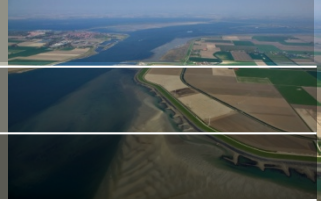
Deltares
Enabling Delta Life

System Integration

Albrecht Weerts/Peter Letitre (and many others)

Peter.letitre@deltares.nl

29/01/14

- Introduction
- Forecasting for Early Warning -current state of the art (20-25 minutes)
- Example/Pilot (Rio Doce), screenshots (5 minutes)

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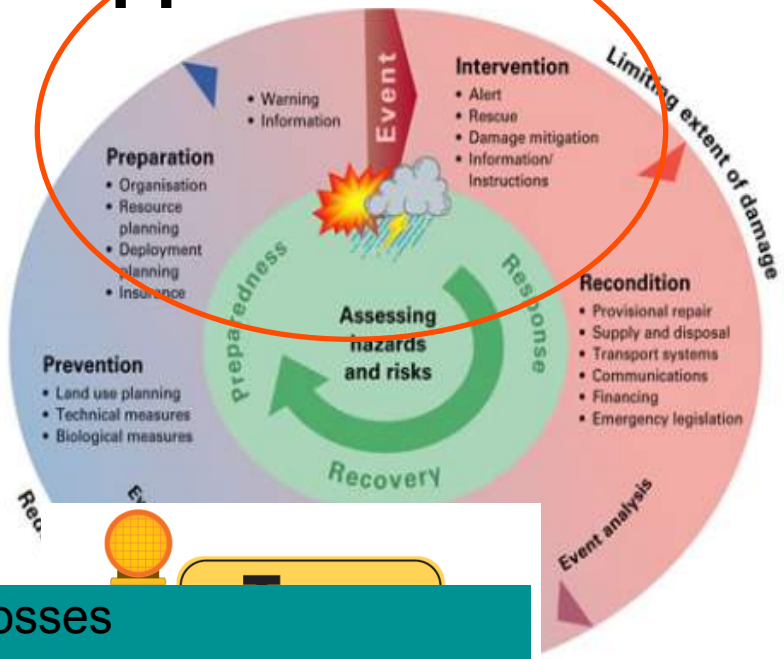
Structural vs Non-Structural approach

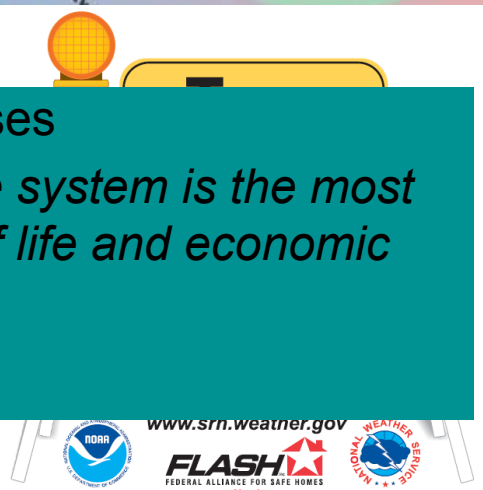
Traditional approach to flood risk management – structural measures

State-of-the-art – more holistic approach, considering both structural and non-structrural approaches



UN ISDR Guidelines for the reduction of flood losses

The operation of a flood warning and response system is the most effective method for reducing the risk of loss of life and economic losses



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Courtesy Micha Werner

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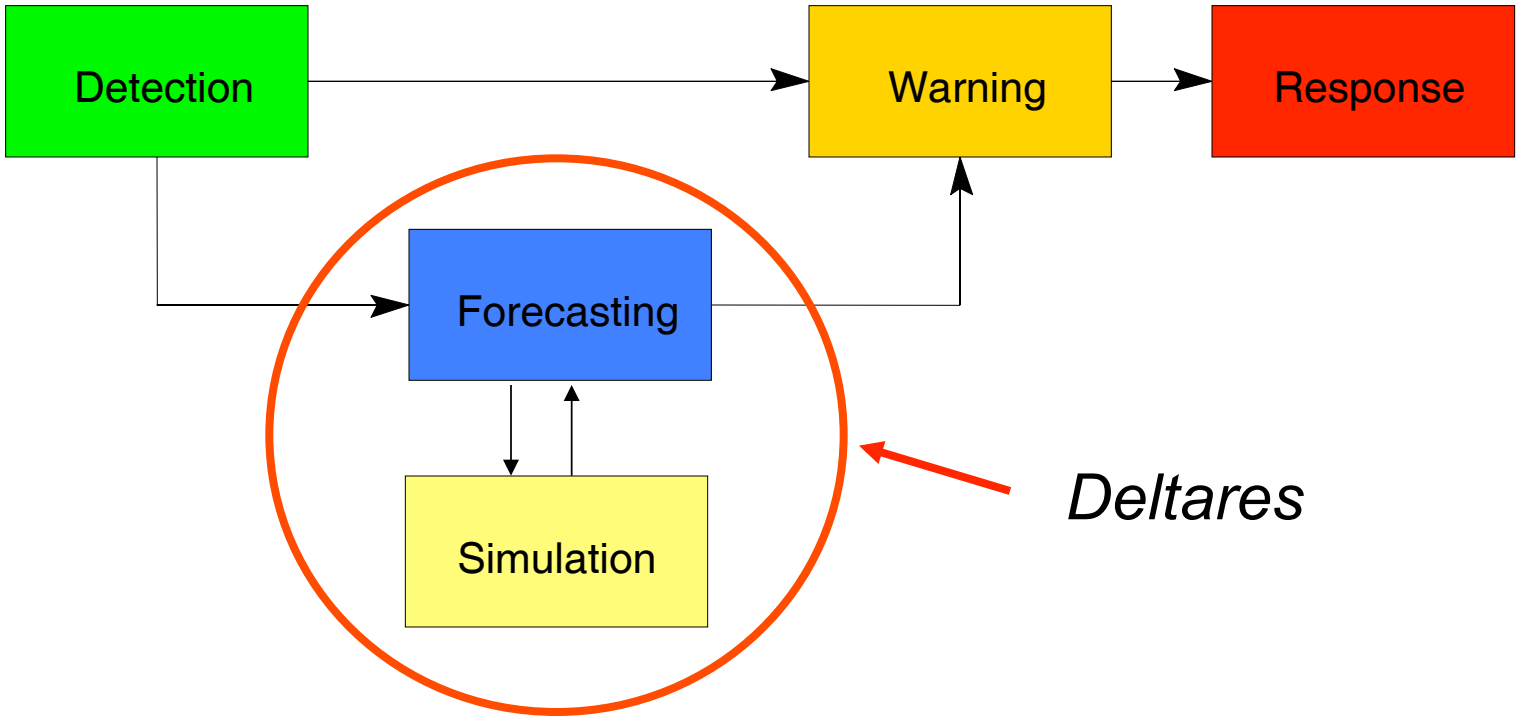
Deltares & (flow) forecasting

- Hydrology in real-time; integrator of complex information to provide decision makers with a platform to take qualitatively good decisions on floods, droughts & operational management
- Water quality (incl. spills) and ecology (e.g. algae blooms)
- Levee strength
- (Scenario & design studies)



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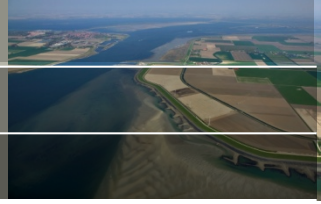
Deltares & (flow) forecasting



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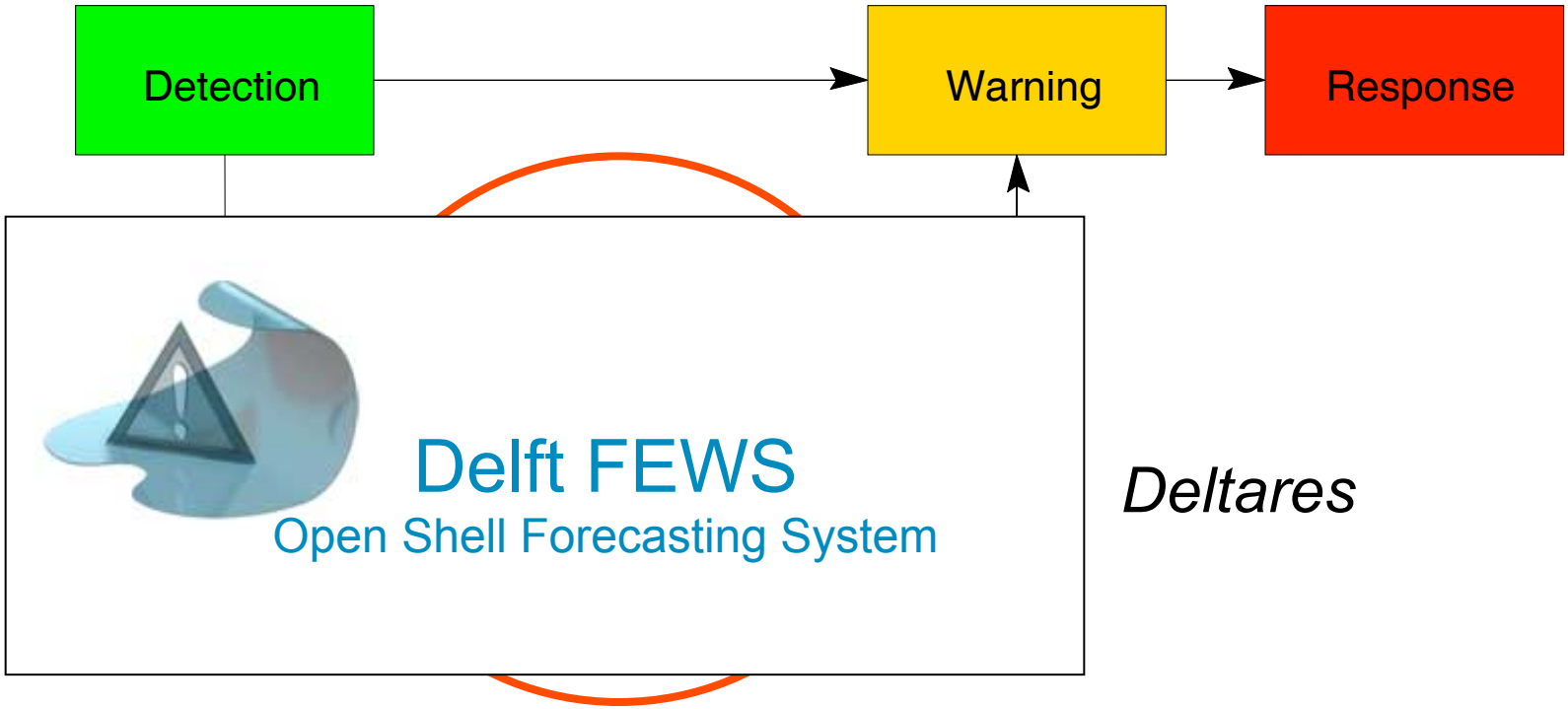
Hydrology in real-time; integrator of complex information to provide decision makers with a platform to take qualitatively good decisions on floods, droughts &



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The Flood Forecasting & Warning Process

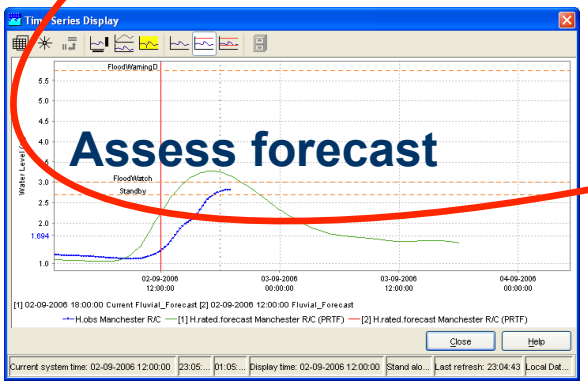
Flood Forecaster

Run model

Get and interpret data

Act ?

Hydrologist



Assess forecast

Flood Warner

Issue?

Warn

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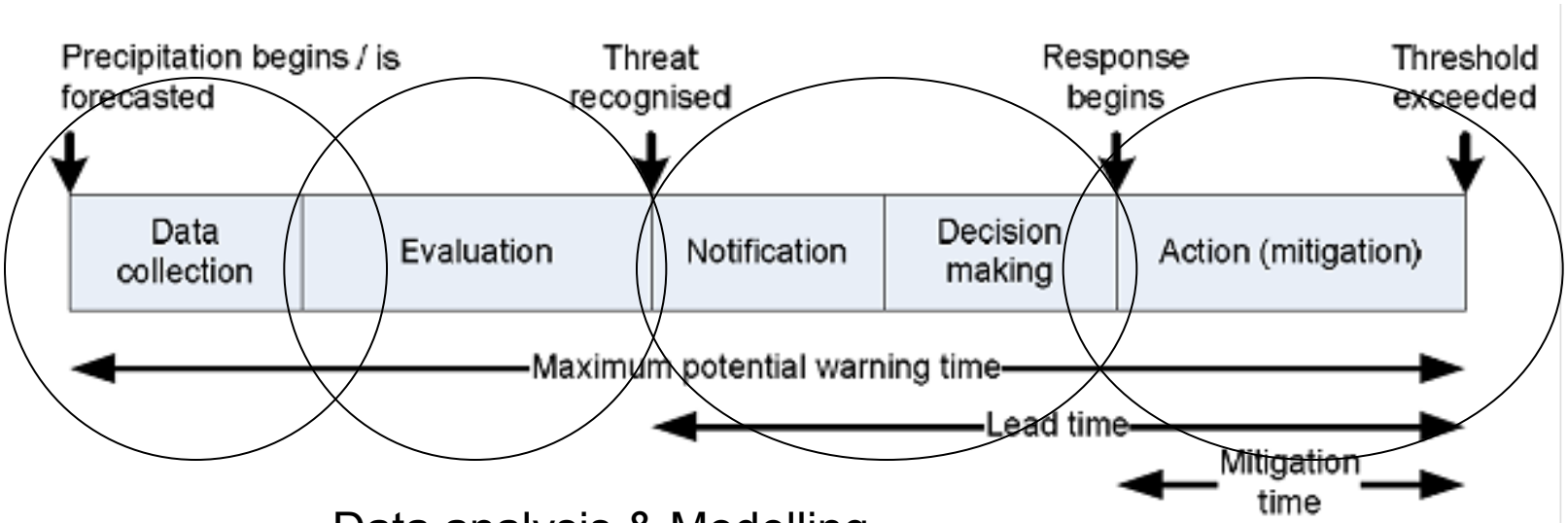
Factors determining leadtime



Data analysis & Modelling

Carsell 2004;

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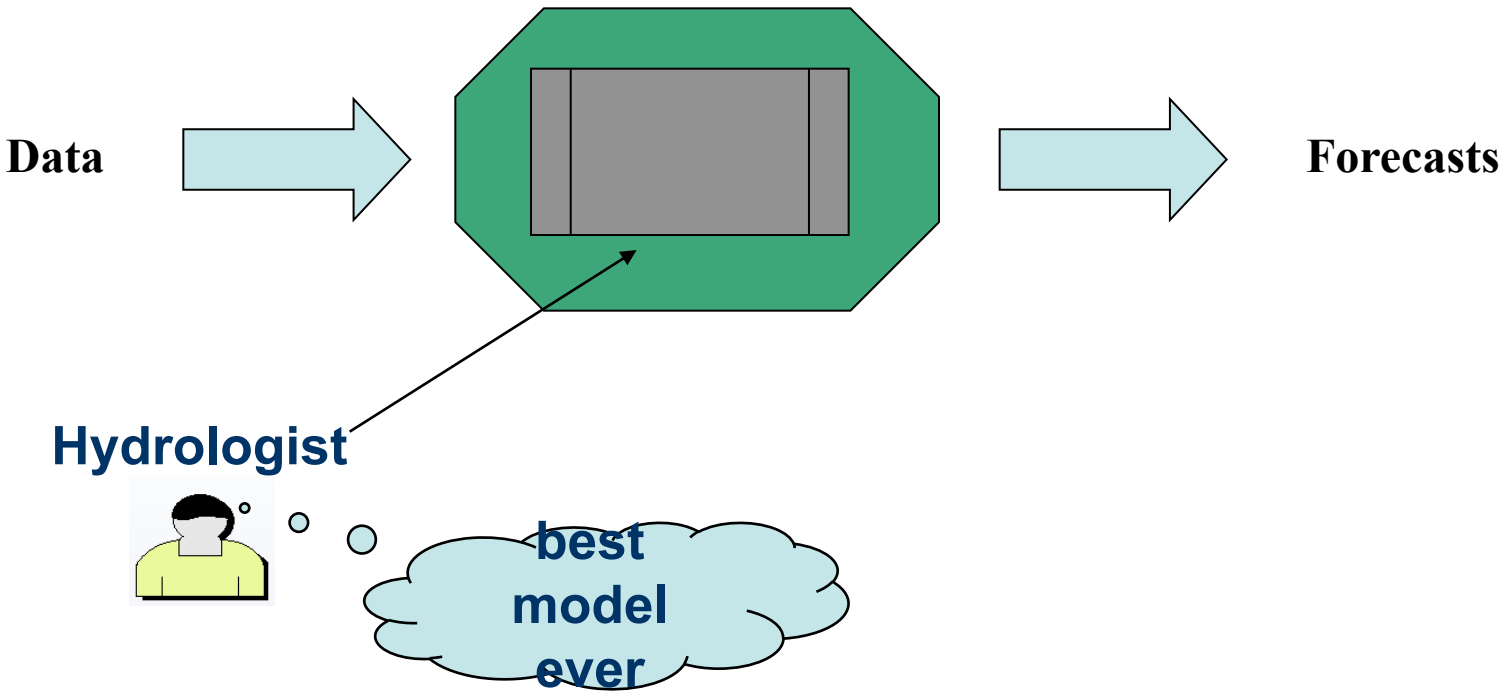
Flood forecasting system development..

