FEWS for CHPS

Design Document

April 2007
DELFT-FEWS- An open shell flood forecasting system

• Philosophy
  - Open shell system for managing forecasting process
  - Shell provides general functional utilities
  - Open interface to forecasting modules
Presentation Agenda

Delft FEWS Standalone System Architecture
CHPS FEWS Pilot Software Architecture
Delft FEWS Design Approach
Delft FEWS Configuration
CHPS FEWS Pilot Setup for NWRFC, NCRFC
Stand Alone System
(Distributed system available but not used for Pilot)

FEWS Explorer
Main GUI
Task Running

Running models
Through adapters
Under control of FEWS-GUI

AWIPS/Linux

FTP Server

DELFT FEWS GUI

DELFT FEWS Operator Client

Module Adapter

Input Data: PI-XML

Module Engine

Native Date

Results: PI-XML

Native Date
CHPS FEWS Pilot software architecture

- Data importer (from IHFS_DB)
- FEWS infrastructure
- Internal data storage; Custom: Maps, Config info, Workflows
- Delft native GUIs

Key:
- OHD provided
- Delft provided
- RTi provided

THIS DOCUMENT ONLY ADDRESSES DELFT PROVIDED COMPONENTS
FEWS Approach

Modular Approach
• **WhiteCart_Forecast workflow**
Open interface to models

General Adapter Module
- Published interface (XML)
- Module adapters

OpenMI adapter

Philosophy
- No model intelligence in DELFT-FEWS
- Model intelligence vested in model adapter
Running modules in a workflow

Import workflow

Communication: Time Series

Export workflow

forecast workflow

Transformation

Interpolation

Transformation

General Adapter

General Adapter
General Module layout

anyModule

- Request data from datastore
- Do something …
- Write data to datastore
DELFT FEWS Configuration

Elements of the DELFT-FEWS configuration

• Main DELFT-FEWS configuration (config directory)

• Root configuration

• Layout configuration
  – Icons
  – Maps

• External Modules
FEWS Configuration

Main DELFT-FEWS Configuration
(Stand Alone: Config directory)

• All configuration in XML format

• Various section
  – RegionConfigFiles  Locations, Parameters etc.
  – SystemConfigFiles  Main system config
  – ModuleConfigFiles  All “processing” modules
  – DisplayConfigFiles  Displays
  – WorkflowFiles  Definition of workflows
XML Configuration and XSD Schemas

- Each XML configuration adheres to a XSD schema
- Independent check on correct information
  - Required Items
  - Optional items
  - Types
Defining Locations

Locations.xml

```
<locations>
  <location id="ABRN8" name="Abercrombie">
    <description>Wild Rice River</description>
    <shortName>Abercrombie</shortName>
    <x>-96.783</x>
    <y>46.486</y>
    <z>276.740</z>
  </location>
  <location id="BRKM5" name="Baker">
    <description>Stoney Creek</description>
    <shortName>Baker</shortName>
    <x>-96.360</x>
    <y>46.740</y>
  </location>
  <location id="SABM5" name="Sabin">
    <description>Buffalo River South Branch</description>
    <shortName>Sabin</shortName>
    <x>-96.627</x>
    <y>46.776</y>
  </location>
  <location id="HAWYM5" name="Hawley">
    <description>Buffalo River</description>
    <shortName>Hawley</shortName>
    <x>-96.329</x>
    <y>46.850</y>
  </location>
  <location id="DILM5" name="Dillworth">
    <description>Buffalo River</description>
    <shortName>Dillworth</shortName>
    <x>-96.840</x>
    <y>46.961</y>
  </location>
  <location id="FGON8" name="Fargo">
    <description>Red River</description>
    <x>-96.877</x>
    <y>46.661</y>
  </location>
  <location id="HWDN8" name="Harwood">
    <description>Sheyenne River</description>
    <shortName>Harwood</shortName>
    <x>-96.632</x>
    <y>46.672</y>
  </location>
  <location id="HICN8" name="Hickson">
    <description>Red River</description>
    <shortName>Hickson</shortName>
    <x>-96.590</x>
    <y>46.984</y>
  </location>
  <location id="BJI" name="Berndji AWOS">
    <description>Red River Basin</description>
    <shortName>Berndji AWOS</shortName>
    <x>-96.687</x>
    <y>46.500</y>
  </location>
  <location id="CKN" name="Crookston Municipal Airport">
    <description>Red River Basin</description>
    <shortName>Crookston Municipal Airport</shortName>
    <x>-96.687</x>
    <y>46.500</y>
  </location>
  <location id="DTH8" name="Detroit Lakes Airport">
    <description>Red River Basin</description>
    <shortName>Detroit Lakes Airport</shortName>
    <x>-96.687</x>
    <y>46.500</y>
  </location>
</locations>
```
**LocationSets**

