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FEWS-Waterways For Economically And Efficiently Navigating On Inland Waterways.

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FEWS-WATERWAYS FOR ECONOMICALLY AND EFFICIENTLY NAVIGATING ON INLAND WATERWAYS

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This paper describes the use of Delft-FEWS as part of a tool for navigating on Inland Waterways economically and efficiently. Delft-FEWS, as developed by Deltares, is an operational real time forecasting system which links data and models in real time. FEWS-Waterways forecasts water depth, flow velocity, air clearance below bridges based on measured and forecasted hydrological and metrological data and current state of the waterway system. This feature of Delft-FEWS will be used in an economy planner giving advice to the skipper with respect to: maximal cargo volume, minimum fuel consumption and the optimal ship speed in order to arrive in time at the destination, e.g. reliable Expected Time of Arrival.

INTRODUCTION

In the Netherlands, the Ministry of Infrastructure and the Environment is looking at reducing road traffic so as to reduce road congestion and emissions such as CO2. And further with the construction of the new North Sea harbor area, Maasvlakte 2, in the coming decade the Netherlands is expecting substantial increase in inland water navigation. In order to manage the increase in inland water navigation traffic and to have the Netherlands maintain its leading position as logistics junction, the program "Impulse Dynamic Traffic Management Waterways" (IDVV) was developed. One of many projects under this program is to design tools for safe, reliable and efficient inland navigation. The "Economy Planner", a tool to provide skippers with an accurate ETA (Expected Time of Arrival) at the berth of destination before departure, optimal amount of cargo to load and the optimal track with respect to maximum draught, fuel reduction and reduced carbon emission, has been developed under this program. The ETA, optimal cargo load and optimal track depend on the actual and realistic expectations of water depth, flow velocities, and air clearance below bridges along the navigation route and period. Deltares is participating in a consortium led by MARIN, which is responsible for designing the Economy Planner tool.

FEWS-WATERWAYS

FEWS-Waterways, based on the Delft-FEWS System, as described in Werner et al [1], combines hydrological, hydrodynamic and morphological models, with bridge height data, to predict water depths, bed levels, flow velocities and air clearance below bridges at least three (3) days ahead. This system forms an essential part of the Economy Planner, based on which the optimal navigation route for a ship is determined (Bons et al [2]).

Figure 1 shows the major rivers, important commercial navigational routes, within the Netherlands, which are schematized in 1D and 2D hydrodynamic and morphodynamic models as given under Table 1. These model schematizations, or project areas, form an integral part of FEWS-Waterways. Output of each of these models is needed (see Table 1) to calculate ETA, cargo load, optimal track of the ship along its navigational route and bridge air clearance.