Traditionally bespoke developments around existing models



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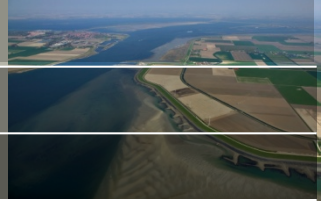
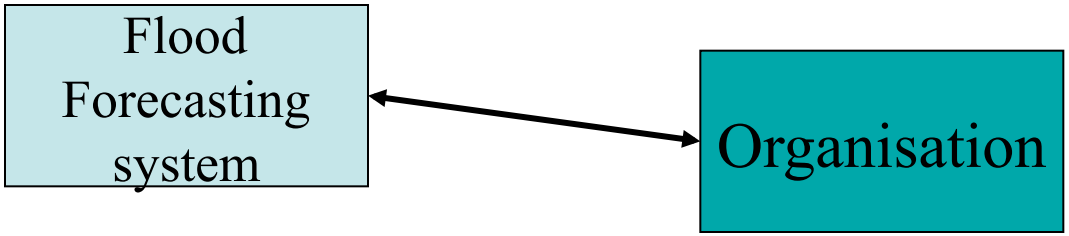
Model Centric approach



Advantages

Model often tailor made to suit situation

Vested interest/knowledge/investment in model



Disadvantages

Inflexible to changing model needs & data availability

difficult to assess objectively

system closely related to organisation

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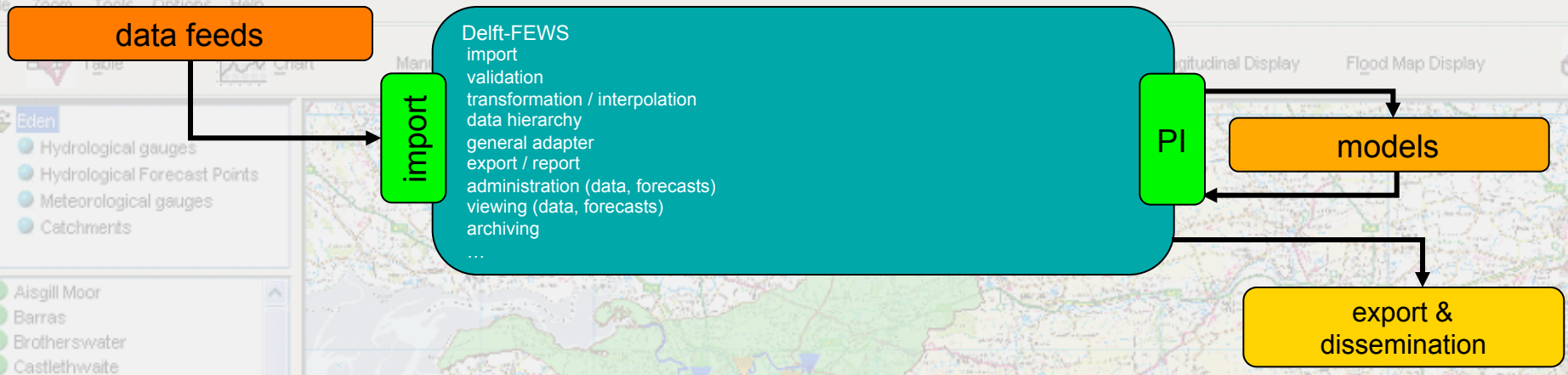
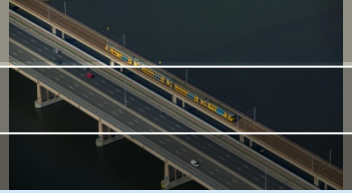


DELFT FEWS – flood forecasting shell

Philosophy

- Data centric
- Framework for organisation for the flood forecasting process
- Integration of data from several sources - present single source to forecaster
- Provides general functional utilities
- Open interface to models used for forecasting
- Dissemination of results
- Delft FEWS is an open system – joint development approach

Data centric approach



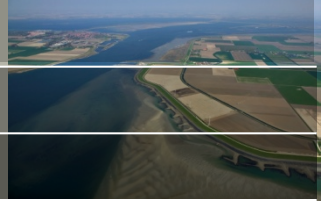
DELFT FEWS – Forecasting Shell concept

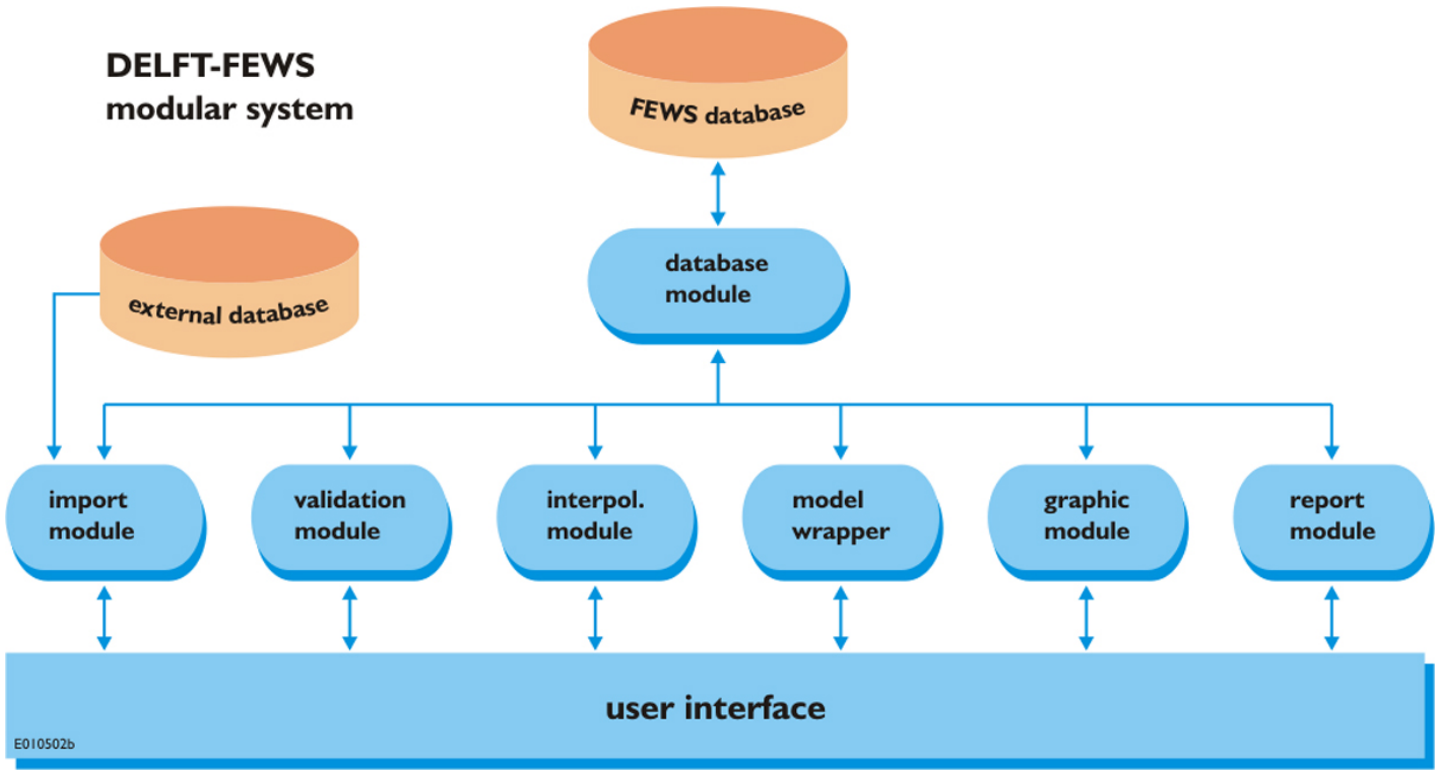
Framework for organisation for the forecasting process

- Integration of data from several sources –
  present single source to forecaster
- Provides general functional utilities
- Component based approach – Services Oriented Architecture
- Open approach to integrating models and forecasting methods
- Plugin architecture (display, calculation models)
- Defined interface to external modules
  (Published interface (PI), OpenMI, OpenDA)

Delft FEWS is an open system – joint development approach

Modular approach





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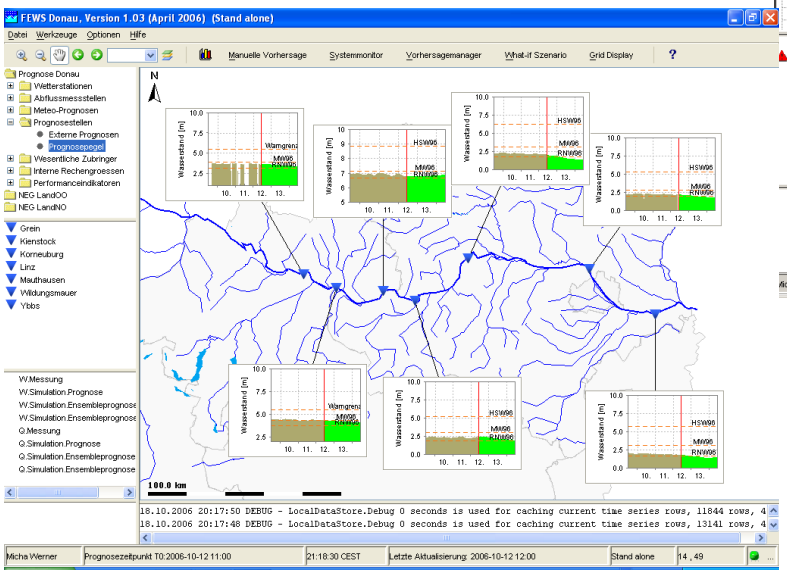
Providing the forecaster an interface to data…

Simple graphical user interface

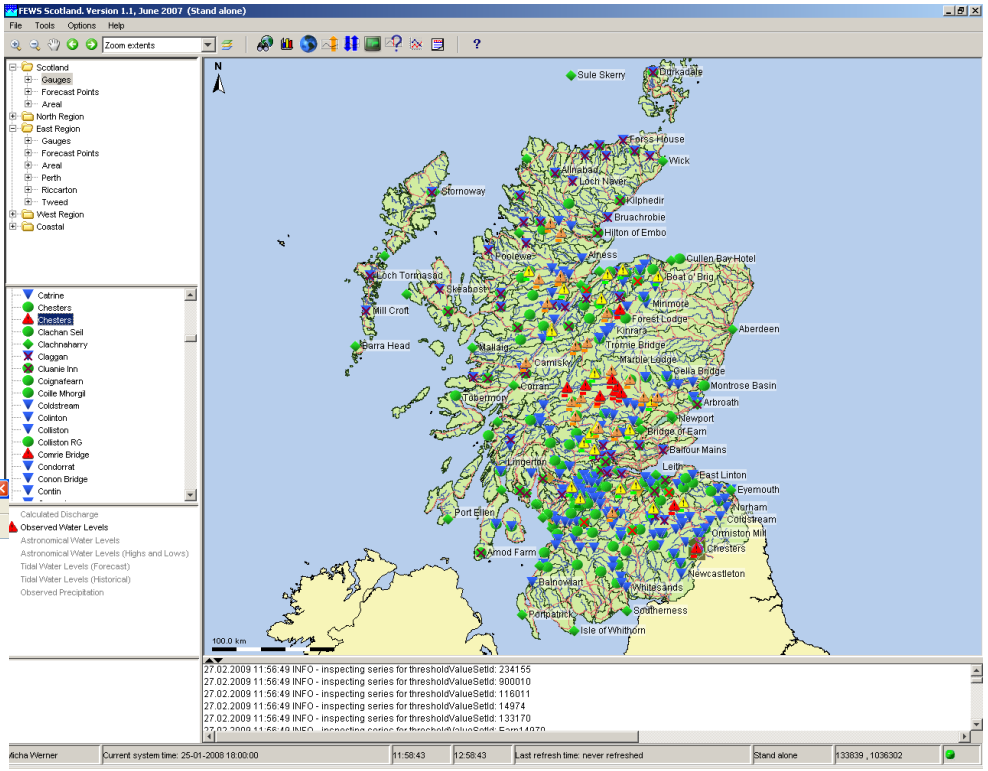
Self explanatory

Key features

- GIS Based
- Overview of data & status



FEWS Donau (Austria) – Graphs at key stations



FEWS Scotland – flood status in several catchments, January 2008

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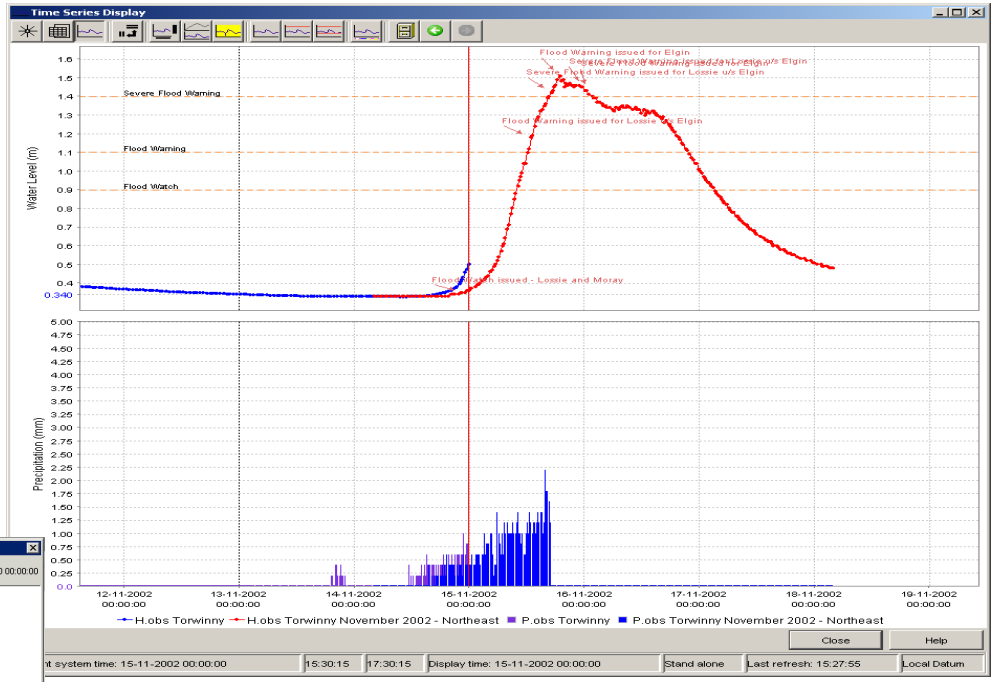
Data visualisation and editing – Graphical data

Powerful graphical tools for viewing time series data

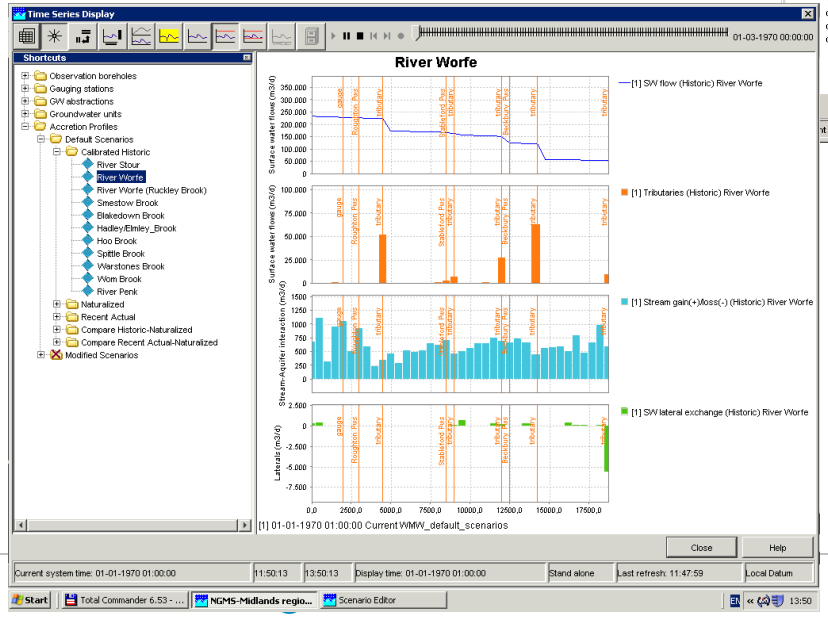
Point time series

Longitudinal profiles (animated)

