Deltares

Enabling Delta Life

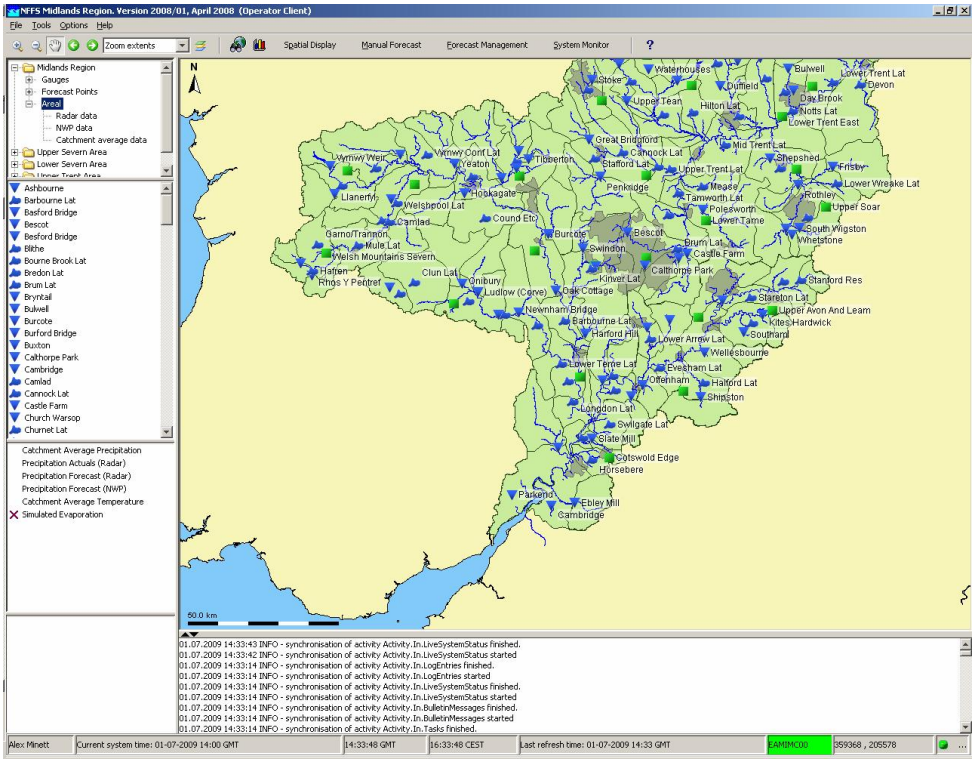
Software

Delft-FEWS

The development of hydrological forecasting and warning systems is an essential element in regional and national strategies. Recent developments in numerical weather prediction, radar data and on-line meteorological and hydrological data collection have resulted in an increasing focus on data import and data processing. The challenges for developing a modern hydrological forecasting and warning system are found in the integration of large data sets, specialised modules to process the data, and open interfaces to allow easy integration of existing modelling capacities.

In response to these challenges, Delft-FEWS provides a state of the art hydrological forecast and warning system. The system is a sophisticated collection of modules designed for building a hydrological forecasting system customised to the specific requirements of an individual organisation.

The philosophy of the system is to provide an open shell for managing the data handling and forecasting process. This shell incorporates a comprehensive library of general data handling utilities, allowing a wide range of external forecasting models to be integrated in the system through a published open interface.



Application of Delft-FEWS for the Severn Catchment, Midlands Region, UK (reproduced courtesy of the Environment Agency, UK)

***Keywords**: Delft-FEWS, Forecasting*

The modular and highly configurable nature of the system allows it to be used effectively both in rudimentary and highly complex systems and be adapted to a range of potential applications including flood forecasting, water quality forecasting, groundwater management, real time control applications or simply used as a data respository

Scalability

Delft-FEWS is a fully scalable system. It can be run as a self-contained manually driven forecasting system operating on a normal desktop computer, but can also be deployed as a fully automated distributed client-server application. The client server application allows further scaling through running time consuming tasks in parallel. The system applies the latest software standards. It has been developed in using Java™ technology, and is fully configurable through open XML formatted configuration files. In the J2EE compliant Client-Server application, JMS is used to provide resilient communication between distributed system components.

