WORLD METEOROLOGICAL ORGANIZATION

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WMO FLOOD FORECASTING INITIATIVE
REGIONAL EXPERT MEETING ON IMPROVED METEOROLOGICAL AND HYDROLOGICAL FORECASTING

Bangkok, Thailand, 6 to 9 December 2005

FINAL REPORT

1. INTRODUCTION

1.1 The meeting was organized in collaboration with the United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP) and held in the UN Conference Centre in Bangkok, Thailand. The meeting was attended by thirteen experts representing six hydrological and 7 meteorological national services from nine countries, namely P.R. China, Hong Kong China, France, Japan, Lao PDR, Malaysia, Sri Lanka, Thailand, Vietnam, as well as representatives from UN ESCAP and the WMO Secretariat. (Annex 1).

1.2 Recognizing the need to improve the capacity of meteorological services in detecting flood-critical situations and to improve the capacity of hydrological services in using meteorological forecasting information to provide accurate and timely flood forecasting services, the expert meeting was organized as part of a series of regional expert meetings worldwide in the context of the WMO Flood Forecasting Initiative. The objective of this initiative is to “Improve the capacity of meteorological and hydrological services to jointly deliver timely and more accurate products and services required in flood forecasting and warning and in collaborating with disaster managers, active in flood emergency preparedness and response”. Expected outputs from the expert meeting were the identification of opportunities and challenges in the development and use of forecasting tools available today; the use of meteorological and climatological forecasting methods including now-casting for flood forecasting and to define an outreach process and agreement on an action plan to achieve the objective of the initiative.

2. OPENING SESSION

2.1 In his welcome address, Mr. P.C. Saha, Chief of the ESCAP Energy Resources Section welcomed the participants and mentioned the timeliness of such a meeting, which he called innovative in its approach for improved collaboration between National Meteorological and Hydrological Services (NMHSs). He highlighted the close cooperation between WMO and ESCAP with regard to flood forecasting and management and in particular the collaboration of the two organizations in activities related to the ESCAP/WMO Typhoon Committee (TC) and the WMO/ESCAP Panel on Tropical Cyclones (PTC). He further called for the continuation of the fruitful collaboration that should bear visible results for the region’s NMHSs and thus would support sustainable socio-economic development in the region in the context of the Hyogo framework.

2.2 In his opening remarks, Mr. W. Grabs, Chief of the WMO Water Resources Division thanked Mr Saha for the support of the meeting by ESCAP and highlighted the long-term beneficial results of the collaboration between WMO and ESCAP that is extending to hydrological aspects of disasters and disaster prevention including aspects of flood management. He put emphasis on the necessity of NMHSs to improve their collaboration with a view to improve flood forecasting products, which he called a corner stone in the development of new, integrated forecasting products for an accelerated socio-economic development. In this regard, he further pointed out that the expert meeting was being organized as part of the implementation of the Strategy for the Enhancement of the Development of National Hydrological Services in WMO Region II (Asia) that had been adopted by the thirteenth session of RA II Regional Association (XIII RA-2 (Asia)) in December 2004.

2.3 In a general introductory discussion, participants recognized the strong interest of countries and donors to improve existing early warning and forecasting systems. Participants stressed that this interest should be reflected in the outcomes of the meeting by proposing specific activities and demonstration projects that could be developed and implemented through national and regional mechanisms and including external donor support.

3. ADOPTION OF THE AGENDA

Participants adopted the agenda for the meeting, which is attached as annex 2.

4. OVERVIEW OF THE WMO FLOOD FORECASTING INITIATIVE

4.1 In an overview of the WMO Flood Forecasting Initiative, Mr Grabs provided information on the background of the initiative and in particular outlined current weaknesses in forecasting systems and provided suggestions to overcome this situation including the outline of an outreach process. The overview of the initiative is reproduced in annex 3.

5. ACTIVITIES OF THE UN ESCAP ON FLOOD MANAGEMENT AND MITIGATION IN ASIA AND THE PACIFIC

5.1 The representative of ESCAP, Mr. L. H. Ti provided information on flood management and mitigation in Asia and the Pacific. Through the presentation of ESCAP's activities and projects, some of these offering high potential to be relevant for the WMO Flood Forecasting Initiative. In this regard he mentioned in particular the need to link forecasting services to socio-economic factors including the development of a standardized methodology for damage assessment. He informed that ESCAP would undertake a survey of existing early warning systems in Asia complementing related work of the TC and the PTC. Under the Hyogo framework of action, the three working groups of the TC (working groups on the meteorological and hydrological components and disaster prevention group) will meet in September 2006. Of high relevance to the WMO Flood Forecasting Initiative are the most advanced TC projects, namely those on hazard mapping, model improvement, flash flood early warning and reservoir operation for flood forecasting purposes.