Editing capabilities –
copy to-from e.g. Excel



Historical event at Torwinny, Scotland



Longitudinal Display

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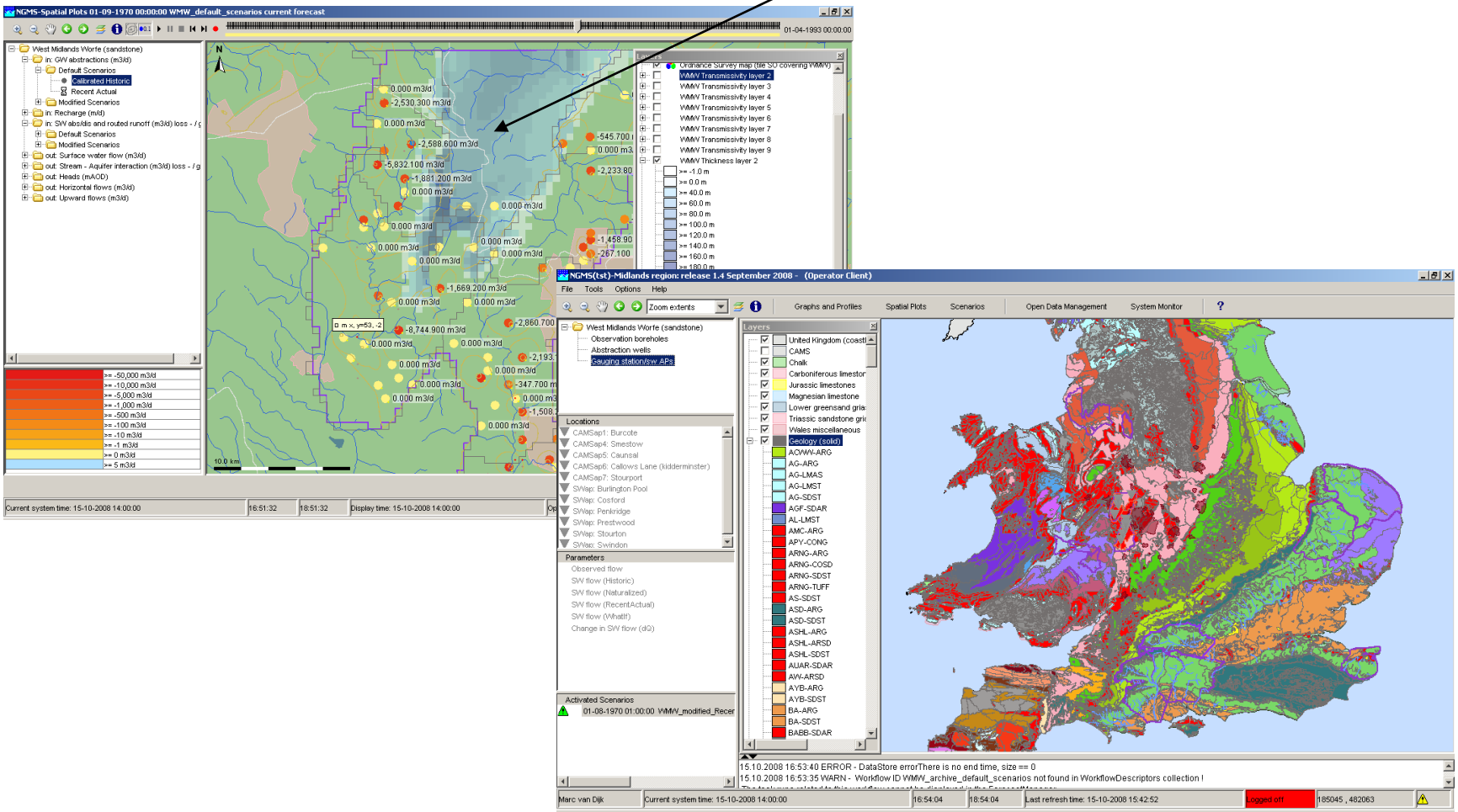
Data visualisation – GIS Data

Animate Flood Inundation Map



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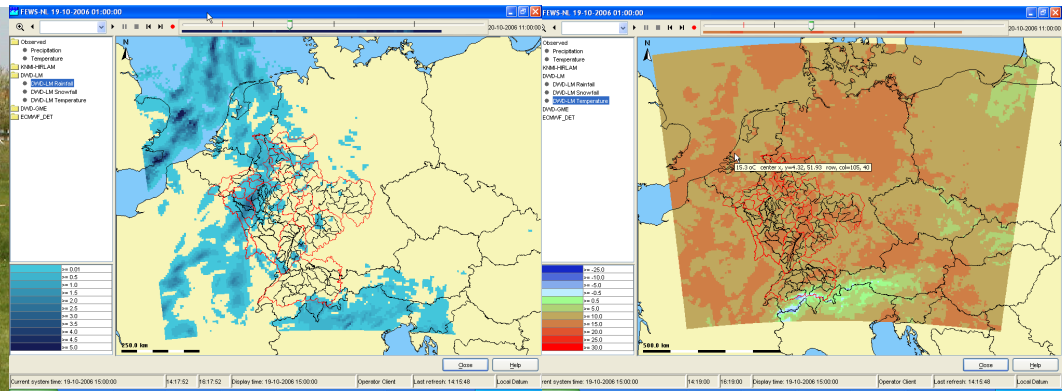
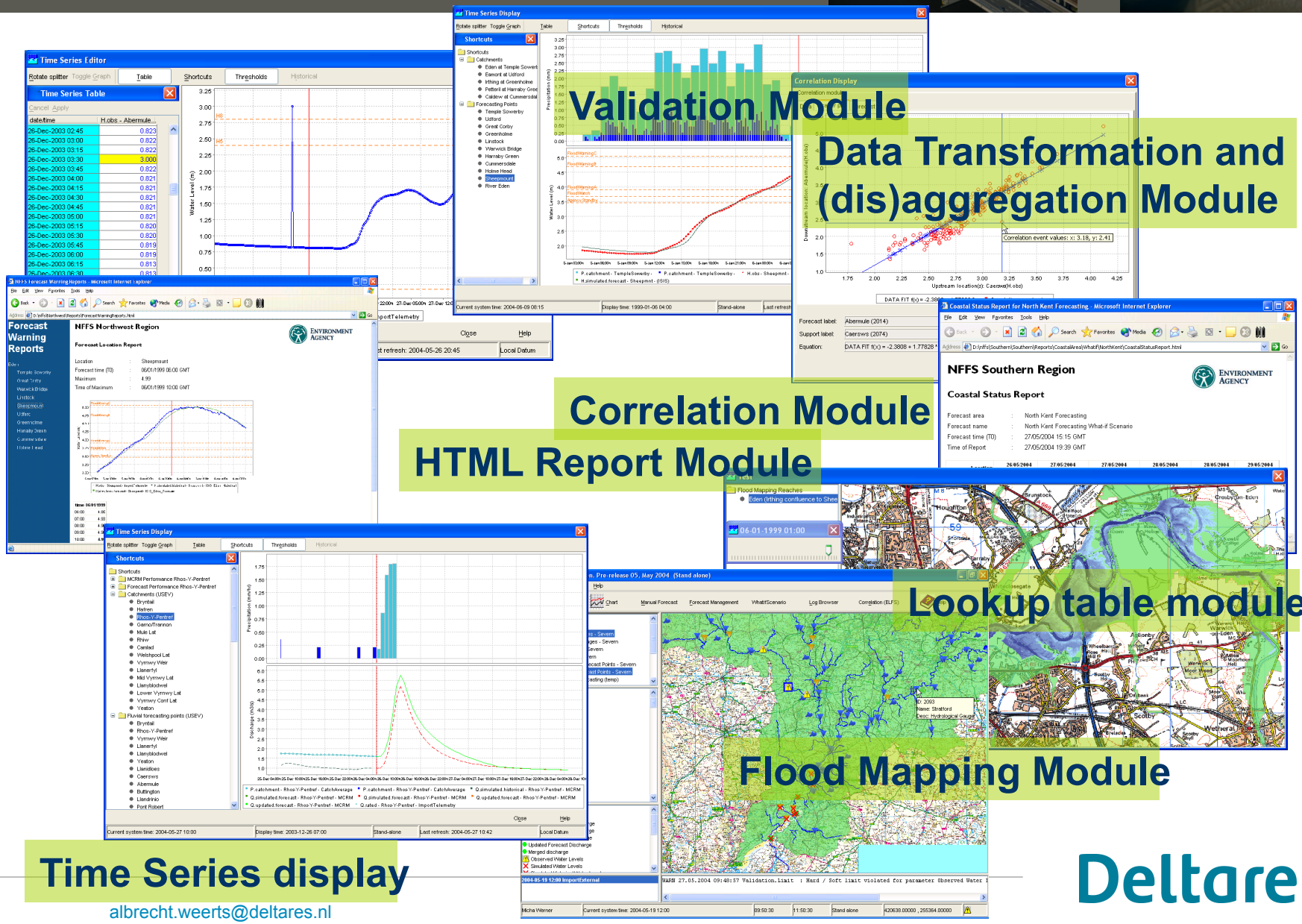
Integration of data

Interfaces to data sources

- Supports standards in data exchange formats: GRIB, NetCDF etc.
- Data exchange with HIMS (e.g. WISKI)
- Plugin-technology to extend integration of data formats
- Emerging standards: WaterML – OpenGIS standard for exchange of hydrological data (USGS, NWS, CUAHSI)



Data Management



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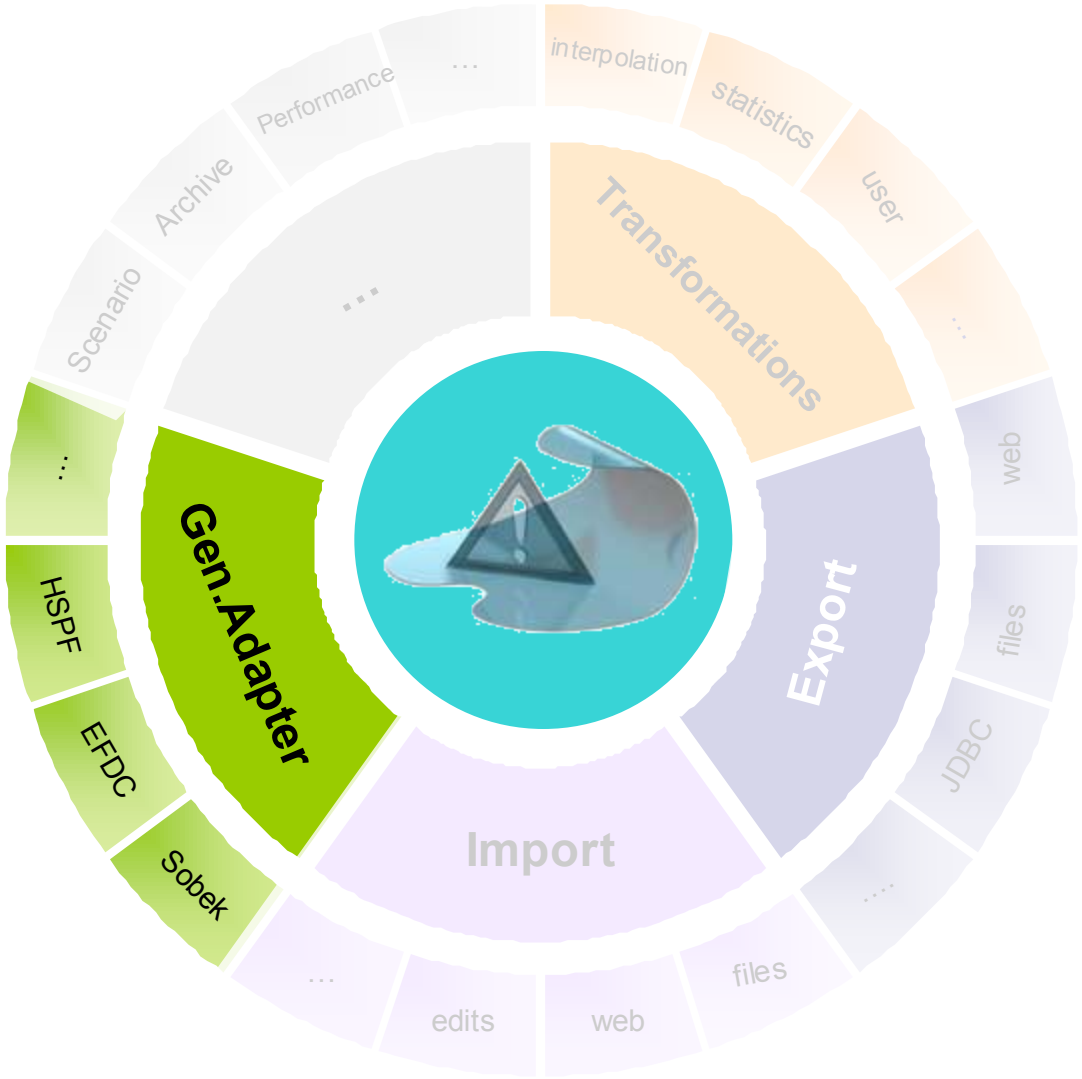
Delft-FEWS in nutshell



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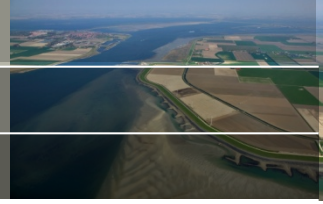
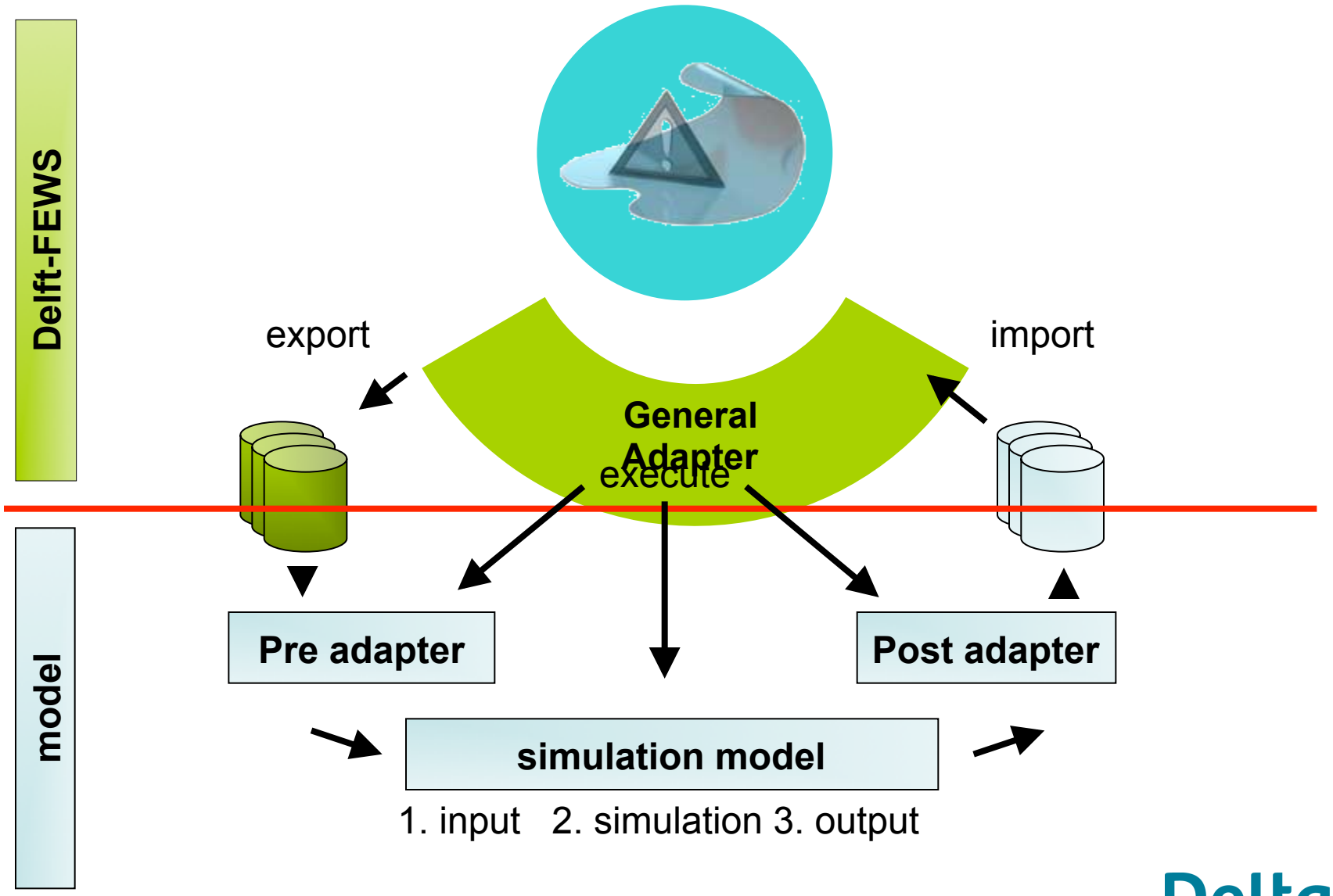
Coupling models