Connecting Delft-Fews to external data sources

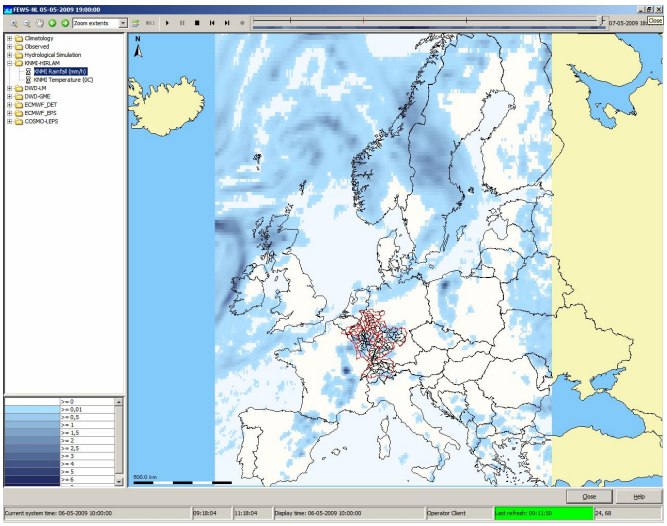
Of paramount importance in an operational flood forecasting system is an efficient connection to external data sources. Delft-FEWS provides import modules that allows import of data from external sources such as on-line meteorological data or hydrological data from external databases. These data include for example time series obtained from telemetry systems such as observed water levels, observed precipitation, but also meteorological forecast data, radar data and numerical weather predictions. Data are imported using standard interchange formats, such as CSV, XML, GRIB and ASCII. The import of external data also supports ensemble weather predictions now commonly produced by a number of meteorological forecasting agencies.

Delft-Fews contains allows the additional java libraries to be accessed by the software giving organisations the opportunity to create their own import routines and connections to external data sources.

Validating, interpolating and transforming data

Particular emphasis is placed in Delft FEWS on quality checking of data obtained from external sources, using extensive data validation options. Serial interpolation (gap filling) is available to complete data series where required. Data hierarchy options allow alternative data sources to be used as a fallback, ensuring continuity of the forecasting process, even if available data is incomplete or inconsistent. Validation and interpolation will normally be automated, but user intervention can also be configured.

Another set of utilities is available for transforming data with disparate spatial and temporal scales. This includes spatial interpolation to derive for example areal weighted precipitation from spatially distributed point sources, or from spatial data such as radar data and numerical weather prediction models. Data transformation utilities also include methods for temporal aggregation and dis-aggregation, evaluation of simple equations, and typical hydrological functions such as stage-discharge relationships and evaporation calculations.
Delft-Fews also enables the use of the PCRaster language for complete control of grid manipulations within the system.



Starting with simple forecasting models

Delft-FEWS provides a number of modules to rapidly establish a simple forecasting system where hydrological and/or hydraulic models are not available, or are under development. This includes a correlation module that generates forecasts for a downstream location based on the correlation of events at that location and a suitable upstream location. A lookup table module can be used to derive warning levels on the basis of a heuristic combinations of critical conditions in the imported data.

Once more advanced models become available these simple modules may be replaced. Alternatively these can be retained for comparison purposes, or as a backup should these models fail.

Expanding to more advanced modelling

The philosophy of Delft-FEWS is to provide an open system that allows a wide range of existing forecasting models to be used. This
concept is supported by the general adapter module, which communicates to external modules through an open XML based published interface, effectively allowing “plugging-in” of practically any forecasting model.

An adapter between the native module data formats and the open XML interface is typically required, and such adapters are already available to support a wide range of hydraulic and hydrological models.