6. STATUS OF EARLY WARNING AND FORECASTING METHODS IN NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES (NMHSs) CASE STUDIES AND DISCUSSIONS

6.1 Participants made presentations of the status of collaboration and forecasting procedures in National Meteorological and Hydrological Services in their countries. The original presentations are reproduced on the CD attached to this report.

6.2 It was recognized that there is a wide range of capabilities both between countries but also on national level between capabilities of the hydrological and meteorological services. There are also cases, where flood forecasting is done with no or minimum meteorological information especially when either the meteorological service is not providing adequate forecasting products or when the hydrological service is at a low development

stage that makes it impractical to use meteorological forecasting information. In this regard, participants highlighted on several issues, namely:

6.2.1 Improvement of rainfall-runoff model-based flood forecasting, improved precipitation estimation and long-range weather forecasting

In countries, where the hydrological service is less developed, there is hardly a demand for meteorological information, whereas in cases where the hydrological service is highly developed, either the service operates its own networks or receives meteorological information for use in flood forecasting. However, often the meteorological information provided needs to be improved in quality, timeliness and being more quantitatively and risk-qualified. Often, products needed for now-casting services, i.e. for flash floods are not available. Participants felt that this was true in many cases also for the availability of medium range and seasonal weather forecasting and in particular of precipitation including PMP. The differing development status of services is also reflected in the use of rainfall-runoff models. Especially NHSs that are developing their flood forecasting abilities expressed their need for professional guidance in the selection, adaptation, calibration and use of rainfall-runoff models to suit operational requirements.

6.2.2 Improve the use of NWP for flood forecasting purposes

The presentations showed that there is no wide use of NWP for flood forecasting purposes and that the use of ensemble prediction procedures, where presently used, is still mostly at an experimental stage but with the objective of using these techniques operationally as soon as the have been proven to be reliable. This issue is further discussed under items 8.3 and 8.4 below.

6.2.3 Develop detailed user requirement profiles for flood forecasting

In the development of improved user services from NMHSs it was felt that detailed user requirements from a wide range of clients are necessary and that clients need to make their requirements assessment. A consolidated requirements assessment then would form the basis to jointly develop tailor-made forecasting products. Participants expressed their opinion that felt societal needs will ultimately determine the financial support to NMHSs.

6.2.4 Strengthen institutionalized cooperation between National Meteorological and Hydrological Services

One important issue that emerged from the presentation and discussion of the country presentations is the need for an institutionalized cooperation between NMSs and NHSs in terms such as: lines of responsibilities, sharing of specific data and information. Participants felt that the issue of administrative reforms from the viewpoint of forecasting services is an important development process in many countries. These institutional reforms are important steps to improve the efficiency and effectiveness of forecasting services to the public. An example is the preparation and standardization of joint Meteo-Flood bulletins.

7. COUNTRY SPECIFIC OBSERVATIONS

The following paragraphs relate to observations made by country representatives that are relevant for an improved collaboration between NMHSs for flood forecasting:

7.1 China

In China, 80% of the floods are flash floods that cause the highest percentage of loss of lives in flood-related events. The real-time flood forecasting system utilizes 6-hourly mean areal rainfall data as input. The actual model used is based on a number of models including Unit Hydrograph models, adapted models such as the SACRAMENTO model, lumped models as well as statistical and empirical methods, depending on the rivers and available data and expertise in forecasting. The Bureau of Hydrology maintains its own precipitation network and meteorological service. The China Meteorological Agency provides 7-days Numerical Weather Prediction to the Bureau of Hydrology. In practice however, NWP is not utilized as of now for flood forecasting, except on experimental basis. The need for improved cooperation between CMA and the Bureau of Hydrology is recognized and cooperation between the agencies is in a process to become much closer.

7.2 Hong Kong China

Real-time rainfall forecasting is a special strength of the Hong Kong Observatory thanks to a good radar network. However, due to the lack of proper models for the highly specific geographic and topographic situation in Hong Kong, there does not exist an operational flood forecasting service except so-called flood special announcements. Since the early 90-ies, regular rainfall warning systems and special announcements for flood events is provided on an hourly basis for the northern territories of Hong Kong. Clients representing different sectors determine the criteria for warnings, which is an iterative process. Weather forecasts have been extremely useful for frequent landslip warning operations in the territory of Hong Kong using 24-hour high-resolution rainfall information that is re-calculated every three hours. The average lead-time for landslip warnings is 1.5 hours. It has also been possible to develop landslip risk patterns in correlation to changing synoptic patterns. As an underlying principle, the societal needs for forecasting and warning information determines the financial support to the organizations responsible for warnings and disaster prevention.

7.3 Thailand

The Thai Hydrometerological Department uses weather forecasting models to improve hydrological forecasting including flash flood forecasting. Water level data and forecasting models are complemented by the use of NWP and radar/satellite information. The Thai Meteorological Department is using radar systems for precipitation forecasting. For flash flood forecasting, established rainfall threshold values are used at present. Riverine flood forecasting is built on water level observations using MIKE 11 as forecasting model with complementary radar/satellite precipitation information and NWP-information.