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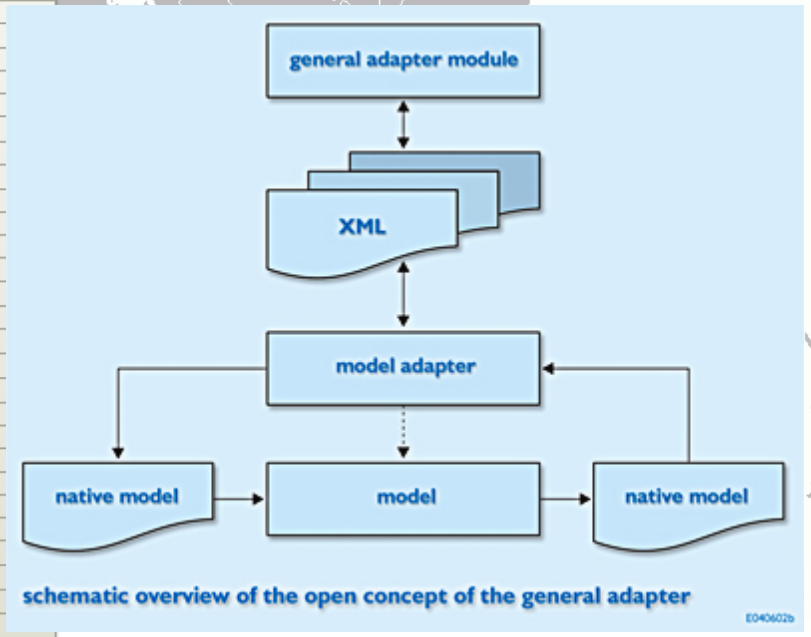
Models coupled

Delft FEWS

Operational Forecasting Platform

Model	Type	Supplier/Owner	Country
ISIS	Hydrodynamics	HR/Halcrow	UK
PDM	Rainfall-Runoff	CEH	UK
TCM	Rainfall-Runoff	CEH	UK
KW	Routing (kinematic wave)	CEH	UK
PACK	Snow Melt	CEH	UK
ARMA	Error Correction	CEH	UK
PRTF	Event Based RR	PlanB	UK
TRITON	Surge propagation/Overtopping	PlanB	UK
STF	Transfer functions	EA	UK
DODO	Routing (layered Muskingum)	EA	UK
MCRM	Rainfall-Runoff	EA	UK
Modflow96/VKD	3D groundwater	Deltares/Adam Taylor	Netherlands/UK
Mike11	Hydrodynamics	DHI	Denmark
NAM	Rainfall-Runoff	DHI	Denmark
LISFLOOD	Distributed Rainfall-Runoff	JRC	Italy
TOPKAPI	Rainfall-Runoff	Univ. of Bologna	Italy
HBV	Rainfall-Runoff (inc snowmelt)	SHMI	Sweden
Vflo	Distributed Rainfall-Runoff	Vieux & Assiciates	USA
SWMM	Urban Rainfall-Runoff	USGS	USA
HEC-RAS	Hydrodynamics	USACE	USA
Snow17	Snow Melt	NWS	USA
SACSM	Rainfall-Runoff	NWS	USA
Unit-H	Unit-Hydrograph	NWS	USA
PRMS	Rainfall-Runoff	Univ. of Karlsruhe	Germany
SynHP	Hydrodynamics	BfG	Germany
SOBEK	Hydrodynamics, Water Quality, RR	Deltares	Netherlands
SOBEK-2d	Linked 1d/2d inundation modelling	Deltares	Netherlands
Sacramento	Rainfall-Runoff	Deltares	Netherlands
RIBASIM	Water distribution + Reservoir	Deltares	Netherlands
REW	Distributed Rainfall-Runoff	Deltares	Netherlands
DELFT3D	2/3D Hydrodynamics/Water quality	Deltares	Netherlands
TWAM	2D Hydrodynamics	PlanB	UK



schematic overview of the open concept of the general adapter

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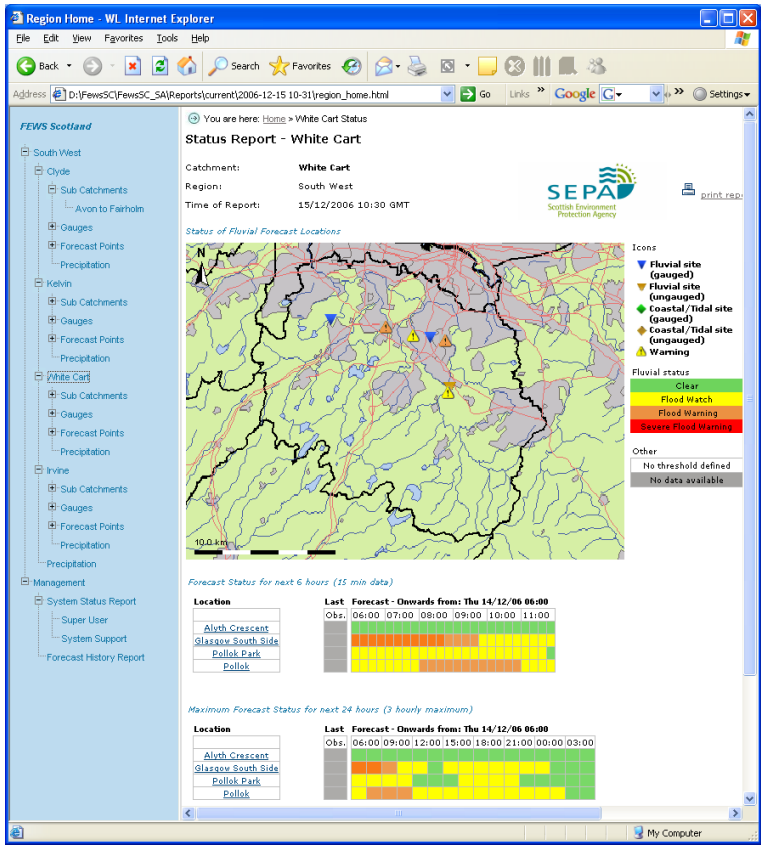
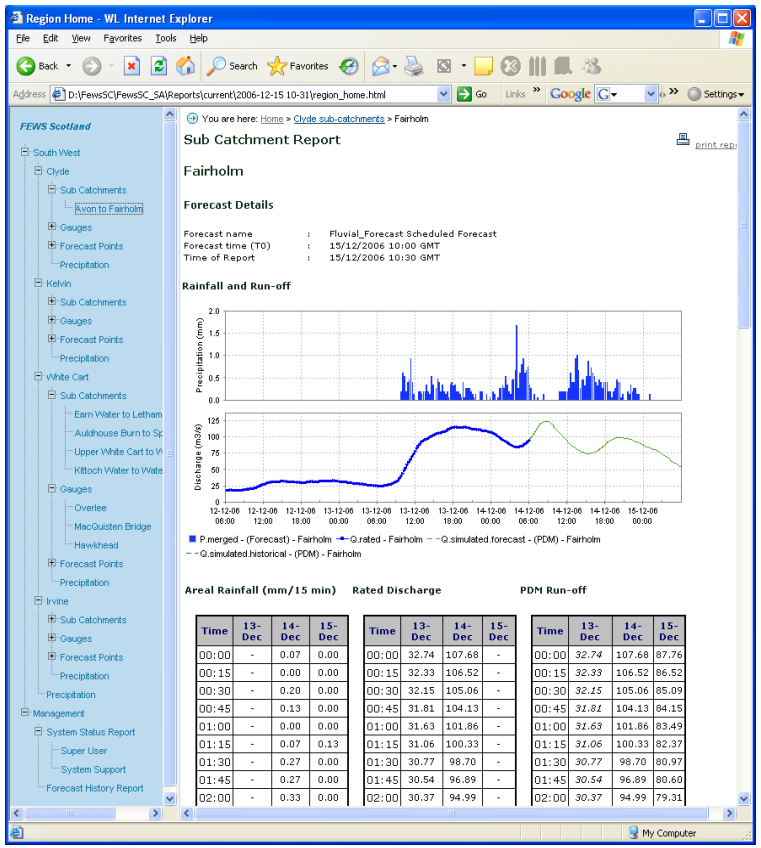
Generating products

HTML Web reports
Internal & External clients



Overview Reports



Detailed Reports

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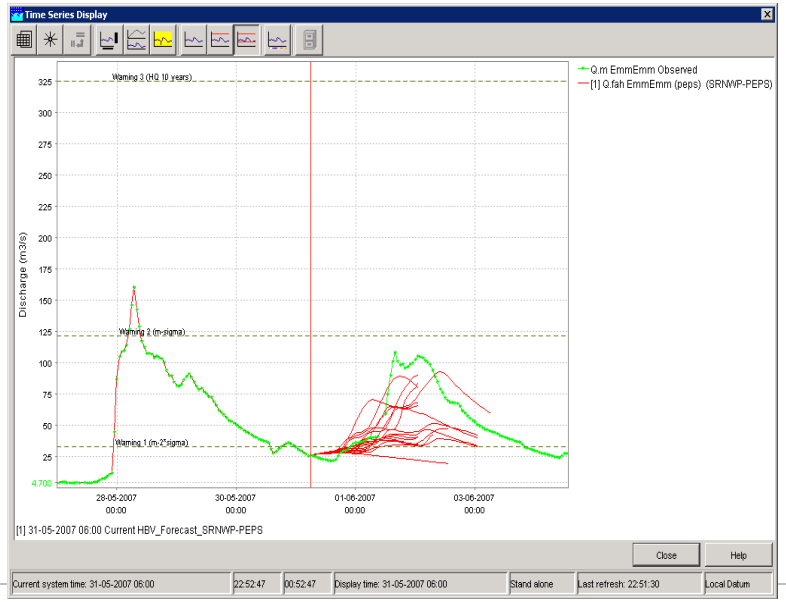
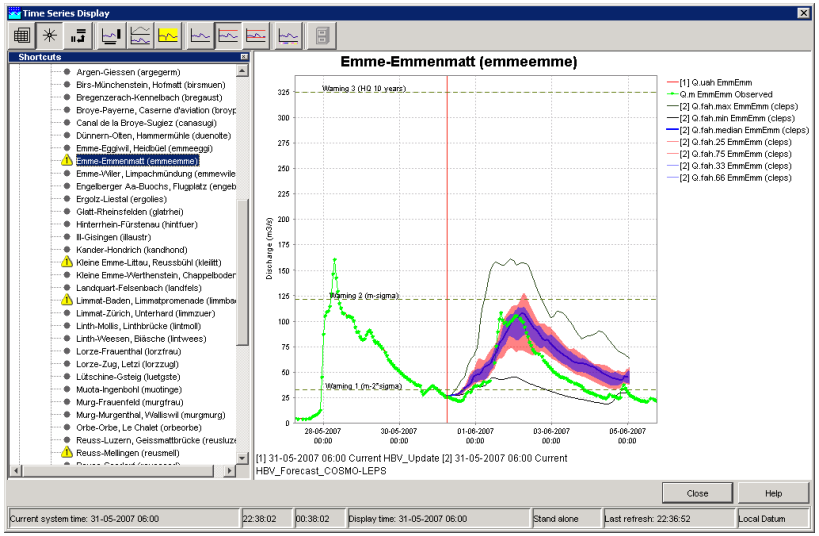
Using and displaying probabilistic data

Delft FEWS database model is inherrently ensemble aware

- Import ensemble data (e.g. ECMWF, COSMO-LEPS)
- Run models for ensemble members
- results
  - statistical summary
  - verification



FEWS-CH:
SRNWP-PEPS Forecast for 31-05-2007 00:00 UTC



FEWS-CH:
COSMO-LEPS Forecast for 31-05-2007 00:00 UTC

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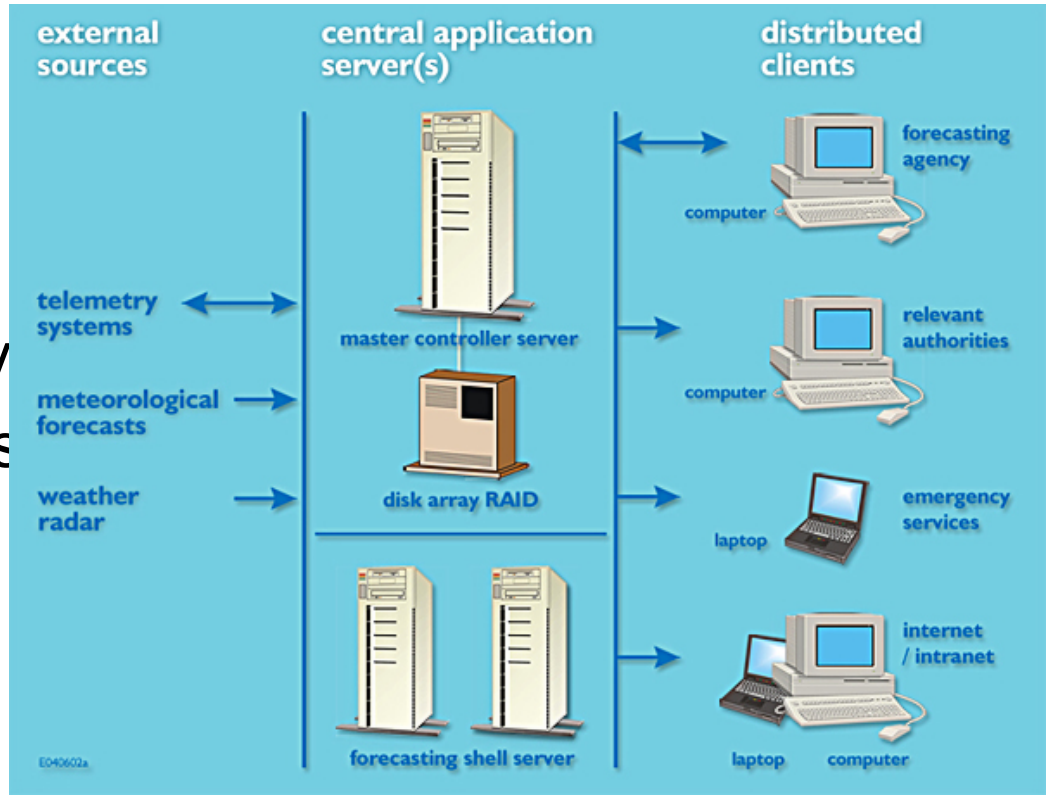
System flexibility



Highly scalable

- Single river basin
- National Forecasting Sy
- Intl. River Basin Organis

Deployment

- Stand alone
- Automated client-server

Software & Hardware

- Developed using Java™, J2EE compliant
- Platform independent (Windows, Linux)

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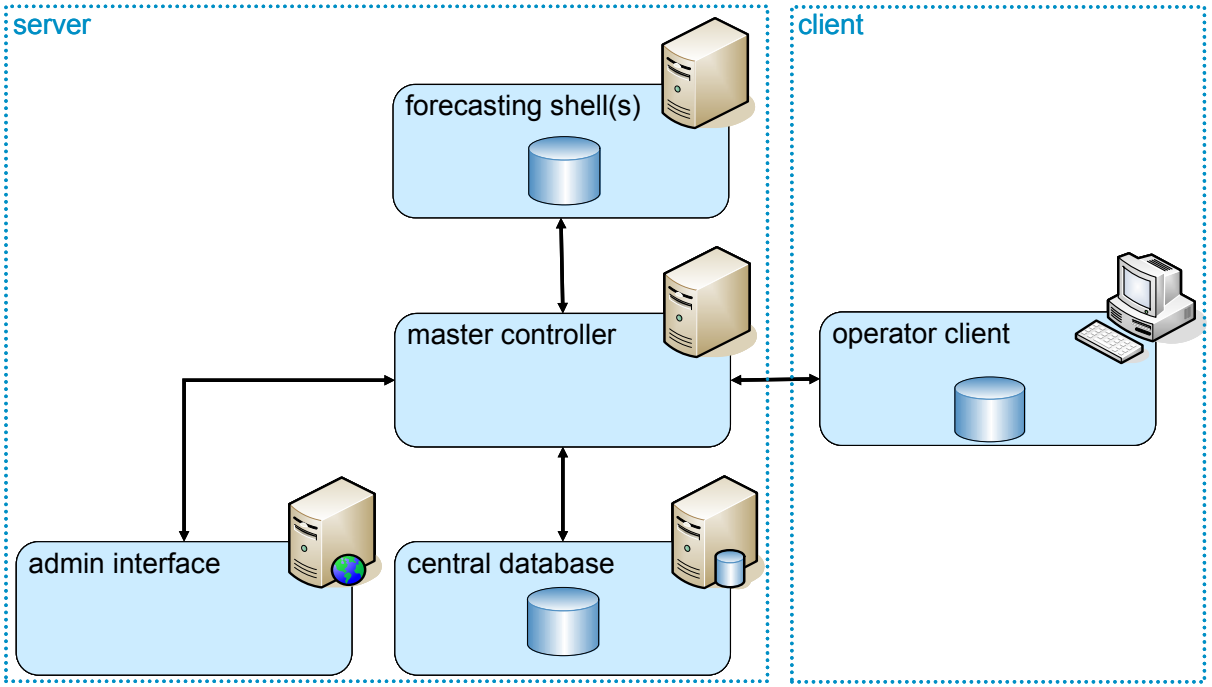
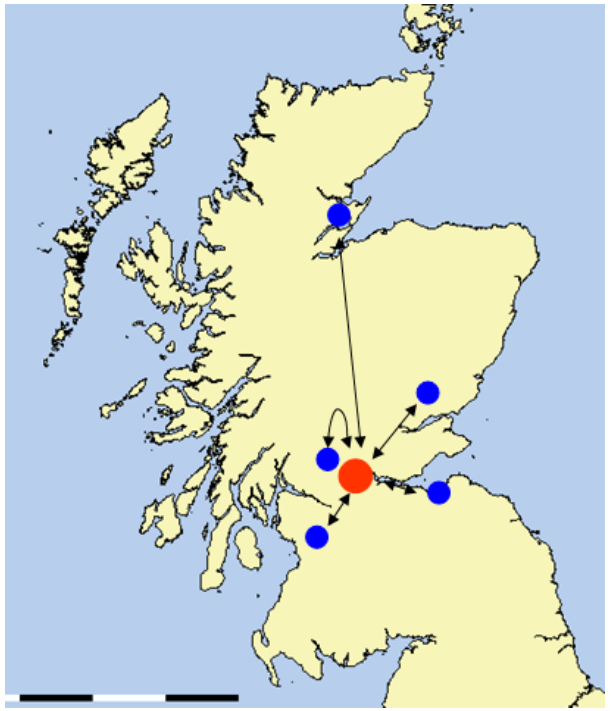
Delft FEWS – Client Server System





