TANDEM DSS - THE PROTOTYPE OF DISTRIBUTED HYDRO-INFORMATION SYSTEM
Ostrava 2008

Ing. Petr Vavroš[1], doc. Dr. Ing. Jiří Horák[2], Ing. Josef Stromský[3], Ing. Antonín Orlík[4], Ing. Markéta Hanzlová[5], Mgr. Kateřina Makalová MBA[6]

[1,2,5] Institute of Geoinformatics, Faculty of Mining and Geology, VŠB-TU Ostrava, 17.listopadu 15, 70833, Ostrava-Poruba, Czech Republic
petr.vavros.hgf@vsb.cz
jiri.horak@vsb.cz
marketa.hanzlova@vsb.cz

[3, 4]ArteGIS CZ s.r.o., Pohraniční 52/23, 703 00 Ostrava – Vítkovice, Česká republika
josef.stromsky@artegis.cz
antonin.orlik@artegis.cz

[6] GEOgroup a.s., Jana Masaryka 26, Královské vinohrady, 120 00, Praha 2, Česká republika
makalova@geo-praha.cz

Abstrakt. The concepts of web services and open distributed architecture were applied within project "Modular System Research and Development for Integrated Water Management Application Creation" (FT-TA2/009) in a form of T-DSS prototype, customised application for web based hydro-information systems. The main objective of the project is to develop a modular system for application creation, usable in construction of information systems fundamental in integrated water management, which is represented by the prototype of the system. T-DSS provides mapping services, database related services and access to remote components (e.g. WMS, hydrological model, hydro-meteorological condition and prediction), with special emphasis placed on output flexibility (e.g. user-based layer classification, information panels). The remote components are represented above all by distant data and mapping services (e.g. meteorological predictions), modelling and analytical systems (currently HEC-HMS, Modflow and additional utilities), wide information support (e.g. meteo situation). With map, analytic and visualisation abilities the GIS system makes functional and supportive advantage in decision making in water management.

Klíčová slova: hydrology, system geoinformatics, mapping, web services, GIS, model

1 Introduction

Current requirements for water management reflect a complex view of water, resp. water bodies and their key role for landscape and society. Management should satisfy different many time concurrent needs of natural protection, natural habit conversation, flood protection, drinking water supply, irrigation, fish production, transport, energy production, industrial

water supply, and collection of waste water. Even more, these requirements may change during a short time. The new situation is reflected by new substantives „integrated“ and „adaptive“ for water management, which are largely discussed in scientific fora and also applied in many cases.
Such more complicated situation for decision making in water management demands more efficient information support and also the information tools and systems better adapted to the more complex and more diverse situation.
It is easy to say that integrated and adaptive water management needs also integrated and adaptive information system. A Tandem project „Modular System Research and Development for Integrated Water Management Application Creation" (FT-TA2/009) tries to find an appropriate solution for such information systems and required tools.
The objective of the project is a research and development of a modular system for application construction, where these applications are to be applied in information systems for intergrated water management.
The research was concentrated to utilisation of web services and open distributed architecture. Web services play the significant role because they enable machine-to-machine communication with conservation of existing standalone systems/services and to create the distributed web-based system providing more complex information, analytical and modelling support. Originally standalone systems are frequently well specialised to solution of individual tasks in water management. Providing such tools in the integrated system increases the overall performance, adaptibility and complexity.
The research issued in a T-DSS prototype. Basic features of its architecture and concept can be found in (Stromsky et al. 2007). More elaborated view of pros and cons of applied web services in T-DSS is described in (Horák et al, 2007).
In this paper we would like to introduce the final design of the prototype and present the main features of the current version.

2 Review of main technical features

Tandem DSS is a web-based hydro-information system, using service oriented and open architecture. One of the most important feature is the extended application of web services, which enables to create integrated system above heterogeneous individual parts (fig. 1). Similar system were developed in the frame of TRANSCAT project (Horak et al. 2006).

The core of T-DSS is represented by ArteGIS Server, which extends University Minnesota MapServer capabilities and ensures:
- Communication with every particular services, via SOAP protocol
- Definition of scenarios performed on the service-oriented architecture
- Providing an environment for generating a graphical user-friendly interface
- Publication of own web services, encapsulates selected scenarios/tasks
- Combination of required information including map compositions (map server) and serving results to appropriate interfaces (GUI, WS, WMS, …)
- Security features of information system (authentization and authorization, protection against attacks from outside.