An important issue is the improvement of data sharing mechanisms within Thailand and the establishment of an adequate national data collection mechanism, based on inputs from various observation platforms and networks. Data and information is being distributed to the National Disaster Warning Centre that is operating under the Office of the Prime Minister.

7.4 Japan

Sophisticated weather forecasting information is available including up to 6-hour now-casting using NWP products and radar-based precipitation information. Flood forecasting is issued to the public by the Japan Meteorological Agency (JMA) jointly with the River Administration Bureau. Disaster management is handled operationally at prefecture level through a well-defined and complex administrative procedure. At present several organizations (i.e. Department of Roads) have established own precipitation networks; the data from these networks is shared with JMA.

7.5 Lao PDR

Flood forecasting has not much improved since it's beginning in 1996. At present, available meteorological information cannot be used in the existing flood forecasting procedures that are based on empirical and statistical methods. Flash flood forecasting continues to be a major issue that cannot be addressed adequately at present. The newly established radar station in Vientiane is expected to improve rainfall forecasting and flash flood warnings.

7.6 Malaysia

The Malaysian Meteorological Department (MMD) and the Drainage and Irrigation Department (DID) are the two government agencies tasked to provide meteorological and hydrological services in Malaysia respectively. MMD maintains a technically advanced observation station network, including automatic weather stations, upper air and radar stations, meteorological satellites data receiving and processing facilities to monitor the weather development in the region. MMD also run regional numerical weather models to provide better meteorological forecasting services. DID has a dense network of rainfall stations and also installed water level sensors along rivers which are essential for flood forecasting and warning. These data are published in their INFOBANJIR web site. DID also runs numerical flood models to monitor and predict flood occurrence. There is an urgent need to enhance the existing decision-support tools so as to improve meteorological and hydrological forecasting. The products of NWP, especially quantitative precipitation forecast and flood models should be more accurate. Service providers also have the responsibility to communicate uncertainty of forecasting to the user community.

7.7 Sri Lanka

At present, no models are used for weather forecasting, rainfall forecast is qualitatively only with no radar and NWP available. However, cyclone warnings are provided for cyclones approaching 50 km off the coast. Threshold precipitation values have been established for several areas for warning purposes. Except for the Kelani basin that has an operational flood warning system, flood forecasting in most rivers has not been established and gauge–level thresholds have been established for warning purposes. Flood forecasting including the use of meteorological information is in a developing stage. Improvements are sought in network development including automatization of the network, telecommunication and also getting connected to the GTS.

7.8 Vietnam

Real time information from hydrological and meteorological networks as well as satellite and NWP products as well as medium-range weather forecasting products are being used for flood forecasting in several river basins and are being expanded into more basins. There is an advanced stage of cooperation between meteorological and hydrological services, where real-time information from meteorological and hydrological networks and satellite information is used. Various state-of-the-art flood-forecasting models are in operational use. Most modern techniques are being tested and used in the Red River basin.

7.9 France

The example of service improvement in France served as case study for discussion in the meeting. Despite sophisticated meteorological and hydrological service facilities, fragmented responsibilities and insufficient mutual communication between a multitude of services had resulted in inadequate flood forecasting services. The creation of a new body – SCHAPI – where meteorologists and hydrologists operate on 24-hour shifts has recently resulted in largely improving timeliness and accuracy of flood forecasting services provided down to the local level and in close cooperation with disaster prevention and management authorities. For flash flood events, no model is presently available but expert rules and knowledge of hydrological forecasters is used and exchanged in high frequency video conferencing. The implementation of a common platform for real-time communication between relevant services is under development.

8. SELECTED TECHNICAL ISSUES RELATED TO IMPROVED FLOOD FORECASTING

8.1. Improvement of observations

Participants felt that in many countries there is an urgent need to expand the terrestrial observation hydrological and meteorological networks and as well to upgrade and improve the existing networks. With regard to the automatization of observations it was observed however that there needs to be a good mix of automatic and manned stations especially to ensure continued observations in particular in flood prone river basins. Likewise it was mentioned that satellite information – in particular on water levels of large rivers, quantitative precipitation estimation and information of flooded areas – have the potential to provide valuable additional information in flood forecasting and the management of floods. Radar-based observations coupled with dense networks and additional satellite information have been proven of high value for modeling and flood forecasting including now-casting. Participants also discussed different approached to improve product generation based on observations. In the discussion, these approaches ranged from the achievement of high-density networks, mixed platform networks (including radar and satellite information) as well as the need for a rationalized approach in recognition that most countries can afford to maintain only networks of limited density. In future, more and more products will be generated from minimum density terrestrial networks, complemented by observations from other platforms, and high-accuracy forecasting will be made using advanced data assimilation and related modeling methods including Numerical Weather Prediction.