central servers & distributed clients
FEWS Scotland

Servers hosted centrally
Client access through internet/intranet

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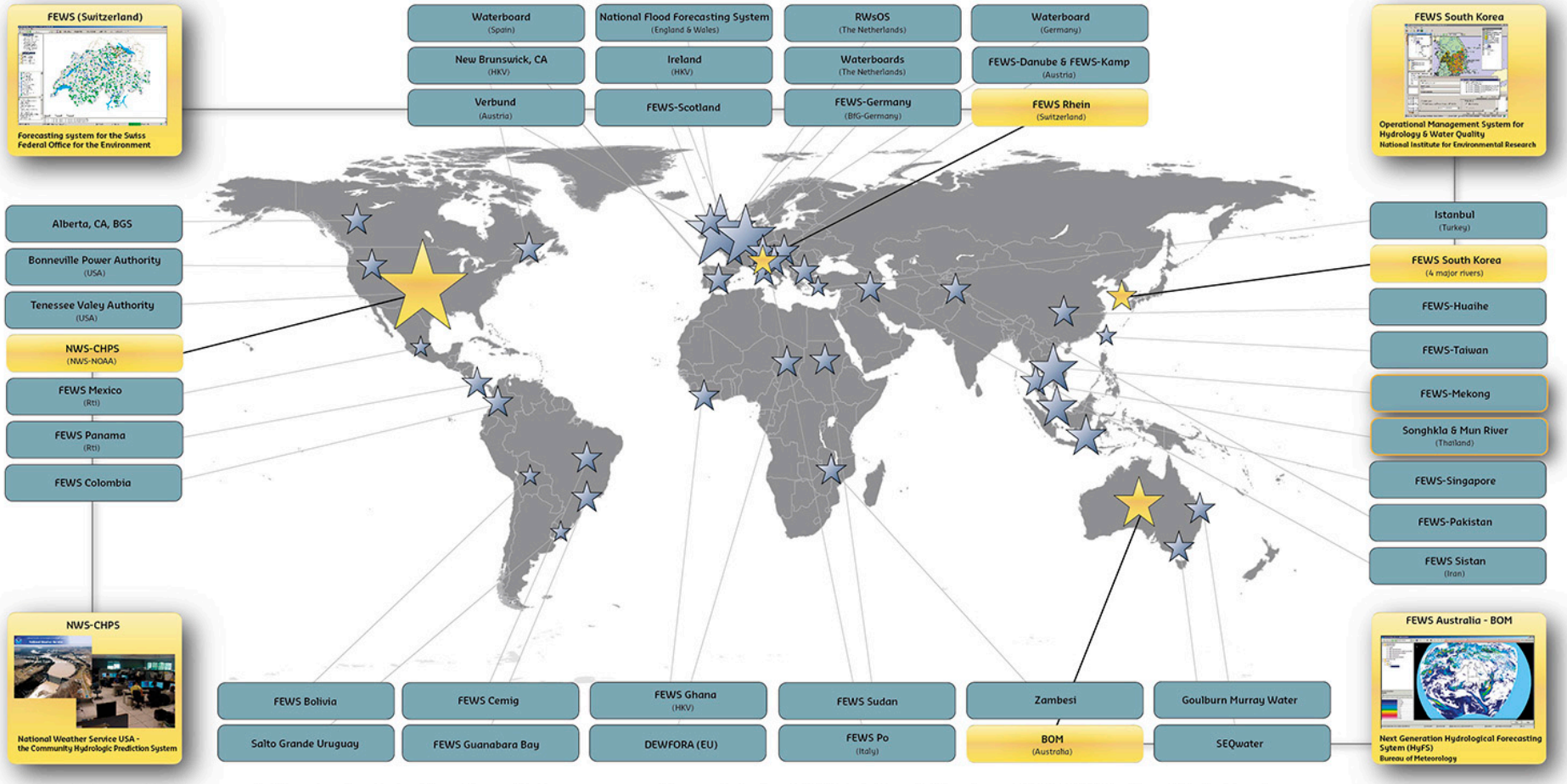
Delft-FEWS worldwide

Delft-FEWS as platform for operational systems worldwide



- Delft-FEWS provides an open shell system for managing forecasting processes and/or handling time series data.
- Delft-FEWS incorporates a wide range of general data handling utilities, while providing an open interface to any external (forecasting) model.
- The modular and highly configurable nature of Delft-FEWS allows it to be used effectively for data storage and retrieval tasks, simple forecasting systems and in highly complex systems utilising a full range of modelling techniques.
- Delft-FEWS can either be deployed in a stand-alone, manually driven environment, or in a fully automated distributed client-server environment.

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Enabling Delta Life

Delft-FEWS and her partners

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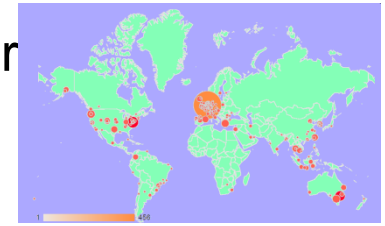
Some figures for Delft-FEWS

An estimated guess: between 250 and 350 people in the world work on a day-to-day base with Delft-FEWS

Delft-FEWS is being used in over 30 countries with over 50 unique applications

Since 2003 our users have invested over 40 M€ in the development of the system and its use. This investment covers:

- configuration of the system for each individual client
- research in operational water management and for
- software development
- training (Deltares staff, client, intermediairies)



16 User Days (7 NL and 9 International)

One community portal with 300 registered users and 200 downloads

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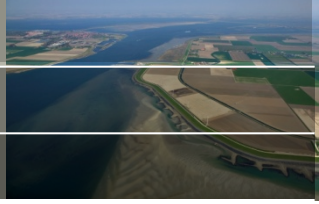
Deltares' role in community



Deltares in the Delft-FEWS community

guard philosophy and guarantee robust and stable software
initiate new ideas and connect people
coordinate developments
facilitate new developments
provide releases on a regular basis
provide detailed information on new developments
provide documentation
provide training & courses

provide third parties with Delft-FEWS and train them
cooperate with third parties on new developments

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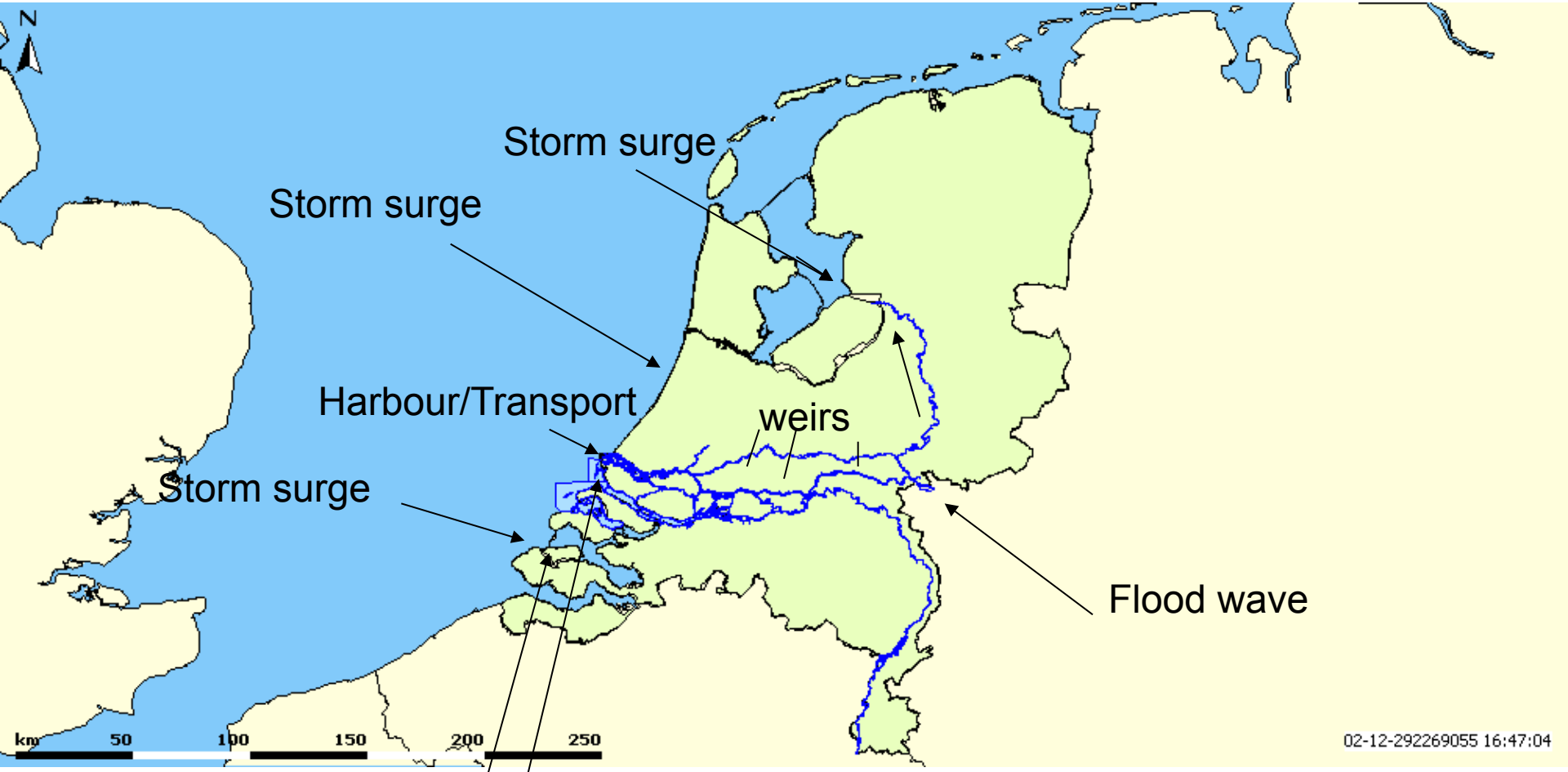
Enabling Delta Life

Towards Coherent Operational Systems - RWsOS

Overview flood issues in Netherlands



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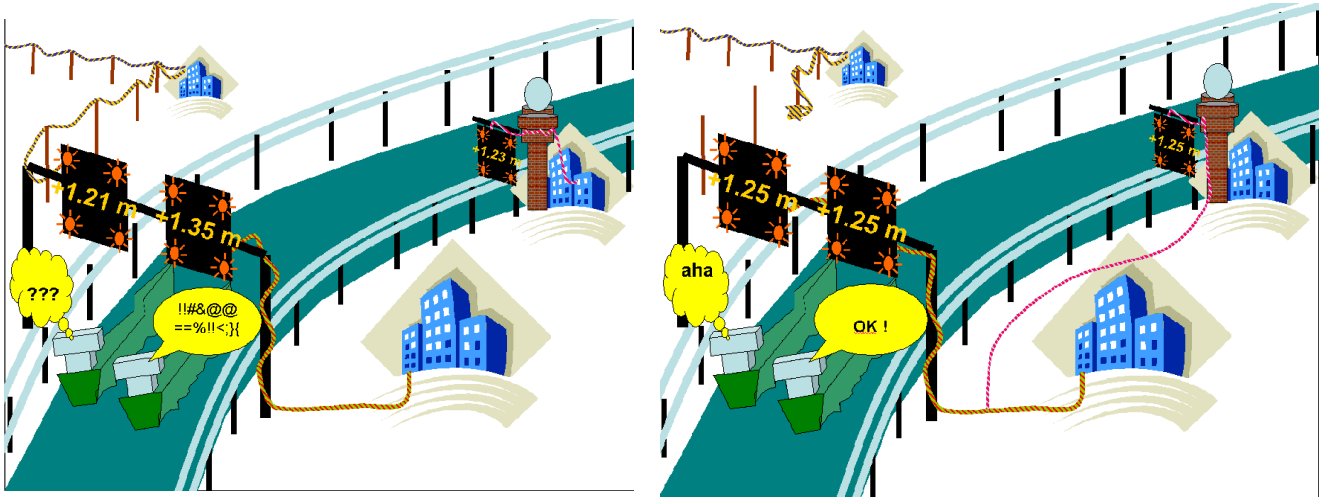
Operational Forecasting at RWS

- Historically organised in Fresh water (rivers) and Salt water (Sea) systems
- Many different groups are responsible for forecasting (HMCN, HMCZ, SVSD, WDIJ, Hoogwatergroep, Infocentrum, ..)
- In 2009 a harmonisation project started to optimize and harmonise the forecasting centres and the dissemination of forecasts



From: Marc Philippart (RWS)

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Situation 2008

Operational centres
Hydro-Meteo Centre Zeeland
Hydro-Meteo Centre Noordzee
Regional Office Limburg
Regional Office Oost-Nederland
Regional Office Zuid-Holland
Regional Office IJsselmeer
Waterdienst
Daily river bulletin (below <14m)

In case of near critical levels
SVSD (Noordsea)
Hoogwatergroep

In case of national crisis
LCW (Water shortage)
LCO (Floods)
LCM (Environmental disaster)

6 different forecasts platforms/systems

Each organisation issues forecasts..but the same?

Overlapping areas..but each feels responsible

Responsibilities were not wel defined

Support & Maintenance x 6

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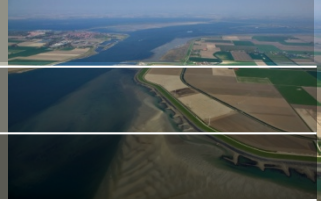
Coherent Operational Systems



Process (joint projects) startedin 2009

1) Harmonized reporting (for public)
   - one value issued per location
   - same format style etc

2) Defining reponsibilties / interfaces / exchange of information !!!
   - boundary conditions / circumstances

3) Harmonized Operational Forecasting system
   - one forecast platform => knowledgesharing and common ground
   - datafeeds / databackup / archiving
   - hosting / double duty standby (requirements per system)
   - validation and shadow test (at Deltares) system

Process that went up and down with hostile attitude and distrust but in the end we are arriving at Coherent Operational Systems for the Dutch Public

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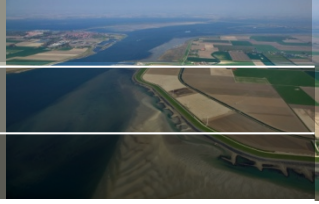
Situation 2012



Operational centres
Hydro-Meteo Centre Zeeland
Hydro-Meteo Centre Noordzee
Regional Office Limburg
Regional Office Oost-Nederland
Regional Office Zuid-Holland
Regional Office IJsselmeer
Waterdienst
Daily river bulletin (below <14m)

In case of near critical levels
SVSD (Noordsea)
Hoogwatergroep

In case of national crisis
LCW (Water shortage)
LCO (Floods)
LCM (Environmental disaster)

