and the influence of Carpathians Mountains are the main factors in pluviogenetic phenomena in Moldova.. As the heavy precipitations which cause floods in summer period have a convective character in most cases, the precise prognosis of convection parameters is of great importance. Synoptic and synoptic-statistical methods are the main forecasting methods. Mr. P. Panteleev, former head of the Weather Office in Chisinau proposed an empiric formula that considered the contribution of the most relevant parameters upon the formation of heavy rains. Based this formula and some others it was developed a program to calculate the probability of precipitations and its quantity using PC. The operative use of this method showed the comparatively high reliability of forecasts, in the range of 85-90%.

Analyzing the heavy rains in the course of 1966-2004 it came out that the distribution of strong rainfall has changed by time: in the course of 1966-1990 the most repetition of such heavy showers occurred in June 38.5%, and in the last years, (1991-2004) in July (37.2%), a bit less in August.

At present the State Hydrometeorological Service is developing methods for forecasting the dangerous phenomena, including the heavy rains, using the method of analogues.

It assumes the following:

- Development of an electronic database of all the dangerous phenomena and severe weather events (intensity, continuity, date and time, areal extent, the concomitant events, characteristics of baric field, etc.).
- Normalization of atmosphere circulation, under conditions of which the extreme weather phenomena occurred..
- Visual identification of circulation types of prognostic fields (baric and geo-potential field 500hPa) and identification of expected Medium Year Phenomena, by filtration of the database by this characteristic.

With a view to further improvement it is necessary to complete the database with new parameters of atmospheric circulation and to automate the method for identification of circulation.

3.5.8 Georgia

A rugged and mountainous territory affects the generation and occurrence of floods. The Likhi range, connecting the main Caucasus in the North and the lesser Caucasus in the South of the country acts as the main watershed in the country and influences climatic patterns. The Western part of the country is under the effects of the Atlantic circulation, while the eastern is under the effects of the circulation processes of the Caspian region. Heavy rainfall are regularly recorded in the Kolkhi lowlands bordering the Black Sea and precipitation peaks of 4000 mm/y are measured in the neighbouring mountainous areas. Floods are affecting all Georgian territory, but are particularly devastating in the Southern Caucasus region.

The existing monitoring system is falling dramatically short with respect to the country's forecasting needs. Only 42 hydrological stations are presently operational, about only one third of the network in place twenty years ago. Flood forecasting is mainly done by estimating the water equivalent of the snow cover in early spring using snow courses, A data bank of about 100000 entry exists on snow measurement carried out in the past, and is operationally used to support forecasting activities. Plans have been prepared for improving the observing network and the telecommunication systems and external support is being sought for their implementation

4 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusions

1. The meeting provided an excellent opportunity to the experts in the region to exchange information and views on the activities related to flood forecasting..
2. Enhancing flood forecasting capabilities is a priority for the region
3. Although all countries in the region have flood-forecasting system in place, significant differences in the level of performance and outputs exist.
4. The countries in region can be divided in three broad categories according to the level of their flood forecasting capabilities:
    a. Countries which need significant upgrading and strengthening of their basic data collection and transmission networks

b. Countries in which the basic infrastructure is in place, but which still require upgrading data management procedure and improving their methodologies and models for flood forecasting

c. Countries with well established flood-forecasting systems with high quality products with opportunities for further improvement through the use of new technologies.

5. The limitation of financial resources and the lack of specialized training on new technologies is a major problem facing countries with weak flood forecasting systems.

6. Major investments in improving flood-forecasting systems in the recent years have been often the reaction to major flood event causing severe damages and losses.

7. Countries are encouraged to improve with the support from WMO quality of measurement and accessibility of data during extreme events.

8. Meteorological radar networks are very powerful tools for tracking precipitation, quantitative estimations and nowcasting. The combination of different information (radar and rain gauges) improves the final outputs, in particular in case of stratiform precipitation events

9. Radar based nowcasting procedures are the most reliable for flash flood forecasting. Knowledge of sol moisture and other parameters in the catchment may improve the quality of forecast

10. There is need to increase the knowledge of the hydrological community on advantages and weakness of the radar applications.

11. Proper flood forecasting services contain a two-fold process. It comprises both the provision of relevant forecasting information and the effective dissemination of this information to the public. That includes other authorities such as Civil Defence, emergency response and local authorities.