Improved observations also encompass issues related to data quality management and the further development of data quality control procedures that have been established in several countries. Likewise, participants stressed that improvements of observations also require the need to ensure standards of measurements in case observations by operators and networks other than the NMHSs are utilized. In order to obtain all necessary information, mechanisms for a more efficient exchange of hydrometerological data and information both from different agencies nationally but also internationally was considered to be essential.

8.2 Medium Range Weather Forecasting

Participants discussed the use of medium range weather forecasting (MRWF) for hydrological forecasting purposes at some length. Only a few countries use the information provided on an operational or semi-operational basis for hydrological forecasting. In most cases MRWF is used as qualitative additional information. Other than flood forecasting, Japan is using MRWF for drought forecasts and drought management and in the context of ensemble forecasting. China produces its own MRWF. Three to five day predictions provide precipitation forecasts for hydrology for long-term flood forecasting both quantitatively and qualitatively as flood outlooks. The 10-day precipitation prediction is used during the flood season.

8.3 Ensemble Prediction

Ensemble prediction techniques are rapidly developing but need further refinement to put these in operational use. Participants remarked that the meteorological interpretation of ensembles largely relates to different model results based on outcomes of different Numerical Weather Prediction runs. Hydrological interpretation of ensembles was viewed in the context of uncertainties arising from a multitude of sources including those in observations, initial conditions/parameter settings and model uncertainties. From the countries represented at the expert meeting, China is finding ensemble prediction useful including the comparison of ensemble probabilities versus different model runs (mean, control run and deviations). Japan uses 1-3 month ensemble prediction outlooks using ECMWF information.

Participants stressed that meteorological ensembles coupled with hydrological ensembles would be a very valuable tool for improving long-range hydrological forecasting and decision-making under uncertainty. In particular probabilities of occurrence of different situations need to be assessed, there is the need to interpret ensembles in a meaningful way for potential users and new, ensemble prediction-based products need to be promoted for use to potential users.

8.4 Use of Numerical Weather Prediction (NWP)

In a general discussion, the meeting was informed that one of the current weaknesses of forecasting systems is that advanced methods and techniques including the use of NWP products and ensemble forecasting techniques are not widely used in the meteorological and hydrological communities, i.e. only slightly over 1/3 of WMO Members have the capability to run NWP models and generate products. Vietnam has acquired knowledge to use NWP in an exemplary way that could serve as example for other services to replicate

the capacity-building process and getting NWP into operation. The representative of Sri Lanka reported that Korea had donated a system to start NWP services to be operational by mid 2006. Lao PDR receives graphical NWP products Vietnam for rainfall information. Malaysia is in the process to develop its own NWP capabilities with assistance from China. NWP is currently not used for flood forecasting. Hong Kong is not using NWP directly for flood forecasting but – due to the unique size and location of Hong Kong – uses a decision-making system to check the consistency of model runs of previous synoptic situations and model behavior in comparison with different model runs. The interface between meteorology and hydrology is the flood forecasting decision system itself, where meteorological information is translated in a warning message that is risk qualified and uses common language. China has been using NWP information for flood forecasting in 2003 on an experimental basis. The China Meteorological Administration provided NWP information on a 6-hourly basis. The NWP information was based on up to 7 days weather forecast, including typhoon tracking and quantitative precipitation forecast. Thailand uses NWP for flood forecasting as input to the MIKE 11 forecasting system on a manual basis with a flood-forecasting horizon of up to 7 days. In Japan, NWP is used only for short-term prediction. For long-range forecasting, including dam management, NWP is used offline using scenarios and includes typhoon tracking. In France, flood forecasting is based on the use of NWP. There is a web-based audio-visual forecasting bulletin with an explanation of the flood situation.

In discussing the more widespread use of NWP in flood forecasting, participants stressed that, as a minimum, NMHSs should be enabled to use NWP products in a meaningful way with the prospect to acquire the capacity to generate NWP by themselves or in collaboration with other NMHSs.

8.5 STORM SURGE ISSUES

Storm surges pose a major hazard to many countries in the region. Despite this fact, operational and accurate storm surge forecasting and warning services are still rare in most countries and participants felt that a concerted effort should be made to further develop and operationalize such systems as soon as possible. In terms of the establishment of warning systems, the concept of multi-hazard forecasting and warning systems should be considered as an advantageous option. Participants also stressed the development of risk qualified coastal flood hazard maps. Characterizing the current situation, Thailand has no operational storm surge model. Japan operates a numerical storm surge model that needs to be improved in terms of accuracy. The representative of France reported that for river estuaries, a storm surge model is in operation and coupled with a flood-forecasting model. Ocean models run continuously and are coupled to the storm surge model that then also is coupled to the flood-forecasting model for the specific conditions of estuaries. The representative of ESCAP informed the meeting that ESCAP undertakes a community-based project with a single system approach regarding cyclones, storm surge, tsunamis and floods. Participants discussed the issue at length and recommended that storm surge issues should be brought back to the WMO/ESCAP Panel on Tropical Cyclones (PTC) with the objective to develop and establish a pilot storm surge project including the production of flood hazard maps in specifically identified regions. The representatives of Sri Lanka and Thailand announced that they would provide information on endangered coastal zones.