1 forecasts platforms/systems – 6 configurations

Each organisation issues its own forecasts

Clear responsibilities per forecast location

Support & Maintenance only once

Forecast platform/system developments only once

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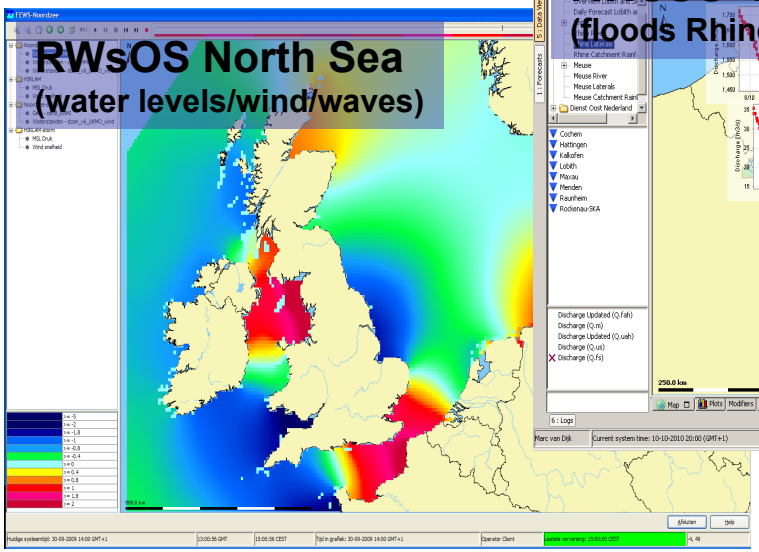
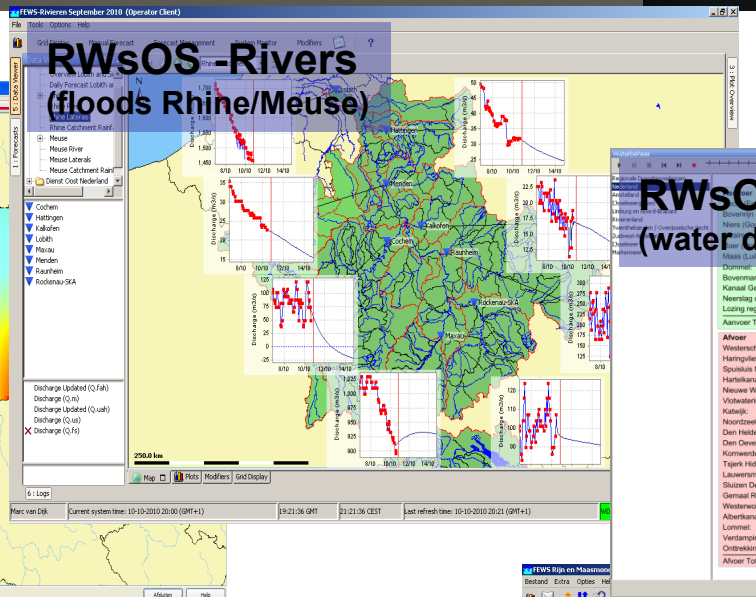
Rijkswaterstaat Operational Systems

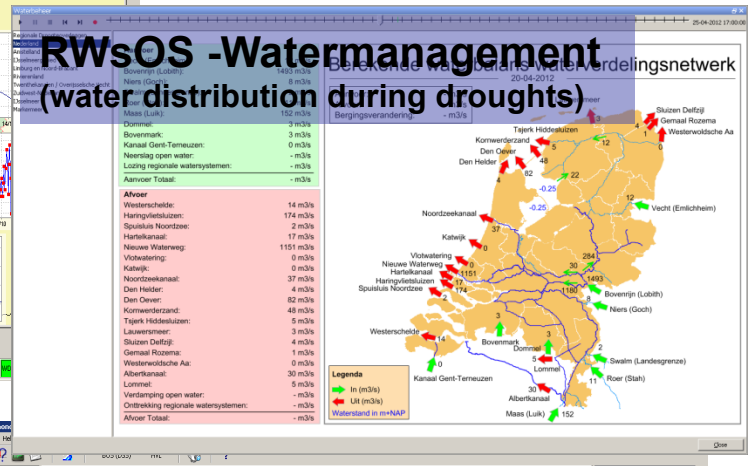
RWsOS North Sea
(water levels/wind/waves)



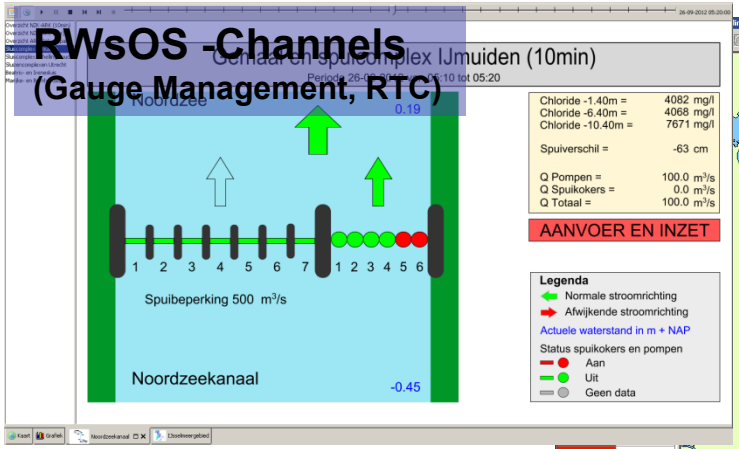
RWsOS -Rivers
(floods Rhine/Meuse)



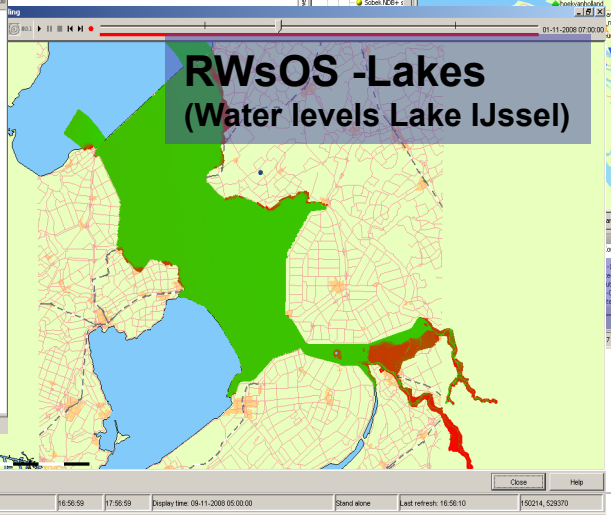
RWsOS -Watermanagement
(water distribution during droughts)



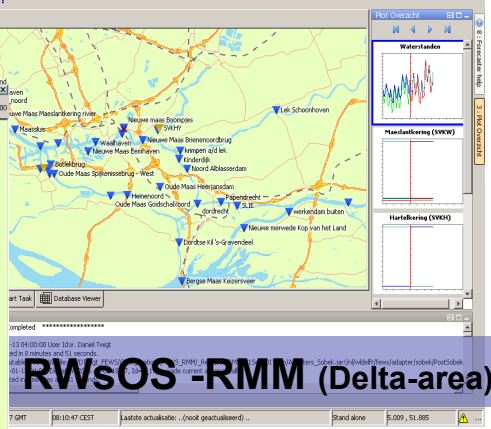
RWsOS -Channels
(Gauge Management, RTC)



RWsOS -Lakes
(Water levels Lake IJssel)



RWsOS -RMM (Delta-area)



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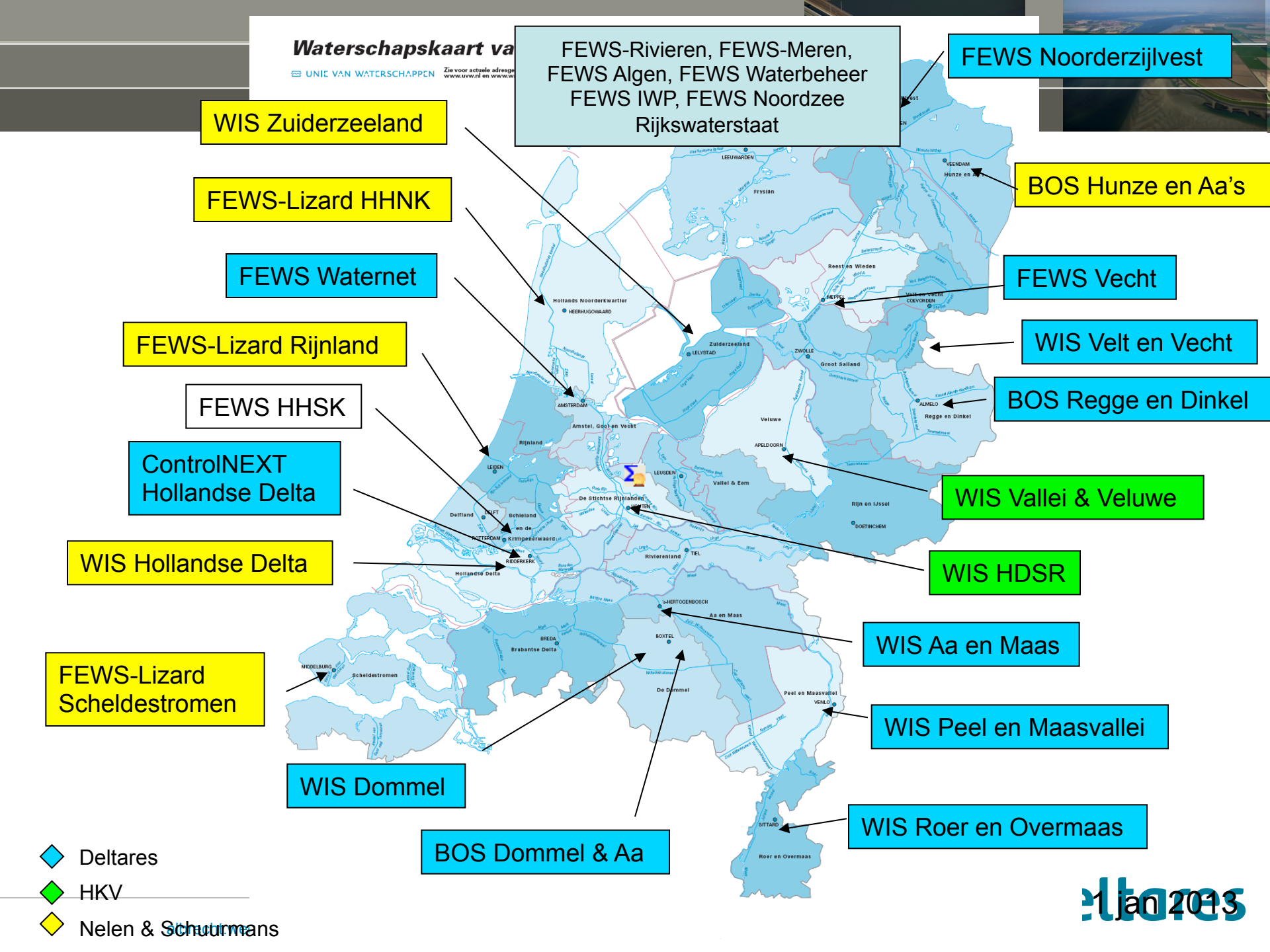
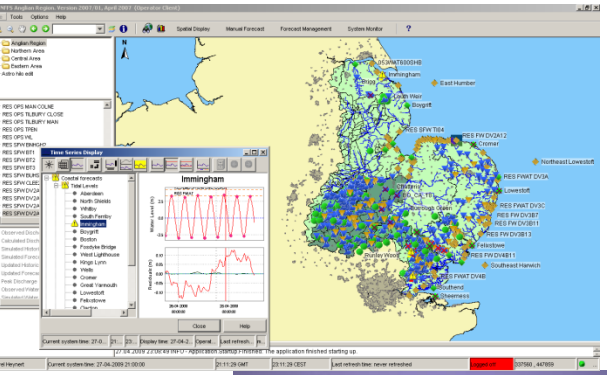
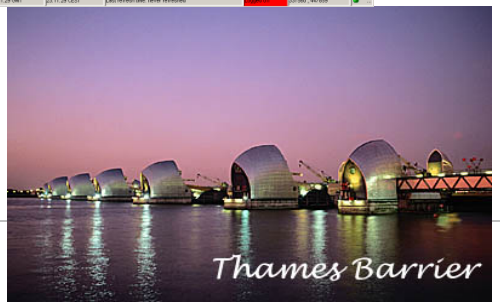
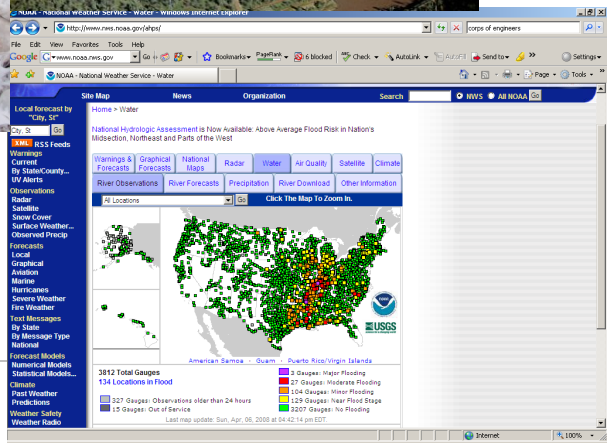

Waterschapskaart va
UNIE VAN WATERSCHAPPEN
FEWS-Rivieren, FEWS-Meren,
FEWS Algen, FEWS Waterbeheer
FEWS IWP, FEWS Noordzee
Rijkswaterstaat
FEWS Noorderzijlvest
WIS Zuiderzeeland
BOS Hunze en Aa's
FEWS-Lizard HHNK
FEWS Waternet
FEWS Vecht
FEWS-Lizard Rijnland
WIS Velt en Vecht
FEWS HHSK
BOS Regge en Dinkel
ControlNEXT
Hollandse Delta
WIS Vallei & Veluwe
WIS Hollandse Delta
WIS HDSR
WIS Aa en Maas
FEWS-Lizard
Scheldestromen
WIS Peel en Maasvallei
WIS Dommel
WIS Roer en Overmaas
BOS Dommel & Aa
Deltares
HKV
Nelen & Schuurmans
1 jan 2013

Some larger Delft FEWS implementations…

- Environment Agency for England & Wales → National Flood Forecasting System (NFFS)
- National Weather Service (NWS/NOAA) in United States → Community Hydrologic Prediction System (CHPS)







National Flood Forecasting System (NFFS) in England & Wales

Environment Agency for England & Wales

Flood warning responsibility

- rivers
- coasts

1.6 million people at risk

Wide variety of catchments

Regular flooding

Implementation 2003-06,

Harmonisation of 8 independent regions

Complex hydrological methods and procedures…

- > 20 different model types
- > 2000 forecasting locations

~ 10 M€ project (financed in stages)

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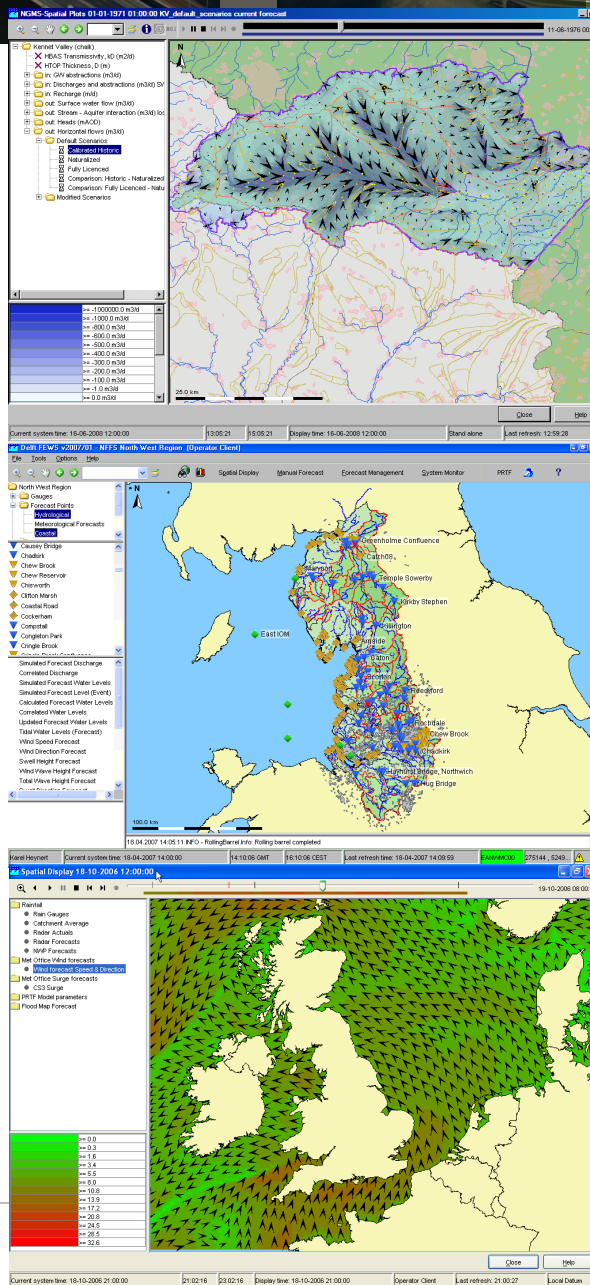
National Flood Forecasting System (NFFS) in England & Wales

Since 2006…

- support & maintenance of NFFS
- technical assistance & training
- introduction of probabilistic forecasting
- setup of Flood Forecasting Centre in London
- upgrade coastal forecasting models Wales

But also…

- National Groundwater Modelling System (NGMS)
- Bathing Water Quality System pilot



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Community Hydrologic Prediction System

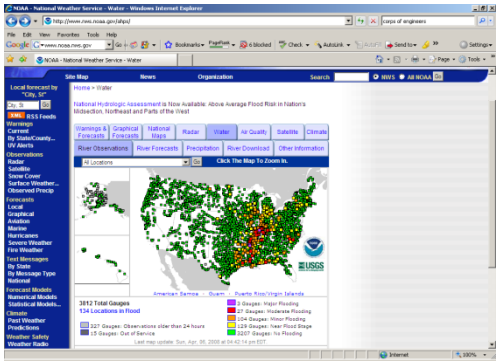
First talks about CHPS & Deltares: Silver Spring, April ’06

What did we see?

- Strong wish for more flexibility in development of FFS
- CHPS architecture on paper (Service Oriented Architecture)
- NWSRFS a very comprehensive national forecasting system (unique!)

What could Deltares offer?

