World Meteorological Organization
Working together in weather, climate and water

WMO

Reporting on Task Team on Interoperable Technologies to Advance Flood Forecasting

Hwirin Kim / Paul Pilon

CHy recommendations

4.2 Hydrological application, products and services and water resources management

4.2.1 Flood Forecasting Initiative

Flood Forecasting Initiative Advisory Group (FFI-AG)

4.2.1.1 The commission was pleased to learn that the Executive Council, through Decision 7 (EC-68), had endorsed the FFI-AG and its work plan for 2016-2019

4.2.1.2 The Commission was satisfied with the general direction being taken by the FFI-AG, as it considered it was both appropriate and necessary to **focus activities and assist Members in advancing flood forecast early warning systems**. The commission expressed support **for the development of assessment guidelines for End-to-End Early Warning Systems (E2E EWS) for flood forecasting and in assisting Members capabilities** in this regard.

CHy recommendations

4.2.1.3 Furthermore, the Commission expressed the need to establish a compendium of freely available technology that could be recommended to Members to strengthen areas identified as weaknesses in the assessment process. As mentioned also in **paragraph 5.8** of the general summary, this **E2E EWS interoperable technology to enhance flood forecasting could constitute the basis of a new CHy community of practice**. It was envisaged that such technology should be **interoperable at all levels from data collection to informing users and decision-makers**.

5.8 In reviewing the experiences of the last four years, the Commission noted that some of the communities of practice had been successful, with a high level of participation and contributions, others had been useful as a repository of material, and some had not awoken much interest. ***One possible improvement proposed by several experts would consist in creating communities of practice to support the value chain of particular NHSs products, such as for flood forecasting, from data collection, management and quality control to modeling, forecast production and dissemination****. It was felt that such a comprehensive approach could be more attractive than that based on individual elements of the chain****.***

CHy recommendations

4.2.1.4 The Commission recalled that **freely available technology exists within the CHy community, which could potentially support E2E EWS**, such as the **DEWETRA** and the **Meteorological, Climatological and Hydrological Database Management System (MCH)** systems. These two systems were considered excellent examples of building blocks of E2E EWS covering the value chain from data acquisition and processing to decision support.

DEWETRA http://www.cimafoundation.org/en/workshop-on-the-dewetra-platform/
An operational system for integrated management of hydro-meteorological information for Disaster Risk Reduction by the Italian Civil Protection Department, the University of Genoa, Government of Liguria Region and Administration of Savona Province

MCH http://www.wmo.int/pages/prog/hwrp/mch/index.php
A database management system(DBMS) based on open source database and software by Mexico and adapted by the program of Cooperation for the Iberoamerican NMHSs has been transferred to WMO in 2011

CHy recommendations

4.2.1.4 The Commission noted that **combining the community of practice approach with assistance offered through a HelpDesk** is an excellent means of overcoming perceived weaknesses identified through the assessment process. Several delegates noted that there were **global and regional efforts that could either complement or be contributions to the community of practice on E2E EWS for flood forecasting**, thereby increasing the availability of local products to National Hydrological Services. As well, ICHARM noted that it has developed free runoff and inundation simulation software, such as **the Integrated Flood Analysis System (IFAS) and the Rainfall Runoff Inundation (RRI)** model and has been implementing these in developing countries. It noted the complementarity between its efforts and those of **the WMO FFI indicated its desire to cooperate with the WMO FFI promote the enhancement of E2E EWSs**.

IFAS http://www.icharm.pwri.go.jp/research/ifas/index.html
A concise flood-runoff analysis system as a toolkit for more effective and efficient flood forecasting in developing countries by ICHARM, JAPAN (on going project with ADB, JICA, and etc)
RRI http://www.icharm.pwri.go.jp/research/rri/rri_top.html
Rainfall-Runoff-Inundation (RRI) model is a two-dimensional model capable of simulating rainfall-runoff and flood inundation simultaneously by ICHARM, JAPAN (on going project)

CHy recommendations

4.2.1.9 The Commission was also informed that the Management Committee decided to support a new strategic direction for the APFM that increases its E2E EWS focus within IFM. This new approach, explained in detail in the **2016 APFM Advisory and Management Committee Report**, recognizes **the need for developing an end-to-end forecast and warning system as part of the process of implementing IFM and is designed to strengthen the contribution of NMHSs in applying IFM to communities and river basins**. It also requires the establishment of a project office that is customer oriented, with the primary client being Members and their national agencies as it will be necessary for APFM to assume a facilitative role to coordinate the involvement and roles of national governments, users, donor(s), NMHSs, Support Base Partners and other players in the implementation of IFM. A new business model should be developed and put into practice within 18 months to allow financial sustainability of the program.