9. SELECTED CAPABILITIES AND REQUIREMENTS FOR ASSISTANCE

On the basis of the vastly differing technical capabilities of National Meteorological and Hydrological Services, participants discussed mechanisms for the exchange of know-how and technologies. As a result, a matrix was developed where participants filled in information on capabilities to share such information and know-how as well as areas of expertise where technologies and know-how is needed. Participants viewed this approach as a practical way to develop twinning arrangements but also to develop projects on Technical Cooperation between Developing Countries known as TCDC. Likewise, this approach facilitates networking between experts and organizations in specific fields. The list of Selected Capabilities and Requirements is attached in Annex 4.

10. OUTREACH PROCESS

10.1 Participants discussed various approaches for an outreach process to make maximum use of the exchange of knowledge and know-how gained during the workshop and also to implement recommendations made. Participants were informed that WMO would organize a synthesis conference on improved hydrological and meteorological forecasting within the framework of the WMO Flood Forecasting Initiative. The Technical Conference will be held in November 2006 based on the experiences gained and recommendations made in the regional workshops held as part of the Flood Forecasting Initiative.

10.2 From a regional perspective, participants agreed to initiate, plan and execute activities and also demonstration projects in areas of mutual interest as outlined in item 11 below. The meeting also identified some mechanisms for linkages that should be used in the outreach process, namely through the Typhoon Committee, the WMO/ESCAP Panel on Tropical Cyclones, The WMO Working Groups on Hydrology of WMO Regional Association II (Asia) and V (Asia and the Pacific), the implementation of the WMO RA II Strategy for the Development of National Hydrological Services; the UN ESCAP framework and through the reporting back to the synthesis conference mentioned above.

11. POSSIBLE PROJECTS AND ACTIVITIES FOR COLLABORATION BETWEEN METEOROLOGICAL AND HYDROLOGICAL SERVICES FOR FLOOD FORECASTING

11.1 As an important result of the discussions during the expert meeting, participants discussed and agreed on a number of projects and activities that need to be undertaken to improve collaboration between meteorologists and hydrologists for the purpose of improved flood forecasting. The expert stressed however, that an improved collaboration between meteorologists and hydrologists serves a much wider ranger of uses and benefits aside from floods. These needed to be examined separately. The following list is ranked in the order of priority perceived by participants and reflects proposed projects as well as activities. Only those projects and activities were listed where – tentatively – a custodian was suggested. As many of the activities and projects need to be endorsed by the proposed custodian agencies that were mentioned by the experts, the final list of approved activities will be published, once the parent agencies of the participating experts have endorsed the respective activities below. The experts agreed to provide feedback latest two months after receipt of the report of the workshop.

I. Improvement of quantitative rainfall estimation/prediction for FF - compilation of experiences and techniques;

II. Processing of hydrological relevant NWP information for Flood Forecasting in accordance to specific requirements. WMO was requested to contribute to the development of a project outline to be discussed by experts;

III. Standardized communications and operation terminology for meteorologists and hydrologists in flood forecasting and flood risk management (selected terminology) with a view to communicate to users. This project would be supported by WMO and ESCAP;

IV. Ensemble forecasting techniques related to flood forecasting and effects of seasonal changes. Proposed action: documentation of the state of development in Japan and Europe (Early Flood Alert System, EFAS), assistance from SCHAPI, link up with the Hydrological Ensemble Experiment (HEPEX) undertaken in the context of the Global Energy and water Cycle Experiment (GEWEX) of WMO's World Climate Research Programme (WCRP) and THORPEX, an international project driven by WMO and liaise with the US National Weather Service River Forecasting System;

V. Improvement of institutional arrangements including administrative reforms and capacity building in flood forecasting operations in a national context;

VI. Application of satellite information for flood forecasting in selected river basins;

VII. Pilot project: Common regional warning Internet website for meteorology/hydrology information for disaster risk management. This project could be implemented in the Typhoon Committee.

VIII. Development of a checklist of common areas of cooperation between the NMSs and NHSs in terms for flood forecasting. Proposed action: SCHAPI to provide a first template outlining the French experience, then inputs of countries in a consolidated report;

IX. Documentation: Process of steps in administrative reform in France. SCHAPI agreed to provide a case study for this subject;

X. Documentation: Process of communication with users for their requirements in Hong Kong. The Hong Kong Meteorological Observatory will undertake this activity)

XI. Documentation: Process on how Viet Nam acquired expertise to utilize NWP. The Vietnam Meteorological Agency will undertake this activity.