- Delft FEWS software: community ‘model’
- Experience with implementation of large scale migration projects (England and Wales) → hydrology & IT



From Scot Lindsey NWS RFC Alaska

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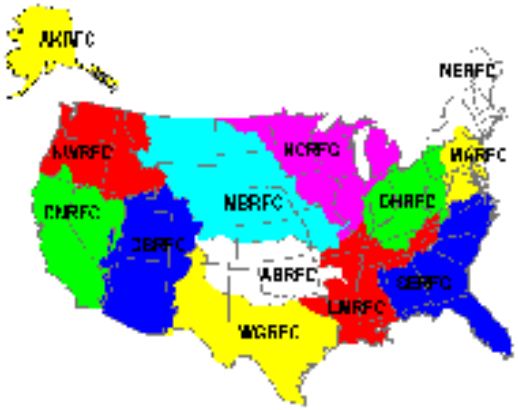
Community Hydrologic Prediction System

- National Oceanic and Atmospheric Administration (NOAA)
- National Weather Service (NWS)
- Office of Hydrologic Research (OHD)
- 13 River Forecast Centers (RFC)



Contract value: ~ 5.5 MUSD (4.0 M€)

Preparation & design: 2006-08

Implementation period: 2008-11

Support for project via Deltares-USA Inc. office in Silver Spring, Maryland (Edwin Welles & Matthijs Lemans)

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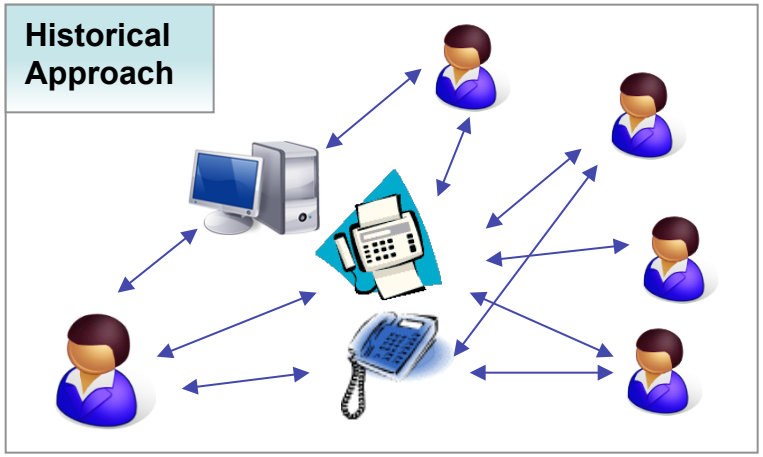
Community Hydrologic Prediction System (CHPS or US flavor of FEWS) brings a New Business Model

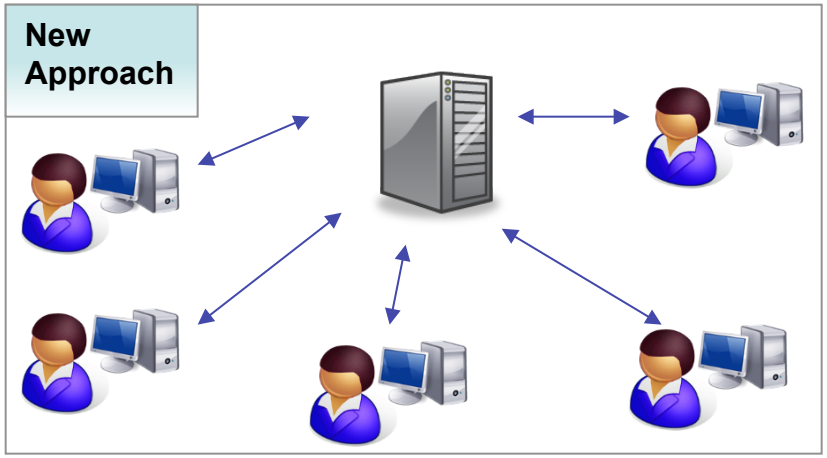
Historically, organizations and groups:

- Worked independently
- Developed their own unlinked systems
- Duplicated efforts
- Used disparate tools and processes

The new approach strives for

- Data flowing among linked algorithms across organizational boundaries
- Open architecture that is flexible enough to utilize existing applications and services





From Scott Lindsey NWS RFC Alaska

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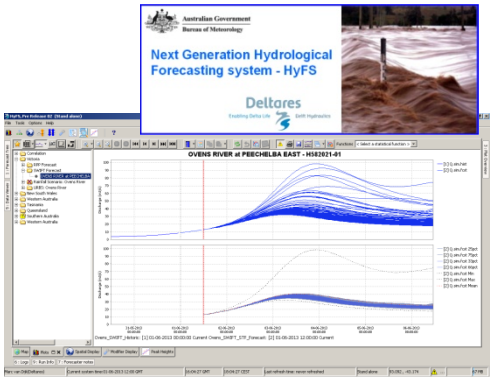
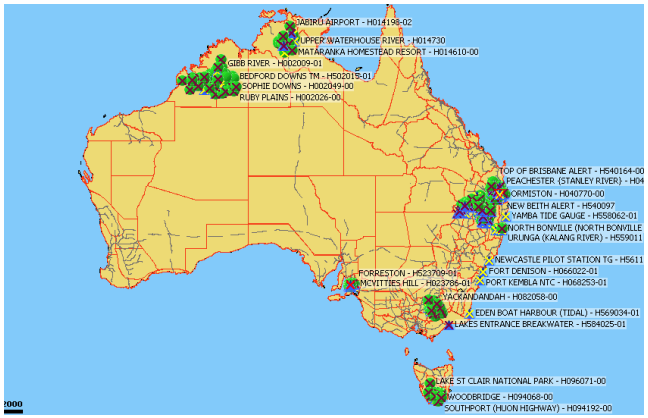
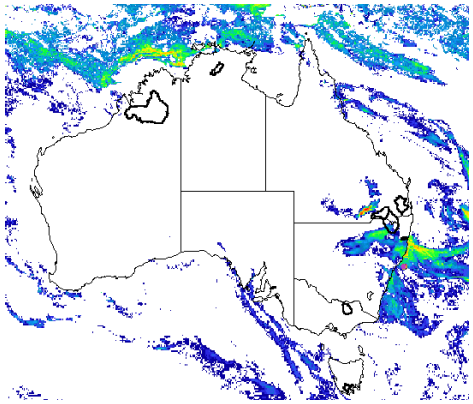
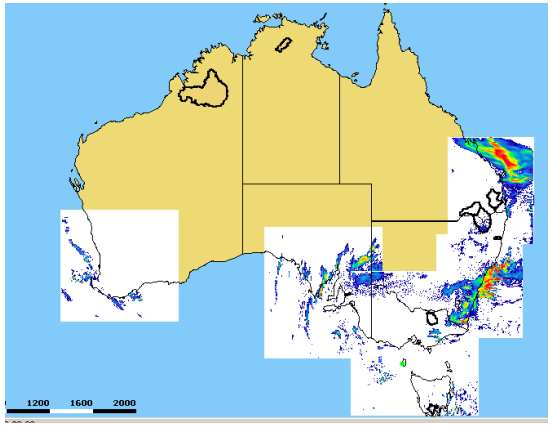
Hydrological Forecasting System in Australia

- National Flood Forecasting system for the Bureau of Meteorology
- Migration of existing systems (Peak-Heights, URBS)
- Use of new modelling techniques
- Challenge: one system for 7 regions
- Challenge: add new “research” products
- Challenge: migrate towards a centralised approach









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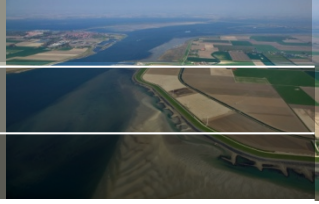
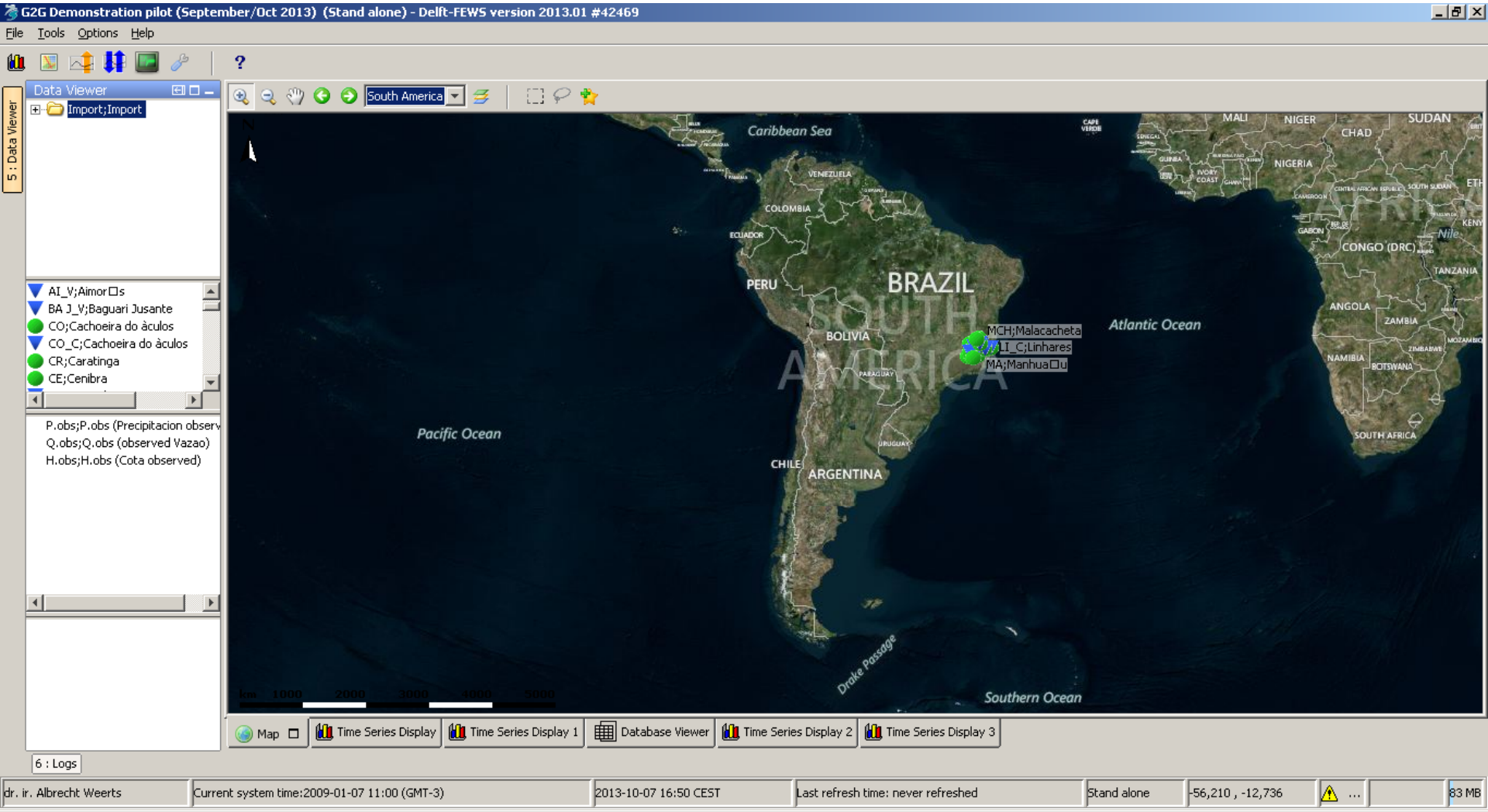
Rio Doce (food for thought)





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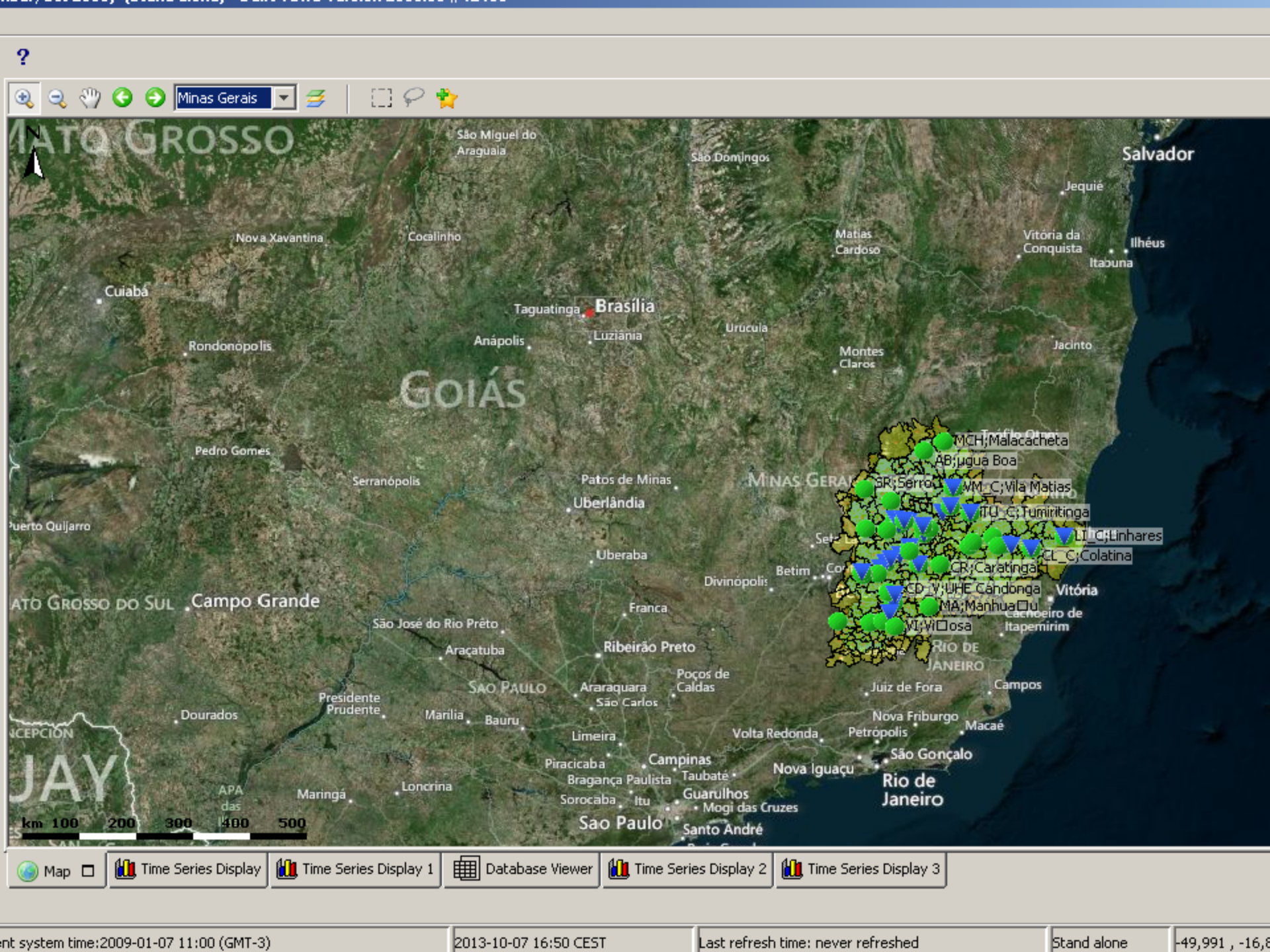
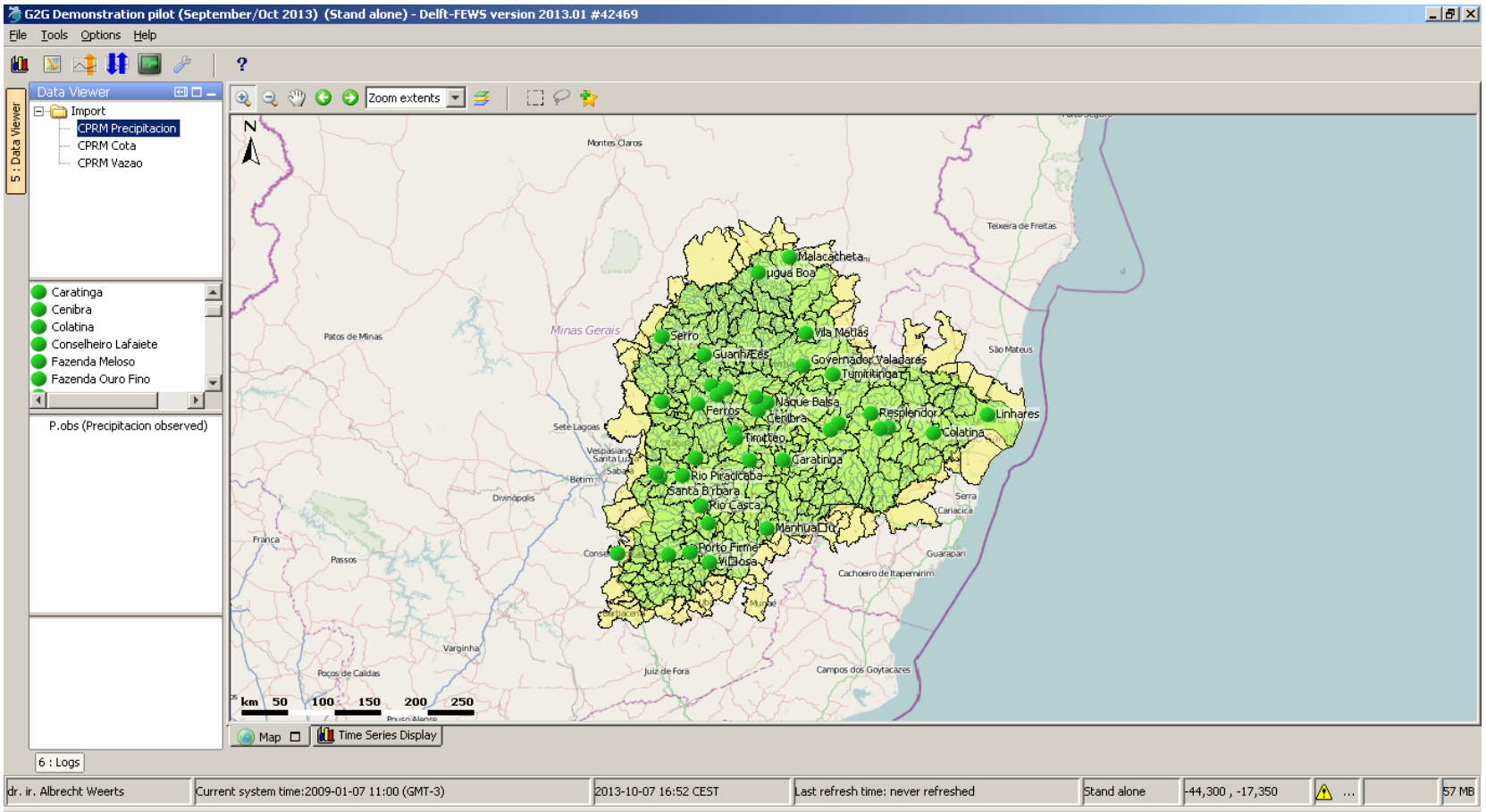


nt system time:2009-01-07 11:00 (GMT-3) | 2013-10-07 16:50 CEST | Last refresh time: never refreshed | Stand alone | -49,991 , -16,8