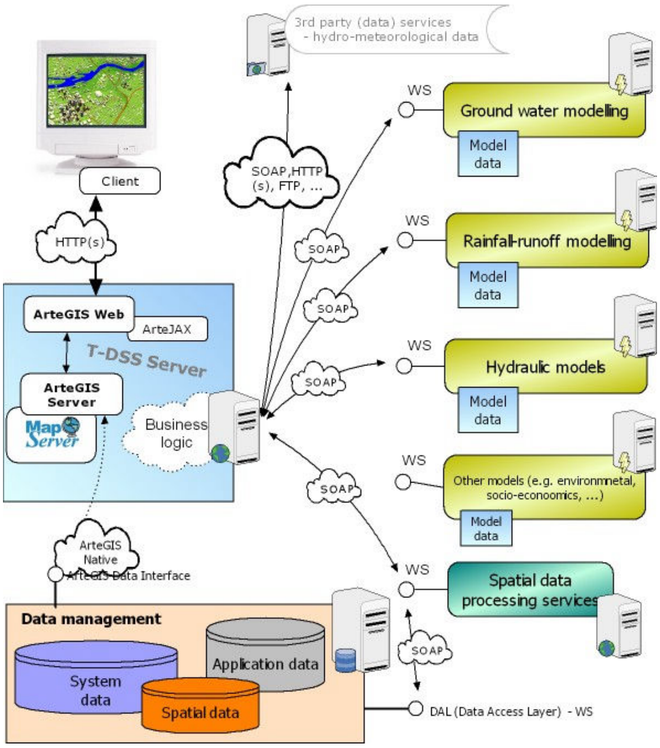

Fig.1 - Schema of the model

The database management system utilizes PostgreSQL with PostGIS extension, which is used for the storing of spatial data into a database. Database is used for storage 3 kinds of data:

1. system data,
2. spatial data and
3. application data.

The system data is essential for management and operation of the system. It includes e.g. definition of all objects in the system, description of users, groups, access rights and ownership, metadata.
The spatial data represents different vector or raster data used for map creation, spatial queries and analysis, modelling.

Remote Modelling and Data Processing services are available due to interfaces developed in the frame of the project. There are:

Interface to HEC-HMS

HEC-HMS 1D hydrological model http://www.hec.usace.army.mil/software/hec-hms/hechms-hechms.html contains hydrological rainfall-runoff model which enables to predict a water flow for selected profiles at a river.

Interface to ModFlow 2000
ModFlow 2000 (MODular three-dimensional finite-difference ground-water FLOW model) (http://water.usgs.gov/nrp/gwsoftware/modflow2000/modflow2000.html is used for development and modification of hydrogeological model (the water table, groundwater flow etc.).

Interface to GRASS

The web client is an application written as DHTML using JavaScript. The client (fig. 2) provides spatial data visualization and various functions for manipulation described in following chapter.

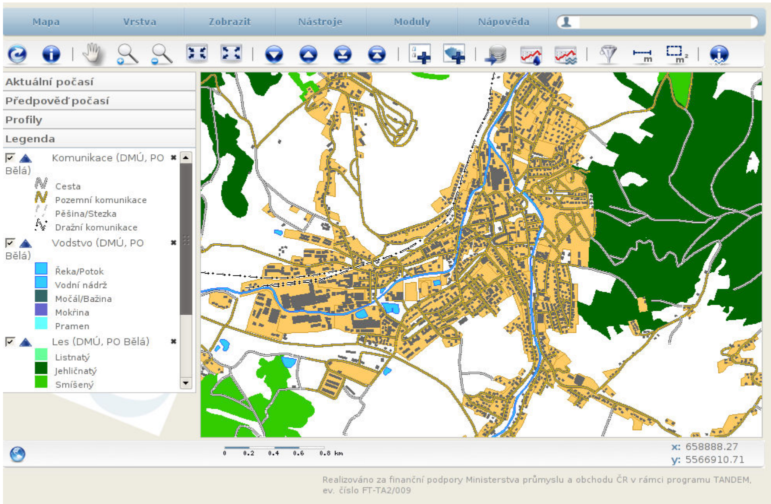

Fig.2 – Introductory view of Tandem DSS client

2.1 Toolbar

In a toolbar a user can find:

- cursor query

the design of the tool looks similar to many other mapping system, nevertheless the difference is in the result. The user do not need to specify the interviewed layer but the system provides the list of all objects in indicated place without regard to in what layer they are stored.