12. It is well recognized that the role of the human expertise input to the flood forecasting process is very important and cannot be overruled by the advances of technology.

13. There is need to promote and encourage the dialogue, cooperation and exchange of expertise between the meteorological and the hydrological communities

14. There is also need to improve the quality of forecast and better meet the various requirement of the end users.

15. An effective dissemination system, delivering products adequate to the needs of the end users, is vital for ensuring the maximization of the benefits of flood forecasting systems.

16. The flood forecast information disseminated to the public should be as fast, accurate, reliable, relevant, timely, and easy to understand as possible.

17. To this purpose it is essential to establish a continuous dialogue between the producer of flood forecasting and the end users, and seek end users' feed back in order to improve the interpretation of the forecasts

18. There are many sources of uncertainty in the flood forecasting process. The value of forecasting information is increased significantly if presented together with an associated uncertainty assessment. There is need to continue teaching the users how to understand it.

19. In some countries where it exist a multiplicity of actors issuing meteorological and hydrological information products, there is need for better coordination among the various suppliers of forecasting in order to ensure that consistent information is delivered to the end users.

20. Cooperation among countries and NHMS can contribute to enhance the quality of flood forecasting in some particularly needy countries; this cooperation can take form of dissemination of successful experiences, regular transfer of information, training

and workshops. Special training on EPS, nowcasting and other modern methodologies is of high priority.

21. It has been noted that different types of forecasting models are used in the region and there is a need to conduct an intercomparison exercise to guide the member states to identify the most suitable models to serve their requirements
22. For the countries in the Sava River Basin (Albania, Bosnia and Herzegovina, Croatia, Serbia and Montenegro and Slovenia) the implementation of the Sava Initiative project is a tool to achieve a better quality of forecasts.

4.2 Recommendations

1. WMO is requested to continue organizing such type of fora for strengthening the capacity of the countries in the region and allowing continuous dialogue and exchange of experience in the field of flood forecasting and warning.
2. WMO shall make use of the existing training facilities in the region to strengthen national capacities in flood forecasting.
3. WMO is requested to compile case studies with the experience on flood forecasting and warning procedures in the region and to publish as Technical Document for circulation to the member countries.
4. It is also requested to prepare guidelines on dissemination of flood forecasting and warnings products in order to improve their impact on and use for the end users.
5. Countries are urged to strengthen their cooperation and coordination in issues related to data exchange at national, international and transboundary river basins levels.
6. WMO is requested to assist the countries in exchanging data and information through FTP and/or Internet sites to provide access to products in periods of flood.
7. Countries are encouraged with WMO assistance to elaborate data coding, data format, data bases standards for the exchange of distributed, grid and similar data for facilitating exchange procedures for new types of products to ensure compatibility.
8. WMO should assist the Sava River countries in implementing the Sava Initiative project to contribute to the improvement of their forecasting systems
9. The countries are encouraged to provide hydrological and meteorological data to the WMO sponsored global data centres (GRDC, GPCC) to allow access to the necessary data needed by the countries to improve their capabilities.
10. Countries are encouraged to participate actively with WMO support in the EUMETSAT SAF-Hydrology project to strengthen their capabilities in the use of satellite technology.
11. WMO was invited to conduct an intercomparison exercise among various forecasting models currently in use in the region.
12. It is recommended the creation of joint working groups of hydrologists and meteorologists to work on the development of new methods and technologies of forecasting, e.g. the improvement of flash flood forecasting

5. ADOPTION OF THE REPORT AND CLOSING

5.1 The meeting adopted the report of the session and requested the WMO Secretariat to finalize the text and distribute copies to all participants.

5.2 In closing the meeting, Mr P. Rončák, Director General of SHMU and Permanent Representative of Slovakia with the WMO, thanked all the participants for their valuable contribution to the meeting and WMO for the support in its organization. He underlined the value of the event that allowed experts from different countries to gather and exchange their experience. He also noted that there are still major improvements to be done in the production and dissemination of flood forecasts and in the cooperation among countries in this issue.

5.3 Mr M. Tawfik added his word of thank to the participants for their presentations and productive discussion that contributed to the success of the meeting and to the Director General and staff of SMHU for the excellent organization of the meeting.

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