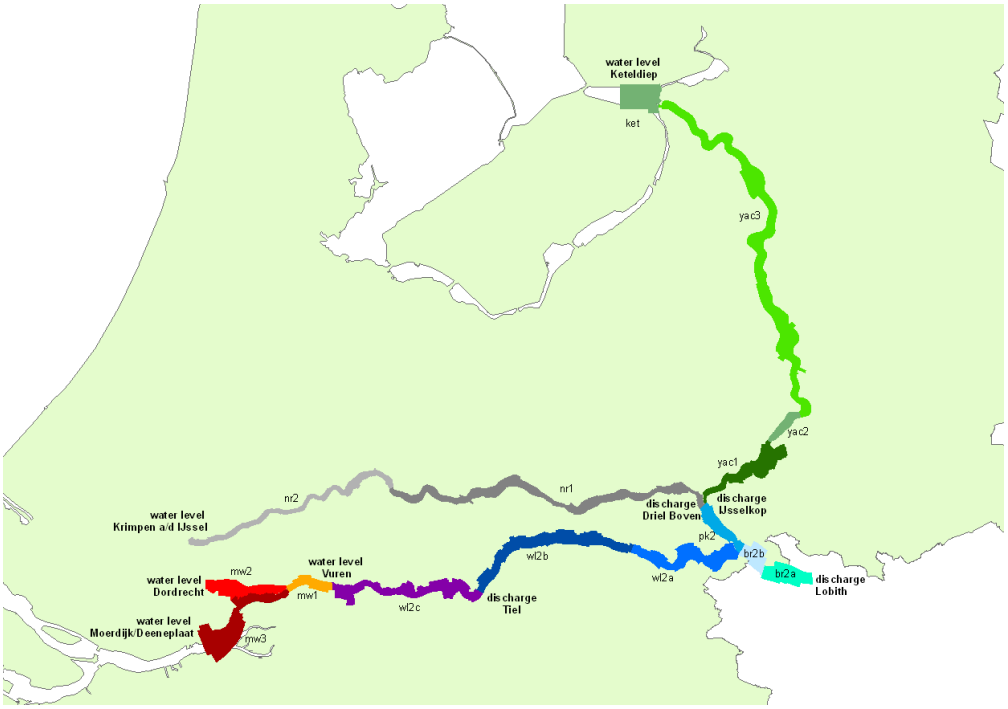

Figure 1. FEWS-Waterway Project area

Existing Deltares models are used such as Delft3D-, WAQUA- and SOBEK-models, as described in Van der Mark, et al [3]. The output of the Economy Planner consists of navigational charts showing the actual available water depth, including depth contours for the navigable river width, as well as the available air clearance relevant for the number of layers of containers that can be transported. The actual information collected on commercial ships equipped with echo sounders is used to validate the modeled river bed levels. Table 1 provides an overview of model results (parameters) as needed (used) within the Economy Planner based on current and forecasted meteorological and hydrological inputs.

The FEWS-Waterways system is able to run all models at a predefined interval of four (4) hours. Figure 2 shows the schematized representation of FEWS-Waterways. The measured and forecasted water levels and discharge at the boundary conditions (see Figure 1) are imported directly from Matroos, a database of the Netherlands Ministry of Infrastructure and the Environment. Apart from the measured and forecasted data, FEWS-Fairways also imports the

sounding data measured on ships as shown in Figure 3. This data is used to validate the model river bed levels. After processing of the Matroos data, it is fed to the 1D and 2D hydrodynamic and morphodynamic models to generate water depths, flow velocity and bridge air clearance.

Figure 2. Schematized representation of FEWS-Waterways.

Table 1: Model Parameters used within the Economy Planner.

Parameter	**Model**	**Needed for**
Flow velocity (2D)	2DH hydrodynamic (WAQUA)	o Correct echo sounder data for squat and trim o Most energy-saving track during the trip o RPM during the trip
Water level (1D)	1D hydrodynamic (SOBEK)	Air clearance below bridges
Water level (2D)	2DH hydrodynamic (WAQUA)	Actual and forecasted water depth
Bed level (2D)	2DH morphodynamic (DELFT3D)	Actual and forecasted water depth

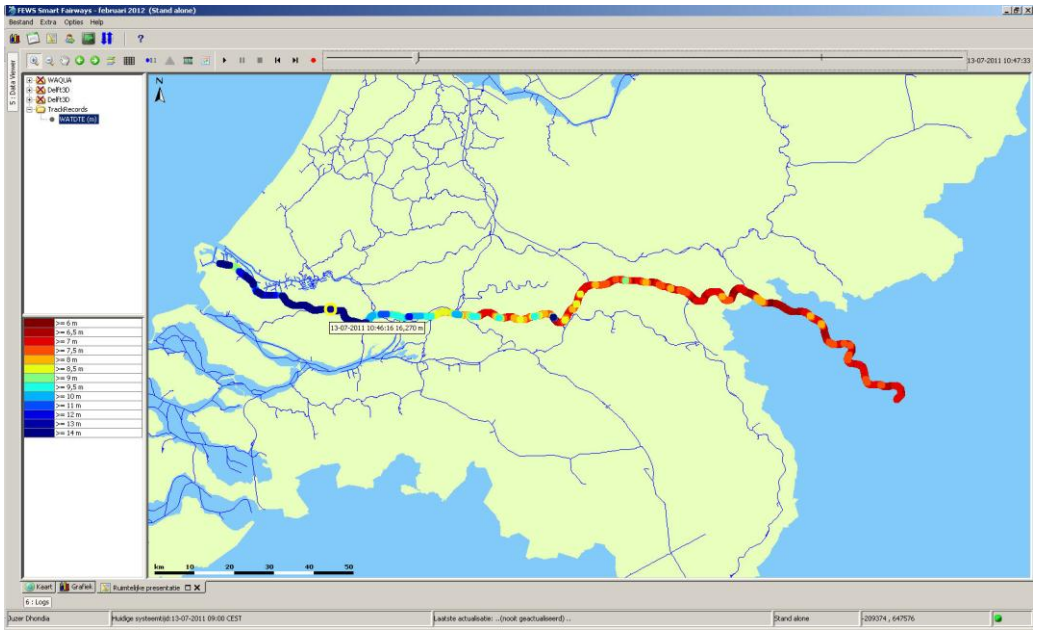

Figure 3: Sounding data measured on a ship imported within FEWS-Waterways.

Figure 4 shows the water depths within the navigation channel in FEWS-Waterways grid display. The generated (forecasted) water depth, flow velocities and air clearance (model results) is exported to the Economy Planner in standard NetCDF-CF format. The Economy Planner generates an optimal navigation route with suggested ship speed, water depth, RPM, draught, fuel consumption for a given ship navigation route as shown in Figure 5.