The great advantage of this open interface is that existing hydrological and hydraulic models and modelling capabilities can easily
be integrated in the forecasting system, without the need for expensive re-modelling using a specific model.

There are currently over 40 commercial software packages supported by Delft-Fews including Delft-3D, HBV, HEC-RAS, ISIS, Mike11, Modflow, PDM, Sacramento, Sobek, SWMM, TopKapi and URBS.

Using some of the advanced forecasting tools

Delft-FEWS provides a number of advanced forecasting tools that can be used in improving and assessing the quality of forecasts.

This includes generic data assimilation methods such as an ARMA based error correction module; a what-if scenario tool can be used to quickly establish the effects of different input scenarios; a performance module is also provided to assess the accuracy of forecasting models used and provides a powerful set of analysis tools to assist post event analysis. A flood mapping module can be used to project forecast levels as flood extent maps.

Viewing results and disseminating forecasts

Delft-FEWS provides easy to understand, advanced graphical and map-based displays to help the user carry out the required tasks for hydrological forecasting in a structured way.

The interactive map display allows geographic navigation, while icons give the user rapid insight in warning levels being reached.

The time series display can be used to explore data further, or edit input data when necessary. Additional insight in the dynamics of a flood event may be gained through the animated longitudinal profile and flood map displays.

Forecast results can be disseminated through configurable HTML formatted reports, allowing easy communication to relevant authorities and public through intranet and internet.

Configuring and deploying the Delft-FEWS system

The system may either be used in a stand alone environment, where forecasts are run and analysed manually, or as a J2EE compliant client-server application. Established standards such as Java Messaging Service (JMS) ensure smooth and resilient communication between clients and servers.

In the client-server configuration, the heart of the system is the master controller, which manages the forecasting process and schedules all forecasting runs. Forecasting modules are run on dedicated forecasting shell servers. For most forecasting systems one forecasting shell server may be adequate, but the system is fully scalable, and where required multiple forecasting shell servers may be applied to process forecasting tasks in parallel.

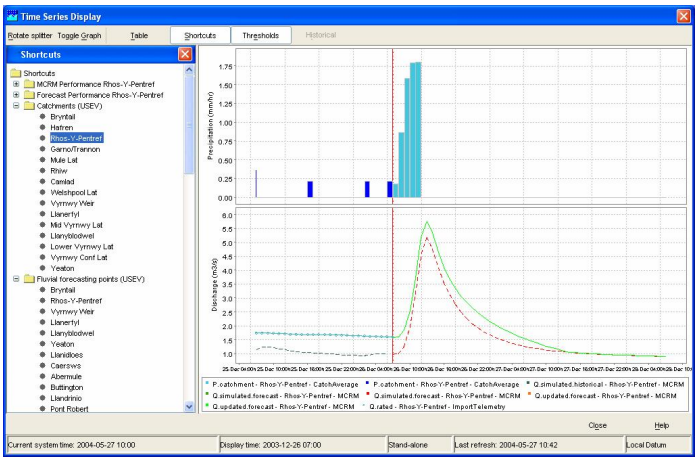
Duty Forecasters access the forecasting system through client software, allowing full control whether in the office, or at home connected through a Modem. Reports generated by the system showing relevant forecasting results may be accessed by relevant authorities, emergency services, or even the general public through the web server connected to Internet/Intranet.

System application and training

Deltares will normally be closely involved with the client in setting up Delft-FEWS as an operational flood forecasting system in combination with a comprehensive training programme on the operation and maintenance of the system. In-depth training courses are available, teaching users not only how to use the system, but also how to independently add new models to the system and customise Delft-FEWS to the changing requirements of an operational system.