12. RECOMMENDATIONS

12.1 With regard to data availability, participants stressed that the availability of data and information acquired within a quality management framework is essential to ensure timely and accurate flood forecasting services.

There was the general feeling that the access to data is impeded due to a number of constraints including organizational, legal and technical constraints. With regard to the latter, participants felt that communication systems need to be developed to allow inter-operability of present-day hydrological and meteorological data communication streams. In this context, the meeting was informed of the European Flood Alert System. The representative of Japan sued this occasion to introduce the plans for the establishment of a Global Flood Alert system (GFAS).

12.2 In a review of the main discussion items of the meeting, participants expressed their interest to document assimilation techniques based on information from different sources (observation platforms, national and regional observation centers, data processing centers etc). These techniques could be used for improved decision making in flood forecasting. Experts also urged the Typhoon Committee and the WMO/ESCAP Panel on Tropical Cyclones to renew or initiate activities related to storm surge risk management supporting technology and forecasting techniques.

12.3 There was a general consensus for the need to extend forecasting services down to community level beyond the responsibility of a national agency. Some experience was exchanged using the concept of "Tiers of responsibility" that has been developed in China, and the French experience to extend warnings to community level. The meeting was informed of WMO's pilot project on community approaches to flood management in the framework of the Associated Programme on Flood Management (APFM).

12.4 Further in the line of making flood forecasting more meaningful for communities participants stated the urgent need for risk qualified hazard maps in a way that can be easily visualized for the target group. Japan: "Moving hazard maps" visualization, computer animation

13. CLOSING SESSION

In a general feedback discussion, participants felt that the meeting contributed to improve mechanisms to exchange know-how and technology and to facilitate networking between experts and National Meteorological and Hydrological services (NMHSs). Participants also expressed satisfaction over the informative meeting as it allowed an in-depth interaction between knowledgeable representatives of hydrological and meteorological services, common problems, solutions and skills. There was a unanimous agreement that full benefit of the results of the meeting would be achieved through a planned follow-up process including identified commitments and lead organizations/experts to implement the follow-up activities including pilot projects. With a vote of thanks and replies from participants, the meeting ended on Friday, 9 December at 3:30 p.m.

ANNEX 1

WMO FLOOD FORECASTING INITIATIVE
REGIONAL EXPERT MEETING ON IMPROVED METEOROLOGICAL AND HYDROLOGICAL FORECASTING
Bangkok, Thailand, 6 - 9 December 2005

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ANNEX 2

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AGENDA

Tuesday, 6 December 2005

Morning Session

0900-0930	Opening of the Expert Meeting Election of Officers Adoption of the agenda
0930-1000	Overview of WMO Flood Initiative Related activities of UNESCAP on flood management and mitigation in Asia and the Pacific
1000-1020	Coffee break
1020-1200	Status of early warning and forecasting procedures in National Meteorological and Hydrological Services (NMHSs) - case studies

Afternoon Session

1330-1500	Case studies continued
1500-1520	Coffee break
1520-1630	Cooperation of NMHSs in forecasting and warning of Tropical Cyclones – challenges and opportunities
1630-1730	Cooperation of NMHSs in forecasting and warning of Storm Surges– challenges and opportunities

Wednesday, 7 December 2005

Morning Session

0900-1000	Observational networks including space-based systems and hydrological radars, data exchange/transmission and data analysis including data quality
1000-1020	Coffee break
1020-1120	Meteorological models used by National Meteorological Services including now-casting
1120-1200	Hydrological modeling and forecasting including applications in now-casting of flash floods

Afternoon Session

1330-1430	Objective functions for flood forecasting and information requirements from National Meteorological Services
1430-1530	Capability of National Meteorological Services to deliver NWP precipitation forecasts
1530-1550	Coffee break
1550-1630	Assimilation of the outputs of NWP, including ensemble forecasts in hydrological models and operational flood forecasting/warning

1630-1730 Availability of weather forecasting products and use of these products in hydrological forecasting

Thursday, 8 December 2005

Morning Session

0900-1000 Medium range weather forecasting and climate prediction tools for improved early warning and hydrological forecasting
1000-1020 Coffee break
1020-1115 Development and application of climate predictions in the preparation of seasonal river-flow outlooks
1115-1200 Critical aspects with respect to predictability, thresholds, interpretation and use of forecasts related to precipitation and forecasting of floods

Afternoon Session

1330-1430 Issues related to uncertainties and verification of forecasts
1430-1530 Cooperation between NMHSs in improved hydrological forecasting and warning
1530-1550 Coffee break
1550-1730 Success and deficiencies in early warning and flood forecasting – round table discussion