http://www.floodmanagement.info/2016-advisory-and-management-committee-meetings/

http://www.floodmanagement.info/2017-advisory-and-management-committee-meetings/

CHy resolutions

Focus Area: Hydrological Applications, Products and Services

1.4 The AWG members will, with support from OPACHE experts as required, maintain responsibility for the following activities:

(e) Implementation Strategy for the End-to-End Early Warning Systems (E2E EWS) for flood forecasting (using the Community of Practice approach): **develop assessment guidelines for NHSs to evaluated their E2E EWS for flood forecasting, furthering the earlier work on "Efficiency of flood forecasting services**" (including testing developed procedures) possibly through the establishment of a Task Team/Working Group, consistent with the FFI AG-Work Plan of 2016-2019, **develop access to the interoperable technologies including platforms and models for use in flood forecasting**; **provide access to training and guidance material, in conjunction with item 1.4(g) below, on the aforementioned items; and assist in the development of projects;**

CHy resolutions

1.4 (g) APFM: **work with APFM on provision of guidance and training material on E2E EWSs for Flood Forecasting through the IFM HelpDesk, and other topics such as preparation of guidelines** on how to formulate numerical weather prediction information for use in flood forecasting, consistent with the FFI-AG Work Plan of 2016-2019. Represent CHy on the APFM AC/MC meetings.

Activity E2 Work plan

Action	Outputs	Milestones	Linkages
inventory and assessment of capabilities of existing platforms and hydrological forecast models	1. Guidance material on platforms and models;	1. Guidance material on platforms and models - 1st video conference (Aug 2017) - Establish Task Team (Sep 2017) - Develop initial draft short-list of hydrological models and platforms based on principles (e.g., freely available, widely used in operational forecasting) (Oct 2017) - Develop initial list of review assessment criteria (Oct 2017) - Task Team meeting (Nov 2017) - Prepare final initial list of models and platforms including links to guidance material on components (e.g., link to USACE HMS documentation) (Feb 2018) - Consider best approaches for inclusion of reservoir management within system (April 2018) - Finalize Guidance material and make available through E3 (by CHy-16, 2020)	WMO OPACHE CHy-AWG; FFI-AG; Member

Activity E2 Work plan

Action	Outputs	Milestones	Linkages
inventory of existing guidance material (what is available and what is missing), including river-ocean modeling and forecasting	2. Guidance material (e.g. NWP formulation for FF);	2. Guidance material (e.g. NWP formulation for FF??) (Yuri);	WMO OPACHE CHy-AWG; FFI-AG; Member
inventory of existing training material (what is available and what is missing	3. Training material needed to support CoP	3. Training material needed to support CoP - Acquire or develop training material including examples on approaching interoperable flood forecasting system development	

Activity E3 Work plan

Action	Outputs	Milestones	Linkages
design (assemble content) web portal (using existing IFM Helpdesk capabilities) allowing access to technologies (e.g. models), guidance and training material;	1. web portal of the CoP with easy access to available materials and technologies, and communication means with end users	1. Task Team meeting to develop CoP approach that will influence web-design (Nov 2017) 2. Develop functionality of web portal using existing IFM HelpDesk to allow access to models, platforms and training material (June 2018) 3. Test prototype of web portal before officially launching it (Aug 2018)	WMO OPACHE CHy-AWG; FFI-AG; Members

Task Team on Interoperable Technologies to Advance Flood Forecasting

The purpose of our task team is to develop inventory and guidance material on platforms and models, training material needed to support CoP including examples on approaching interoperable flood forecasting system development

- Hwirin Kim: Ministry of Land, Infrastructure and Transport, Repulic of Korea
- Jeff Perkins: Bureau of Meteorology, Australia
- William Scharffenberg: U.S. Army Corps of Engineers, United States of America
- Yeshewatesfa Hundecha Hirpa: Swedish Meteological and Hydrological Institute, Sweden
- WMO secretariat

Task Team on Interoperable Technologies to Advance Flood Forecasting

- a small number of identified hydrological models suitable for operational hydrological services to use for flood forecasting;
- a small number of identified routing models suitable for operational hydrological services to use for flood forecasting;
- a small number of identified platforms suitable for operational hydrological services to use for flood forecasting;
- ideas on how to combine models for coastal flooding(river-ocean flooding)
- for the above three items, please bring examples, including training and guidance materials that could be included in the inventories.
- ideas on the criteria to discern which models should be part of the initial inventory, and which can be expanded over time, noting the desires of CHy (i.e.. free and open source, user friendly?, etc.).