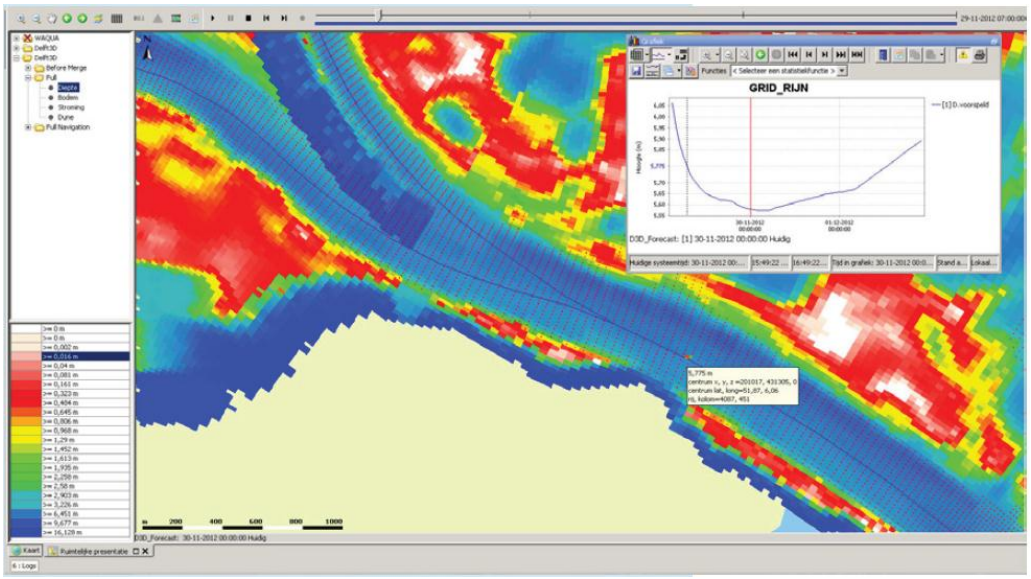

Figure 4. Forecasted water depths in and outside the navigational area of river.

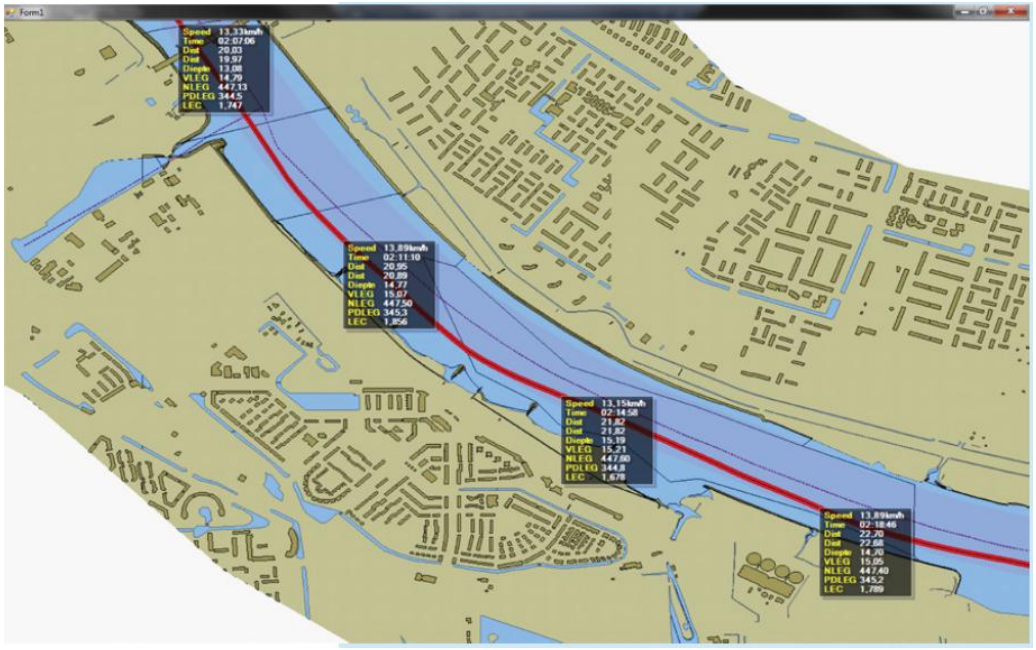

Figure 5. Economy Planner showing optimal navigation route with suggested ship speed, water depth, RPM, and draught.

LOOKING FURTHER

FEWS-Waterways, a prototype, increase the reliability of the Economy Planner due to forecast data. It facilities a long term planning for ship movement by generating water levels for at least three (3) days in advance. The Deltares based hydrodynamics and morphological models applied currently within this project can be complemented by any other hydrodynamics and morphological models, due to the flexibility offered by the Delft-FEWS system. Hence the FEWS-Waterways system can be ported and applied to any inland navigation river in the world.

Further the model results are written in standard NetCDF-CF, any trip advisor application similar to Economy Planner, can use the model results of FEWS-Waterways.

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