Precipitation stations



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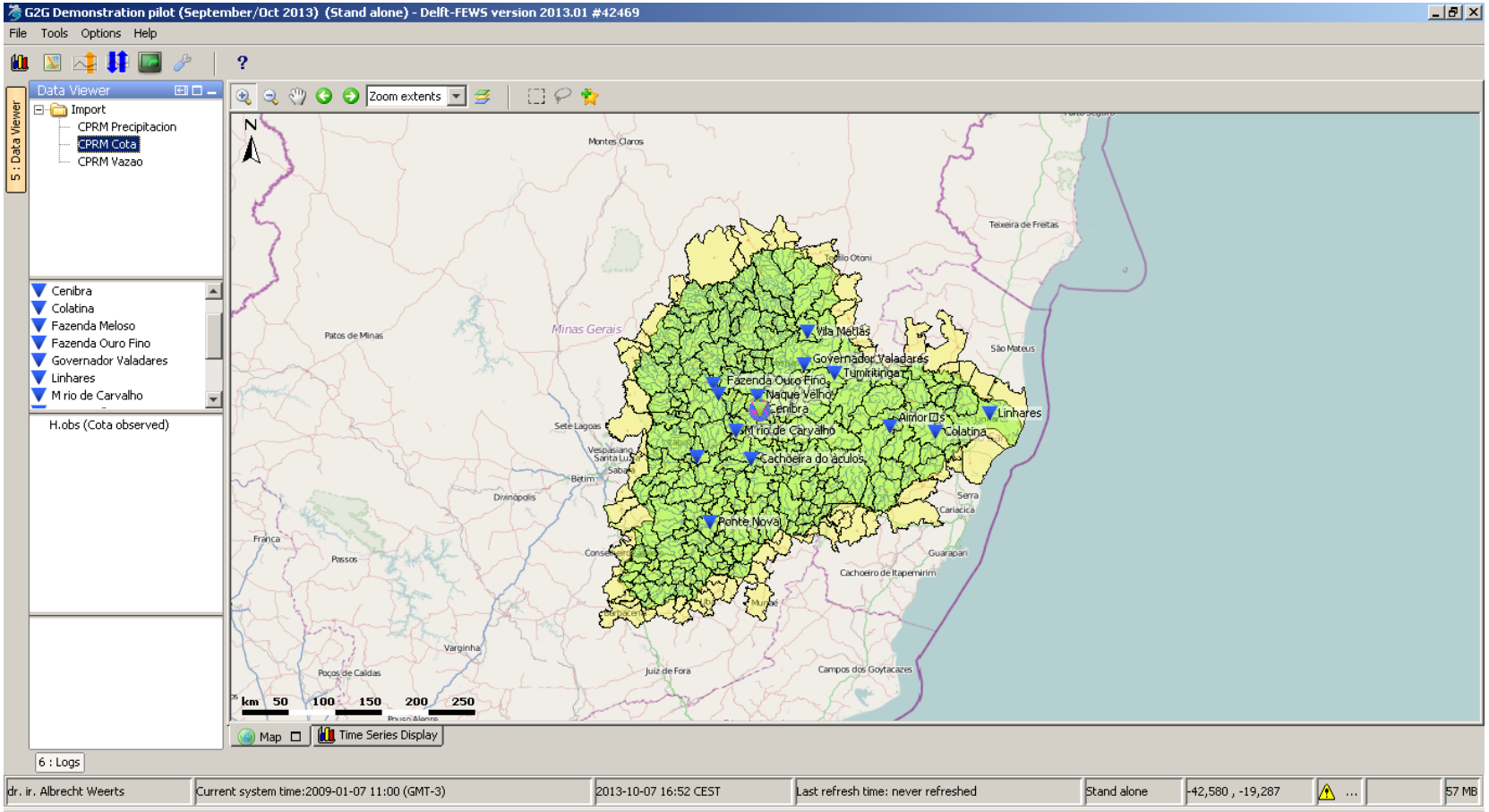
Water level



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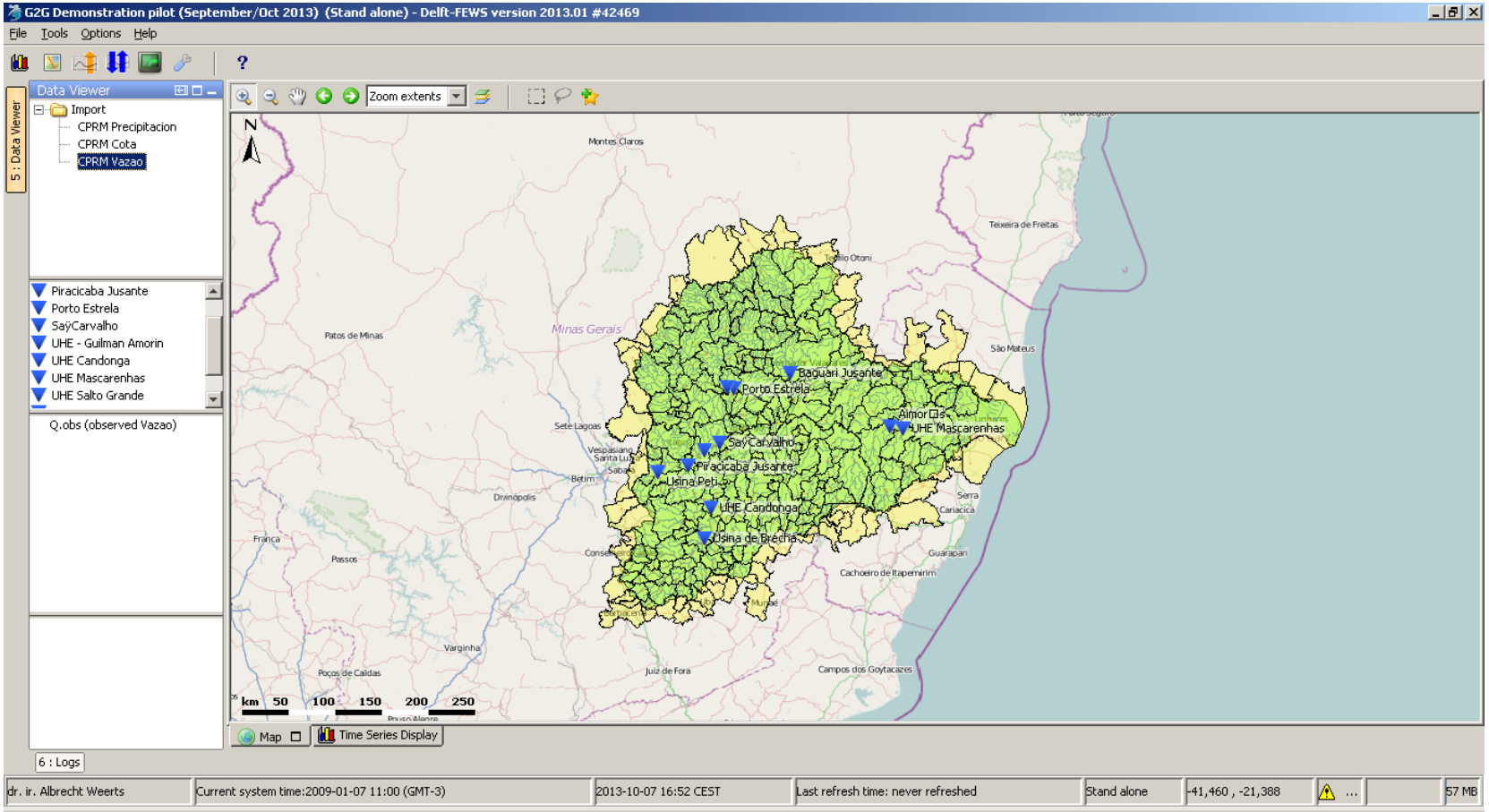
Discharge



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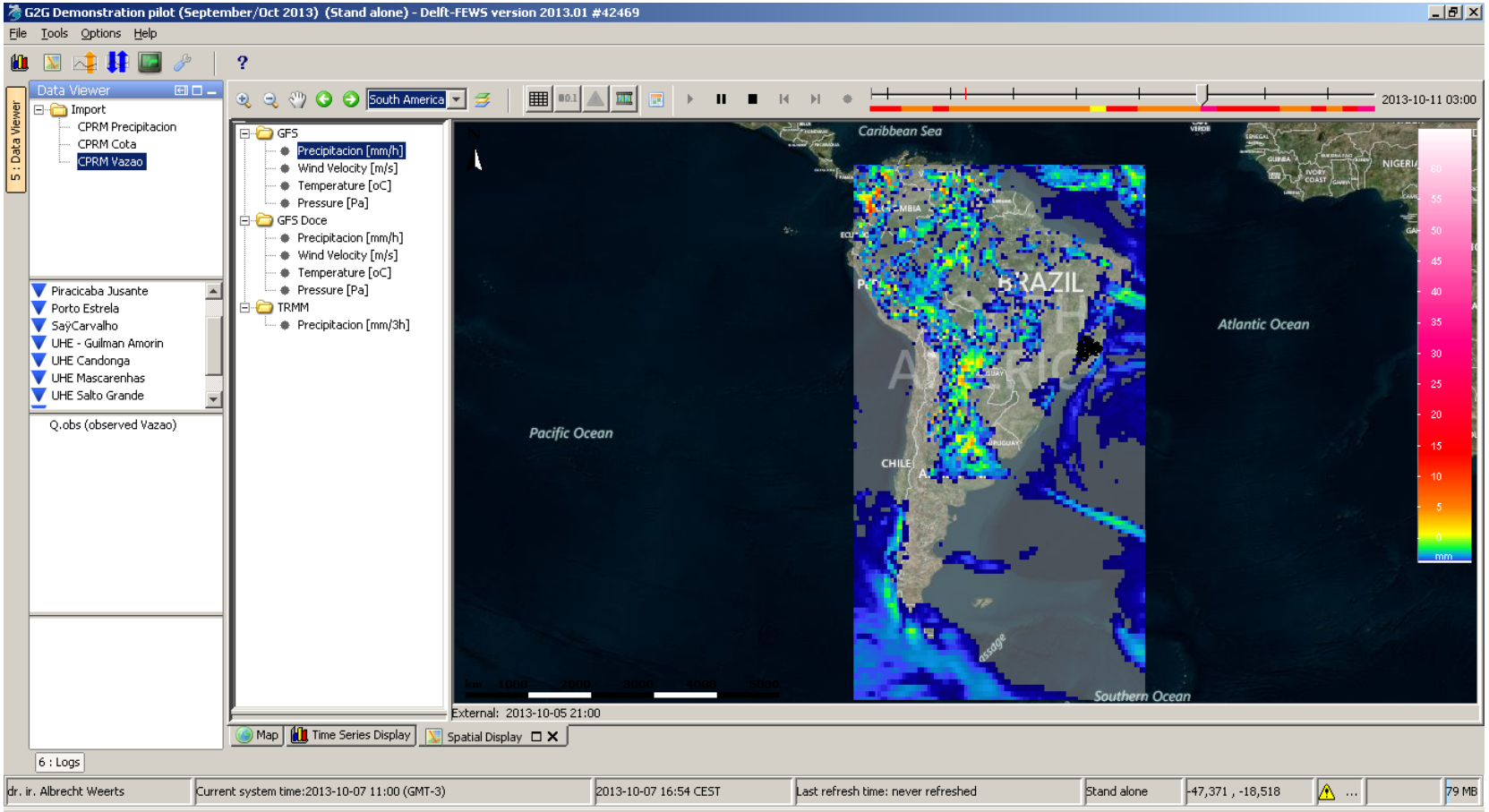

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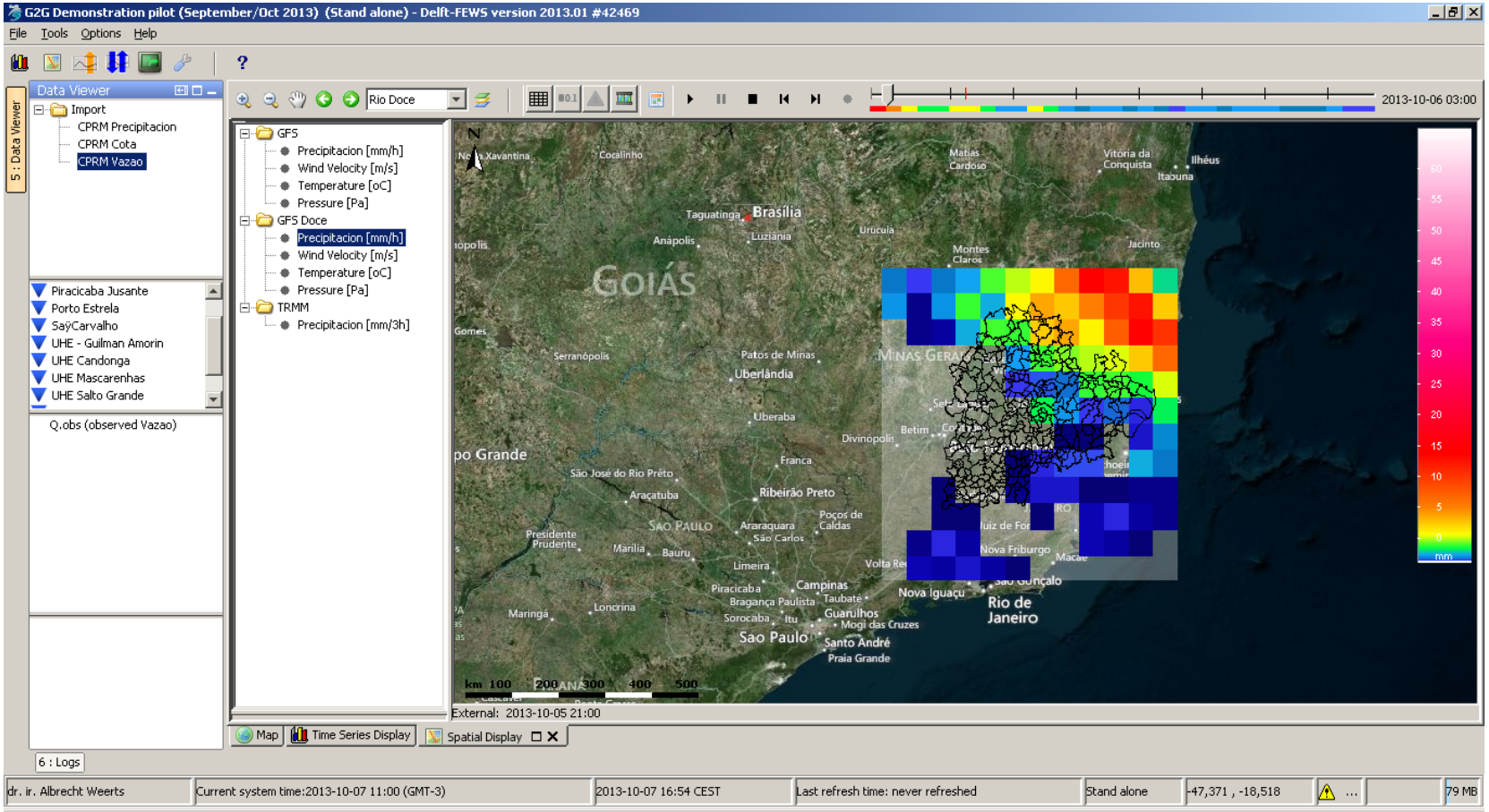

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Finally..

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