Definition

Interoperability: the ability of modelling systems or software to automatically exchange and make use of information from one to another. In the context of the flood forecasting domain, this can also mean interoperability between models made by different individuals or groups, such that they can easily interface with **a *platform***

Platform: software able to provide interoperability of modelling systems that do not possess this capability. It may also allow input of data with different formats and may provide output in a multiple of ways (graphs, tables).

Definition

Interoperable Technology promoted by this CHy initiative ***must*** be operationally used, be freely available, have low hardware requirements, be available in one of the official UN languages, have available training material, be sustainable (longevity aspect) and be institutionally supported. Such technology also ***should*** be open source and be easy to use (simplicity).

Criteria for assessment

Develop initial list of review assessment criteria

- **Must**: Strongly to be required
- **Should**: Important components
- **Could**: Less important but good to have

Develop initial draft short-list of existing hydrologic models and platforms

✓ Models: HEC-HMS, HYPE, URBS, HBV aka HBV96, GRM , GR4H, HEC-RAS
✓ Platforms: HEC-RTS, AEGIR + HYFO, Delft FEWS, K-EWS, SWIFT

Criteria for assessment

Criteria	Model (HEC-HMS)	Platform (HEC-RTS) designed for HEC software
Operationally used(must) model and platform	Y	Y (internally and possibly a few external)
Freely available	Y	Y
Hardware requirements (low end)	Y	Y (windows server, 8-12 cores)
Availability of training material	Y	Under development
Institutional Support	Y	Y
Languages training and software	Y - English	Y - English
Sustainability - longevity	Y	Y (new initiative, uncertain future)
Peer review or Case studies (modelling only)	Y	
Open source or source is available (should) model and platform	N	N
Updating (modelling only)	Y	
Simplicity – calibration, parsimony (modelling only)	Y	
Simplicity – usability(m & p)	Y	N (Powerful & flexible)
Pre-existing CoP (m &p) could	N	N

Criteria	Model (HEC-HMS)	Platform (HEC-RTS) designed for HEC software
Data Format (model) could	N – Uses ACE formats???	
Data Format (platform) must/should		Y, possibly oneWMO format, Y API used
Visualization (platform)		Y
Data QA/QC (platform)		Y
Open/closed platforms		Y (open)(but complex to do)
Internet-based system (platforms)		N
Redundancy capability (platforms)		Y

- **Criteria for "data format" for models**: To promote interoperability, the hydrological, hydraulic or reservoir model's data structure (input/output) ***should*** be documented with the programming Application Programming Interface (API) being made freely available
- **Criteria for "data format" for platforms:** To promote interoperability, the platform ***must*** allow multiple input formats (documented), ***should*** support at least one WMO format, and ***should*** document its output format with the programming Application Programming Interface (API) being made freely available.
- **Open versus closed systems:** open systems can easily incorporate a variety of hydrological, hydraulic and reservoir models, while closed systems are built for specific models and cannot easily add other models without undertaking complex coding

Hydrologic Model Template

Short Name	. HBV
Long Name	. Hydrologiska Byråns Vattenbalansavdelning model
Model Type	. Continuous, semi-distributed model
Usage	. Riverine Flood Forecasting and Flow(low to high) Forecasting . Simulation of hydrological time-series . Short range forecast, Inflow volume forecast, . Simulations in ungauged catchments . Climate change studies
Background	. A computer simulation used to analyze river discharge and water pollution . To create a conceptual hydrological model with reasonable demands on computer facilities and calibration data . The model is a standard forecasting tool in Sweden and other Nordic countries, and also used for simulations in ungauged catchments, mainly in small and unregulated rivers . Developed by SMHI in the early 70´s to assist. . In 1993 the Swedish Association of River Regulation Enterprises (VASO) and the SMHI initiated a major revision of the structure of the HBV model . HBV-96 is the final result of this model revision

Hydrologic Model Template

Developer	. SMHI
Channel Routing	. Muskingum or Nonlinear storage function for channel routing ?
Reservoir Operation	
Number of Calibration Parameters	
Institutional and operational effort	
Snow Accumulation	. calculated after defining a threshold melting temperature . the result is divided into a liquid part that is the surface runoff and a second part that infiltrates
Precipitation	. Sub-basin average
Evapotranspiration	. input to the model
Calibration/Optimization	
Updating/Assimilation	