- Allows Defining locations with common properties
- Locations may exist in various “sets”
- Apply operation to set of n locations - rather than n times to 1 location per time

<table>
<thead>
<tr>
<th>locationSet (29)</th>
<th>id</th>
<th>locationSetId</th>
<th>locationId</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 HydroStations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 HydroStations_Santiam</td>
<td></td>
<td>locationSetId (2)</td>
<td>locationId (8)</td>
</tr>
<tr>
<td>3 Reservoirs_Santiam</td>
<td></td>
<td>locationId (3)</td>
<td></td>
</tr>
<tr>
<td>4 HydroStations_RedRiver</td>
<td></td>
<td>locationId (8)</td>
<td></td>
</tr>
<tr>
<td>5 Ratings_RedRiver</td>
<td></td>
<td>locationId (8)</td>
<td></td>
</tr>
<tr>
<td>6 ExternalForecast0_RedRiver</td>
<td></td>
<td>locationId (4)</td>
<td></td>
</tr>
</tbody>
</table>
Running a model through the General Adapter
SACSMA_GPRO3IU_Historical 1.00 default.xml

```
<generalAdapterRun xmlns=http://www.wldelft.nl/fews
                      xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
                      xsi:schemaLocation=http://www.wldelft.nl/fews
                                        http://fews.wldelft.nl/schemas/version1.0/generalAdapterRun.xsd
                  
                  <general>
                      <activities>
                          <exportActivities>
                              <exportStateActivity>
                                  <exportTimeSeriesActivity>
                                      <exportFile>inputs.xml</exportFile>
                                  </exportTimeSeriesActivity>
                              </exportStateActivity>
                          </exportActivities>
                          <executeActivities>
                              <executeActivity>
                                  <command>
                                      <className>ohd.hseb.fewsadapter.FewsAdapter</className>
                                  </command>
                                  <arguments>
                                      <argument>10</argument>
                                  </arguments>
                                  <timeOut>30000</timeOut>
                              </executeActivity>
                          </executeActivities>
                          <importActivities>
                              <importStateActivity>
                                  <stateConfigFile>%ROOT_DIR%/states/states.xml</stateConfigFile>
                              </importStateActivity>
                              <importTimeSeriesActivity>
                                  <importFile>sacsmaoutput.xml</importFile>
                              </importTimeSeriesActivity>
                          </importActivities>
                      </activities>
                  </general>
```
Workflows

‘hydrologically” logical sequence of running modules
• Multiple modules/steps per segment
• Granularity configurable
  – Workflow per forecast group
  – Workflow per segment

Demo
Amend the Fluvial_Forecast workflow
Provide a “new” workflow that runs the Great Peter Inflow segment only
Workflows

Follow “Hydrological” order

Demo: Configure GPRO3 as separate workflow
CHPS FEWS Pilot

Current Pilot
- Explore/Demonstrate using FEWS for providing forecasting capabilities
- Explore/Demonstrate modularity of FEWS in delivering this and how this approaches the SOA concept

Pilot basins/Segments
- Santiam in NWRFC
- Buffalo River and Red River SOBEK model in NCRFC
CHPS FEWS Pilot

Main Elements of each basin

Santiam
- Catchments (Snow, Runoff, UnitHG)
- Reservoirs
- Routing
- Naturals
- Effective locals

Red River
- Catchments (Snow, Runoff, UnitHG, Frozen Ground)
- SOBEK Routing
Setting up the CHPS FEWS Pilot

Approach to configuration

- Static data (Locations, Parameters) *slides 21-23*
- Importing data from external sources *slides 24-25*
- Pre-processors (MAP, MAT) *slides 26-27*
- Models *slides 28-33*
  - SNOW-17, SAC-SMA, UNITHG, SARRESV, SARROUTE, LAG-K, TATUM
- Additional Data handling *slide 34*
- Displays *slide 35*
  - PLOT-TULSA
- MODs *slides 36-38*
- Calibration of models *slides 39-48*
Static Data

Locations - Santiam Basin to Jefferson

- All locations defined in SEGMENTS set up in FEWS (some reduction in “dummy locations”)
  - Temp/Precip gages
  - River Gages
  - Reservoirs (3)
  - Catchments (14)
Static Data

