Implementation of the Community Hydrologic Prediction System

Jon M. Roe
Chief, Hydrologic Software Engineering Branch
NOAA/NWS Office of Hydrologic Development
Advisory Committee on Water Information:
Subcommittee on Hydrology (ACWI-SOH)
29 April 2010

With tremendous contributions from...
Harold Opitz
HIC Northwest River Forecast Center
&
David Vallee
HIC Northeast River Forecast Center
Topics

► Background
► What is CHPS?
► Hydrology community benefits
► Development timeline
► Risk reduction forecast offices
► Transition challenges
► Operations benefits
► Global user community
Background

► Today’s NWS River Forecast System (NWSRFS) has been the NWS hydrologic forecasting foundation for over 30 years

► NWSRFS architecture hinders use of recent advances in interactive forecasting and modeling

► NWS needs an improved hydrologic modeling infrastructure to leverage community operational concepts and models as well as provide future products and services

► The Community Hydrologic Prediction System (CHPS) will replace NWSRFS

► For more information, see the NWS OHD CHPS web site (http://www.nws.noaa.gov/ohd/hrl/chps/index.html)
What is CHPS?

► CHPS is both a system and a concept
  ▪ Open forecasting system to promote model & data sharing
  ▪ NOAA reaching out to hydro community

► CHPS uses Delft-FEWS from Deltares (Dutch Foundation) as core infrastructure
  ▪ FEWS: Flood Early Warning System
  ▪ Model adapter concept for algorithm modularity
  ▪ Sophisticated data and workflow handling for models
  ▪ Comprehensive forecaster user interface and displays (the IFD)
  ▪ Highly configurable modeling environment via XML files

► Initially, includes NWSRFS models and USACE models (HEC-RAS and HEC-ResSim)

► Later, can include models from other providers
CHPS and FEWS

Models from Federal, State, Local, University and international researchers
FEWS Model Adapters

![Diagram of FEWS Model Adapters]

- **FEWS Forecasting Shell**
  - **FEWS General Adapter**
    - **FEWS-PI XML**
      - **User-specific Model Adapter**
        - **Write**
          - Model native input files
        - **Execute**
          - Model.exe
        - **Read**
          - Model native output files
FEWS Development – Past 10 Years

► First FEWS system: 1992 in Sudan
  ▪ Blue Nile, Atbara & White Nile
  ▪ Used Sacramento Rainfall-Runoff, HD routing & Reservoir models
► 1997/1998 more flexible FEWS system deployed in Pakistan & Czech Republic
► 1999 European Flood Forecasting System (EFFS) was developed
  ▪ Modernize flood forecasting capabilities
  ▪ Birth of the Java-based FEWS
  ▪ Also became the operational system in Switzerland & the Netherlands
► 2002 Environment Agency, UK adopted FEWS as the infrastructure for NFFS
  ▪ Birth of FEWS 2.0 – configured as a client-server system

Today  2007

2006
FEWS Scotland, FEWS Po (Italy)
FEWS DE (Germany),
FEWS Singapore

2005
FEWS Regge & Dinkel, Netherlands
FEWS Beijing (China),
FEWS Oberösterreich (Austria)

2004
FEWS-JRC (EU-Italy),
FEWS Niederösterreich (Austria)

2002
NFFS (England & Wales)

2001
FEWS Taiwan

1999
EFFS (EU)
FEWS-NL, The Netherlands
FEWS-CH, Switzerland

1998
FEWS Orlice (Czech Republic)

1997
FEWS Pakistan, Pakistan

1996
FEWS Vistula (Pilot), Poland

1990
FEWS Sudan, The Sudan
The CHPS Interactive Forecaster Display

[Map and graphical display of CHPS Interactive Forecaster Display]
CHPS and AWIPS

► CHPS will be the river modeling and forecast component of AWIPS when it replaces NWSRFS

► CHPS will be integrated, as a large technology infusion, into AWIPS following AWIPS II (see paper 7B.4)