Hydrologic Model Template

Input Data	. Daily Temperature, Rainfall, Monthly Potential Evapotranspiration
Model Output	. Daily Discharge
Hardware requirements	. PC
Operating System	. Windows
Programming Language	. Fortran
Open Source	. Yes
Download URL	.
Language of Software	. Swedish and English
Training Material URL	
Guidance Material URL (including case studies)	

Hydrologic Model Template

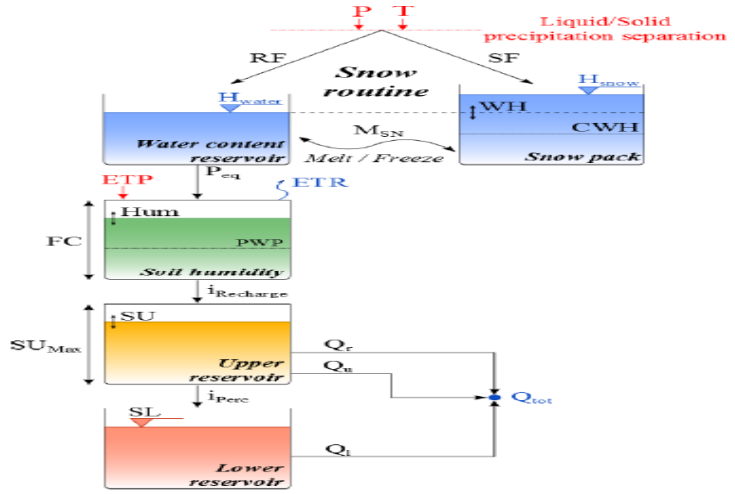
Latest Update & Version	.1996?
References	.Bergstrom, S. (1995) The HBV Model. In V.P. Singh (Ed.) Computer models of watershed hydrology, pp. 443-476, Water Resources Publications, Highland Ranch, Colorado, USA.
Contact Organization	.https://www.smhi.se/en/services/professional-services/energy/hbv-state-of-the-art-hydrological-modelling-1.7540
Model Schematic	

Table update 14 Nov 2017

Additional Models & Platforms

must pass screening criteria

Hydrologic Models

- Lisflood
- Sacremento
- WFlowDeltares
- X
- X
- X

Platforms

- Green Kenue
- La POM
- JRCEFAS platform?
- Y
- Y
- Y

Additional Models & Platforms

must pass screening criteria

Hydraulic Models

- Lisflood
- Telemac 1- and 2-D
- MASCARET (Schapi, France)
- ISIS (EA, UK)
- SOBEK (Deltares)
- Delft 3D-FM
- X
- X

Reservoir Management/Operations

- HEC-ResSim
- HYPE reservoirs module built-in
- Y
- Y
- Y

Further Consideration

- Costal Flooding(river-ocean modelling and forecasting)
- Real time or Pre-processed Flood Maps for impacted communities
- Flood Risk Modelling
- Flash Flood Forecasting
- Linkage with FFI projects and demo projects(FFGS, CIFDP, SWFDP)
- Database System, GIS, etc

Future Plan

Action	Name	Deadline
Platforms draft Template	**Jeff**	**Jan 2018**
Hydraulic Model draft Template	**Jeff**	**Jan 2018**
Reservoir Operation Model draft Template	**William/Yeshewatesfa**	**Jan 2018**
Guidance material of NWP formulation for Flood Forecasting	**Narendra?**	?
Guidance material or Model of CFIDP (the Coastal Flood Inundation Demonstration Project)	**Yuri**	**Dec 2018**
Teleconference (16 Feb 2018 Geneva 12:00 P.M for 90 min)	**TT interoperable**	**Feb 2018**
Request for reviewing our works & collecting case studies to Regional Hydrology Advisors, NMHSs, OPACHE, AWG of CHy	**Hwirin**	**Mar 2018**
Detailed explanation on each item of the criteria	**Hwirin, Jeff, William, Yeshewatesfa and others**	**Jun 2018**
Collect existing guidance and training materials (consider what is available and what is missing)	**TT interoperable**	**Late 2018**
Develop final inventory and assessment of capabilities of existing platforms and hydrological forecast models	**TT interoperable**	**meeting 2019**
Develop final inventory of existing guidance and training material	**TT interoperable**	**meeting 2019**

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

Thank you
Merci

WMO OMM

World Meteorological Organization
Organisation météorologique mondiale