Friday, 9 December 2005

Morning Session

0830-0915 Development of integrated weather, climate and hydrological forecasting information
0915-1000 Needs for capacity building in NMHSs to make use of weather forecasting for hydrological forecasting
1000-1020 Coffee break
1020-1115 Needs and requirements of NMHSs for enhanced cooperation on national and regional levels
1115-1200 Strategy development to improve development and integration of meteorological and hydrological forecasting products

Afternoon Session

1330-1415 Integration of early warning and forecasting services in multi-hazard disaster preparedness and mitigation
1415-1430 Warning procedures and the development of information and its dissemination down to community level
1430-1450 Coffee break
1450-1530 Conclusions and recommendations
1530-1600 Closure of the meeting

ANNEX 3

WMO FLOOD FORECASTING INITIATIVE

- OVERVIEW -

Background for the development of the initiative

Numerous examples around the world demonstrate that floods continue to be amongst the most damaging natural disasters. Preparedness and response actions of the various disaster management authorities to prevent or mitigate flood-related disasters are highly dependent on the availability and proper use of accurate and timely meteorological and hydrological forecasting products and the dissemination of adequate and relevant information to authorities responsible for civil protection and the general public. However, many meteorological and hydrological services do not presently have adequate means or the knowledge to provide extended forecasting services in flood critical situations and to communicate effectively with disaster management authorities. Likewise, there is need for an integration of forecasting services, which amongst other issues require an improved cooperation between meteorological and hydrological services. Therefore, the initiative had been launched by WMO based on the outcomes of an expert meeting held in Geneva in April 2003

Current weaknesses of forecasting systems

Within the thematic scope of the initiative the following weaknesses of current forecasting systems were identified:

a) Meteorological information and forecasting are often not provided in a form usable for hydrological pre-warnings and forecasting,
b) Meteorological forecasts are often qualitative and not quantitative,
c) Extreme meteorological and hydrological events are not risk qualified. What does i.e. severe rainfall mean for the input to hydrological forecasting or the general public?
d) Advanced methods and techniques including the use of NWP products and ensemble forecasting techniques are not widely used in the meteorological and hydrological communities, i.e. only slightly over 1/3 of WMO Members have the capability to run NWP models and generate products,
e) Fragmented data holdings, non-standardized data archiving, data formats and transmission protocols severely limit timely access to data and information,

f) There is a pronounced “communication gap” between meteorological and hydrological services with regard to forecasting concepts, methods, products and services, outreach to end-users and even the technical language used,
g) Forecasting is often not objective-driven; different users of forecasting information require specific forecasting products,
h) Uncoordinated multi-service warnings could conceivably conflict with each other and lessen their usefulness,
i) Warnings directed to disaster management agencies and the general public use technical vocabulary not easily understood by those who should benefit from the warnings.

Objective

Based on the analysis of the weaknesses of current forecasting systems and with a focus to enhance the ability of National Hydrological and Meteorological Services (NMHSs) to cooperate in an effective manner to provide improved flood forecasting services, the objective of the initiative is to:

Improve the capacity of meteorological and hydrological services to jointly deliver timely and more accurate products and services required in flood forecasting and warning and in collaborating with disaster managers, active in flood emergency preparedness and response.

Expected results

It is expected that the implementation of the initiative will contribute to gain the following results to achieve the objective:

a) Improved quantitative and qualitative weather forecasting products are available in such a way that these can be directly used for flood forecasting,
b) Medium-range weather forecasting and climate prediction tools can be applied to extend warning times and produce pre-warning information,
c) NHMSs have improved their capacity to cooperate to jointly deliver timely and accurate flood forecasting information,
d) Integrated weather, climate and hydrological forecasting information are available in a relevant format for use by civil organizations responsible for disaster preparedness and mitigation.

Implementation of the initiative

The initiative is mainly implemented through a series of regional workshops/expert meetings and a subsequent global synthesis conference.

The aim of the regional workshops is to initiate dialogue between NMHSs with a focus of improving tools and methodologies for weather- and flood forecasting taking into account also the potential benefit of seasonal climate prediction. These workshops are designed to define present shortcomings, levels of applied technologies, challenges and opportunities for improved forecasting with a view to strengthening regional cooperation. The regional workshops serve to preparing a reference base of information to structure and conduct

national consultations. Noting, that only slightly over 1/3 of WMO's Members have the capability to run NWP global, regional and/or limited-area models, and a large majority of Members have access and make use of NWP products from other NMCs, bilateral and regional arrangements are envisaged to deliver derived NWP products for use on "local" levels.
So far, regional workshops had been held fore RA I in Pretoria, South Africa in December 2003 and for RA III (South America) and RA IV (Central America) in Valencia, Spain, in March 2004, for RA VI in Bratislava in December 2005 as well as in RA II in Bangkok in December 2005. Further regional workshops are planned for RA I (West Africa), for RA VI and RA I (Mediterranean countries) and for RA V (Australia and the Pacific) in 2006.