- CHPS will be run in an AWIPS environment at NWS RFCs
- Integration with AWIPS must be limited to allow CHPS to be made available as a forecasting environment for non-AWIPS based organizations (e.g., other countries)
Hydrology Community Benefits

► Key motivation for community is to broaden and accelerate research to operations
  - Enhance understanding of hydrologic forecasting within hydrologic research community

► Hydrology community includes
  - NOAA line offices
  - other U.S. Federal agencies (e.g., USACE, USGS, USBR)
  - U.S. Universities (e.g., [http://www.cuahsi.org/](http://www.cuahsi.org/))
  - International researchers

► NWS to make CHPS and hydro models available
The NWS Path to FEWS

- 2003: OHD initiated exploration of a replacement for NWSRFS
- 2005: Several candidates considered – including Delft-FEWS
- 2006: ABRFC, NCRFC, NWRFC and CNRFC volunteered to work with OHD to evaluate candidates
  - (CHPS Acceleration Team or CAT)
- 2006: Selected Delft-FEWS as the candidate for CHPS
- 2007: Built CHPS prototype on top of FEWS to prove viability
- 2008: OHD Director approved decision; proceed with implementation of Delft-FEWS as the CHPS software infrastructure
  - NERFC brought on board to replace NCRFC as a CAT member
  - NOHRSC added as well
  - NWSEO brought on board to help develop path toward operational testing, evaluation and impact and implementation
Risk Reduction River Forecast Offices

► Goal to create and validate transition path for 9 follow-on RFCs based on CAT RFCs’ experiences with one year lead in schedule

► Support for follow-on 9 RFCs from the 4 risk reduction RFCs
  ▪ Each CAT RFC to assist 2 – 3 “buddies”
  ▪ “Buddy” visits were conducted in March through July of 2010
  ▪ Migration activities at these 9 RFCs are in progress

► Also key to risk reduction was establishment of a clear set of “Baseline” Operational Capabilities to avoid requirements creep

► CAT RFCs have moved into some degree of parallel execution with NWSRFS
Transition Challenges

► Challenges are technical
  ▪ Must not disrupt daily forecasting
  ▪ Must assure hydro models perform the same within new infrastructure
  ▪ Must assure model performance not degraded while taking opportunity to move to gridded meteorological forcings

► Challenges are cultural
  ▪ NWS forecasters require training
  ▪ NWS researchers and programmers need to re-orient to highly configurable environment

► Field support requires new paradigm that includes support of external models

► Operating in a truly community oriented environment within the U.S. and abroad
Operations Benefits

► More flexibility to address upcoming major service enhancements
  ▪ Short term ensemble forecasts
  ▪ Gridded hydrologic modeling
  ▪ Gridded water resources forecasts

► Simpler and accelerated research to operations path

► Take advantage of community-developed models

► Simpler and lower cost of software maintenance and addition of small enhancements
  ▪ NWS developers concentrate on hydrology not infrastructure
WFO Benefits

► More efficient and timely delivery of forecasts
► With the infusion of new science and modeling – improved forecasts for short/long range
► Collaborative hydrologic/hydraulic modeling activities
  ▪ Site Specific
  ▪ International Partners – New Brunswick, Canada, NERFC and WFO Caribou, ME
► Potential for a CHPS Client to reside at the WFO
► Improved collaboration between RFCs and WFOs
Global User Community

- FEWS infrastructure and adapter mechanism is used today across Europe and in Asia
  - Many models from around the world have FEWS adapters

- Deltares views a major FEWS purpose as “exchanging ideas by incorporating them into software”
  - Example: IFD forecast modification enhancements via NWS now available to global users
  - Example: hydraulic profiles and skill scores added via U.K. National Flood Forecasting System now available to NWS

- International exchange of ideas will benefit NWS operations

- Deltares hosts an annual user group meeting in Delft, The Netherlands
Questions???