Locations – Buffalo River & Red River
All locations defined in SEGMENTS set up in FEWS
- Temp/Precip gages
- River Gages
- Catchments (5)
Static Data

Parameter Naming Conventions
- Taken from NWSRFS Convention
- UNITS are METRIC
  - Database
  - Displays
Importing Data

Process
• Data extracted from IHFSDB (Danny’s Program) – XML files
• dropped in Import Folder
• FEWS Reads from there

Source Type Codes
• All source type codes exported
• Handshake set to import data for specified type codes per location
Importing Data - Additional

SHEF
• SHEF Data for NCRFC
• Inflows into Red River not calculated in FEWS pilot
• MAP – MAT for checking

MPE (MAPG)
• Gridded radar precip fields
• Imported through GRIB1 Files
Configuring pre-processors

- **MAT**
  - T available at various resolutions
  - 24h data disaggregated
  - 3h data aggregated
  - Merged with 6 hr data
  - MAT calculated
    - Weights (distance)
    - Elevation normalised using temp lapse
Configuring pre-processors

• MAP
  – PP24 used as backup to 6hr
  – MAP calculated as weighted average
Models - Snow

NWSRFS: SNOW-17

FEWS: SNOWMELT
  - Degree-Day model
  - Discrete elevation zones (elevation-areas)

  - Inputs
    - MAT & MAP (SNOG not used)

  - Outputs
    - SWE, RAIM, SASC
Models - Runoff

NWSRFS: SAC-SMA

FEWS: SAC-SMA
- Legacy model migrated
- Adapter developed by Suddha
- Frozen-Ground model (NCRFC)

- Inputs
  - RAIM (legacy)

- Outputs
  - INFW
Models - UNITHG

NWSRFS: UNIT-HG

FEWS: GammaModel
  • Allows UNIT-HG routing
  • Same ordinates as NWSRFS

  • Inputs
    – INFW

  • Outputs
    – SQIN
Models - Reservoirs

NWSRFS: SARRESV

FEWS: SAMRT
- Simple Resv model
- Area-Elevation
- Spill & setting of Pool elevation and Q-out

- Inputs
  - QINE (SQIN)
  - RQOT, FBEL

- Outputs
  - SQIN, PELE
Models - Routing

NWSRFS: SARROUT, LAG-K, TATUM

FEWS: SAMRT
- Muskingum Routing
- Single parameterisation

- Inputs
  - QINE (SQIN)

- Outputs
  - SQIN
Models - Additional

NWSRFS: - FldWav

FEWS: SOBEK
- Hydrodynamic Routing
- Transformed from HEC-RAS model

- Inputs
  - SQIN

- Outputs
  - SQIN, SSTG
Additional Data handling

NWSRFS: ADJUST-Q
FEWS – ARMA Model
   Fixed “blend” rate

NWSRFS – CHANGET, WEIGH-TS, ADDSUB
   (confluences, naturals, effective locals etc)

FEWS – Transformation Module
Displays

Available through pre-configured displays
- On the fly displays also available
MODS (1)

Available as What-if scenarios

Configured changes allowed to
- MAP & MAT
- FMAP & FMAT
- FBEL, RQOT
- QIN

Changes
- Arithmetic operators
- Typical profiles
MODS (2)

Changes to model parameters

• Multiple parameterisat sets available
• Selection of parameter set version
MODS (3)

NWSRFS: MODS

FEWS: What-If scenarios
• Need to be selected explicitly to run with forecast
• not possible to set validity data
• less interaction with model parameters
Model Calibration

Historic dataset
1948-2005
(contiguous for smaller period)

Concentrated on Snow models
• “Translation” of parameters from SNOW-17
• UNIT-HG, SAC-SMA same as in NWSRFS
• Reservoirs – mainly geometric data – translation of some data required (volume –elevation vs area elevation)
• Routing models – simple parameterisation
• SOBEK model – (very) rough
Snow Conditions (Lower)

[1] SNSG Green Peter Inflow Lower
[1] SNSG Green Peter Inflow Lower

[04/01/1993 00:00:00 Current Santiam_Historical]
Runoff (Lower)

Precipitation (mm)

Runoff (mm)

[1] RAIM Green Peter Inflow Lower

[1] INFV Green Peter Inflow Lower

[1] 04-01-1993 00:00:00 Current Santiam_Historical

FEWS for CHPS pilot

04/06/2007
Snow Conditions

- [1] SWE Dillworth Local
- [1] SNSG Dillworth Local

04/01-1992 00:00:00 Current RedRiver_Historical

FEWS for CHPS pilot

04/06/2007