The global synthesis conference is being planned for late 2006 and will provide a synthesis of national and regional issues and strategies for the development and application of improved weather forecasting, climate prediction and hydrological forecasting with emphasis on floods. The results of the global conference will serve as inputs in the review of cooperation mechanisms between NMHSs, the promotion of the application of NWP products for flood forecasting as well as the mechanisms and modes to access relevant meteorological forecasting products and the development of advanced products for use especially in the developing world. As a consequence, the findings from such a conference would also influence present-day capacity building efforts in NMHSs with a view to improving forecasting techniques and practices.

Topics covered in the regional workshops and the synthesis conference

General focus of the initiative is on the needs of the developing world, their information requirements and the use of appropriate forecasting tools to contribute to the mitigation of flood impacts on lives, property and infrastructure in affected river basins.

Therefore, the workshops cover issues including:

a) Observational networks including space-based systems, data exchange/transmission and data analysis including data quality;
b) State-of-the-art of meteorological models used including now-casting,
c) State-of-the-art possibilities of NWP precipitation forecasts,
d) State-of-the-art of hydrological modeling and forecasting and including applications in now-casting of flash-floods;
e) Assimilation of the outputs of NWP, including ensemble forecasts, using radar and satellite information in hydrological models and operational flood forecasting/warning,
f) Critical aspects with respect to predictability, thresholds, interpretation and use of these forecasts related to precipitation and other relevant parameters,
g) Development and application of climate predictions in the preparation of seasonal river-flow outlooks
h) Needs for capacity building in NMHSs to make use of weather forecasting for hydrological forecasting,
i) Means of coordination between meteorological and hydrological services,
j) Operational aspects of integrated flood forecasting/warning systems,
k) Definition of objective functions for flood forecasting
l) Issues related to uncertainties and verification of forecasts
m) Coordination with end-users of information,
n) Warning procedures and the development of information and its dissemination down to community level.

Collaborating agencies and organizations

It is evident that a network of collaborating partners and centers of excellence is required on global, regional and national levels to conduct the workshops and to implement the proposed actions as ell as to meaningfully cover the relevant topics of the initiative. So far, other UN organizations as well as experts from international organizations and national centers have been fruitfully contributing to the initiative.

ANNEX 4

WMO FLOOD FORECASTING INITIATIVE
REGIONAL EXPERT MEETING ON IMPROVED METEOROLOGICAL AND HYDROLOGICAL FORECASTING

Bangkok, Thailand, 6 - 9 December 2005

SELECTED CAPABILITIES AND REQUIREMENTS

The table below provides a summary of the capacity of NMHSs represented in the meeting to provide advice/assistance in the fields identified and also the requirements for guidance/assistance in some fields of expertise (Compiled from original inputs).

	Can offer	Need assistance
China	Experiences of cooperation on improvement between Meteorology and Hydrology	Experiences and techniques to improve the quality of quantitative precipitation forecasting including longer lead-time and more accuracy
France	Exchange of experiences in institutional development and cooperation between meteorological and hydrological services; Sharing experience in storm surge modeling	
Hong Kong, China	SWIRLS Now-casting System Technology and Case Studies; Warning Systems Development; NWP products on SINE server	Satellite precipitation estimation; Rainfall/moisture analysis or observations from non-conventional sources; Rain-gauge observations in real or near-real time from neighboring regions
Japan	Information on: Estuarine models taking into account storm surges; Software to digitize data recorded on paper rolls; Provision of digitized boundary condition data for implementation of NWP models (not including ensemble initial conditions); Accept some experts as trainees to acquire know-how on specialized techniques; Exchange of technical information	Improve accuracy of NWP models; Expertise to address issues related to urban flash flood events

Lao, PDR	On the job training of Hydrologists in flood forecasting; Development of Flood Forecasting systems, improvement of forecasting accuracy	Model development and improved performance as well as improved data collection; High technology and forecasting techniques
Malaysia	Malaysian experience in flood forecasting	Advice on better collaboration between NMS/NHS; Utilization and assimilation of NWP products for flood forecasting; Better rainfall estimation using radar; Flood hazard mapping
Sri Lanka	Observation methods for rainfall and floods; Stream flow discharges for the development of data hydrometric flood forecasting; Network design of Sri Lanka for stream gauging Capacity building	Application of rainfall-runoff models; Application of NWP for flood forecasting with technical assistance; Flood Hazard Mapping
Thailand	Rainfall data and MMS products at www.tmd.go.th	Experts to develop Thailand flood forecasting models and radar data; Training course of Flood Forecasting
Viet Nam	Process how to acquire NWP capability for Viet Nam	Calibrated quantitative precipitation observations using weather radars