Sample of applications and ongoing projects

Community Hydrological Prediction System (CHPS), USA: Fews provides the cornerstone of the National Weather Services, pilot operational hydrological forecasting platform

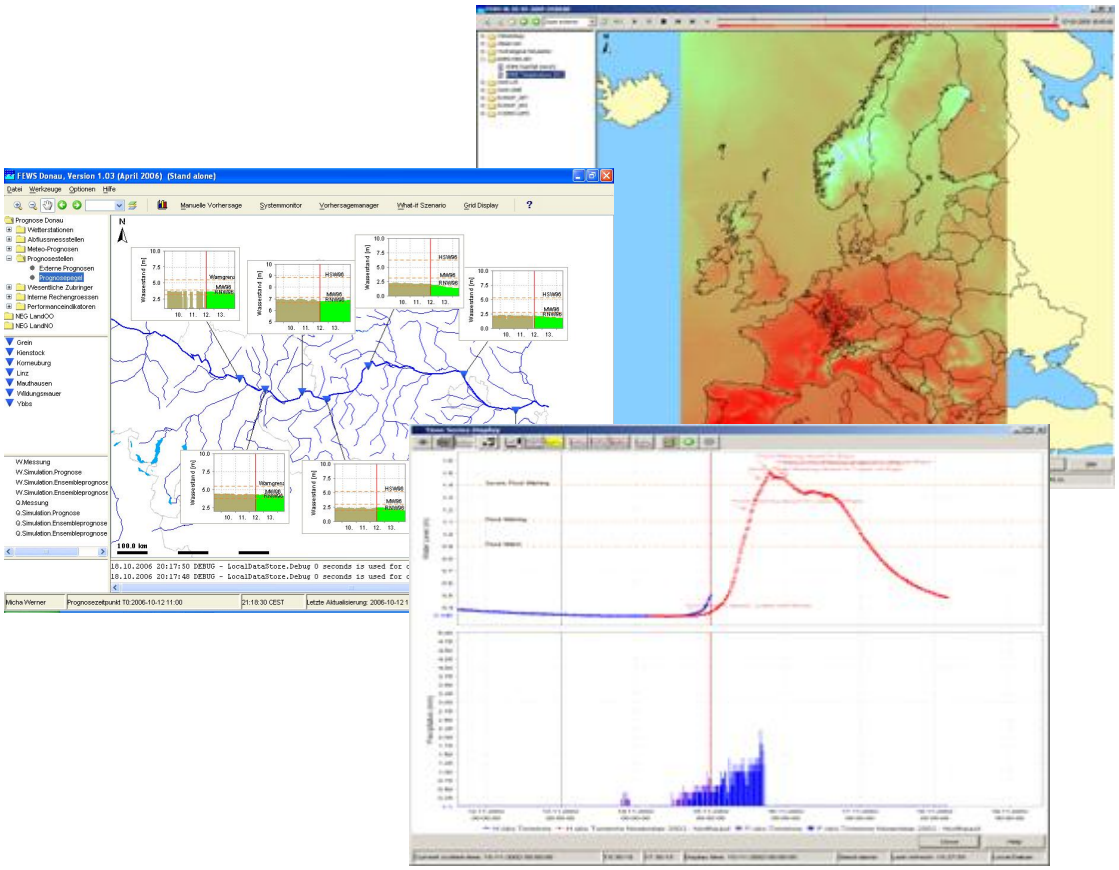


FEWS Mekong: An operational flood forecasting system for the Mekong, delivered to the Mekong River Commission.

NFFS: Development of Delft-FEWS as the National Flood Forecasting System, commissioned by the Environment Agency for operational forecasting across England & Wales.

Water Information System, NL: An operational water management system, delivered to a number of water boards in the Netherlands.

National Groundwater Modelling System: Developed to Delft-Fews system to manage interactive scenarios for groundwater management in England and Wales.
Water quality and flow forecasting system: commissioned by the Public Utilities Board, Singapore
Delft-Fews is now used operationally in more than 20 countries worldwide.



Deltares

Innovative solutions for water and subsurface issues

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