- attribute query

This type of query is used to select the records according the to defined filters. This tool is simple, but powerful (fig. 3).
The process can be specified in following steps:

1. Choose the atributte from the left table.
2. Define the filter with the mathematical operator from the menu.
3. Use the 'Show the values' button to show all the values
4. Choose the attribute value from the right table

5. Result of the query is displayed in the lower field.
The result may be displayed in the map through the „Zobraz vybrané“ button.

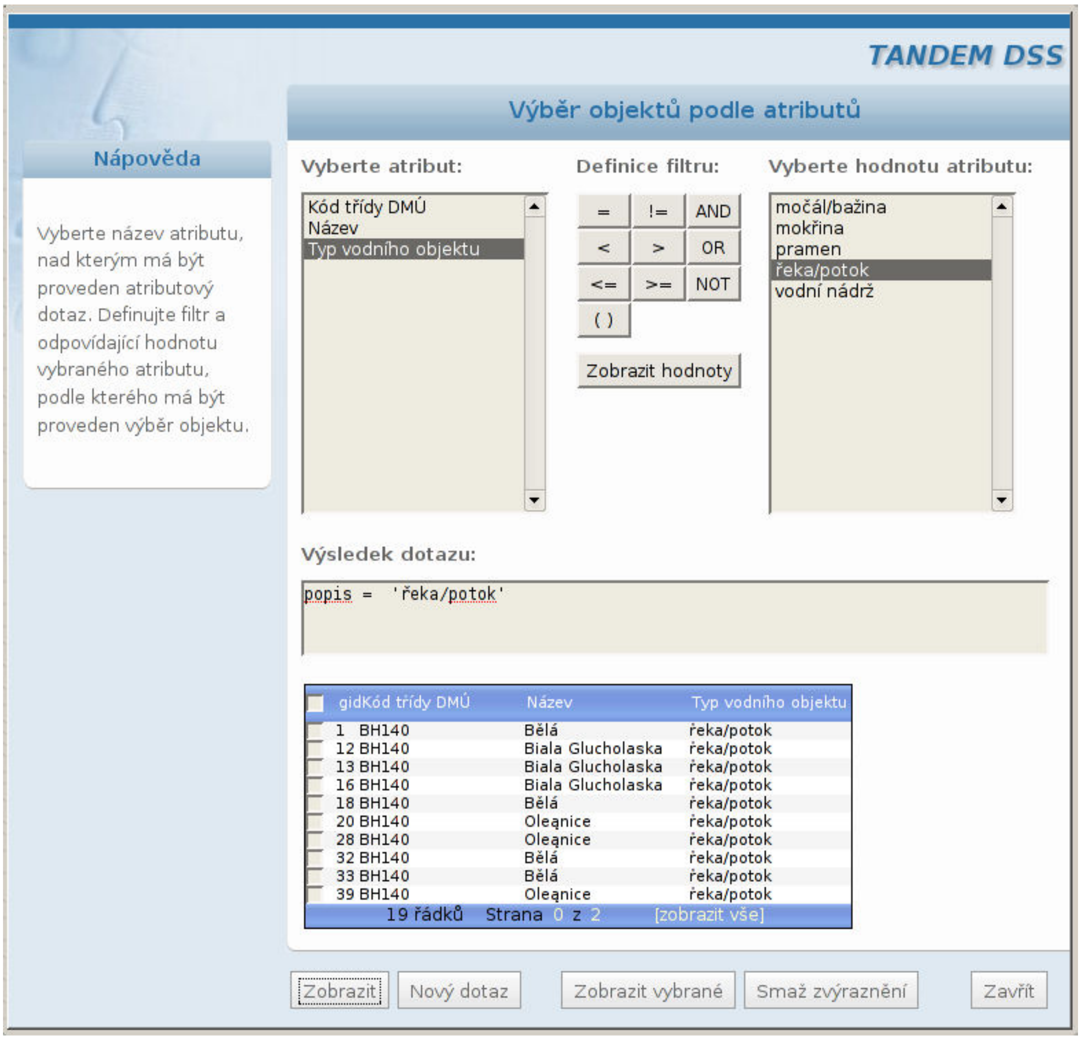

Fig.3 - Selection objects

- *Add layer*

This function operates like in any other map server. More advanced feature is the possibility to select a type of the layer and filtering by a mask (fig. 4). This step restricts types of listed layers to selected one. The type is defined by administrator (more privileged user).
Using the filter function the user can select names of layers by a mask, represented by a part of layer's name.

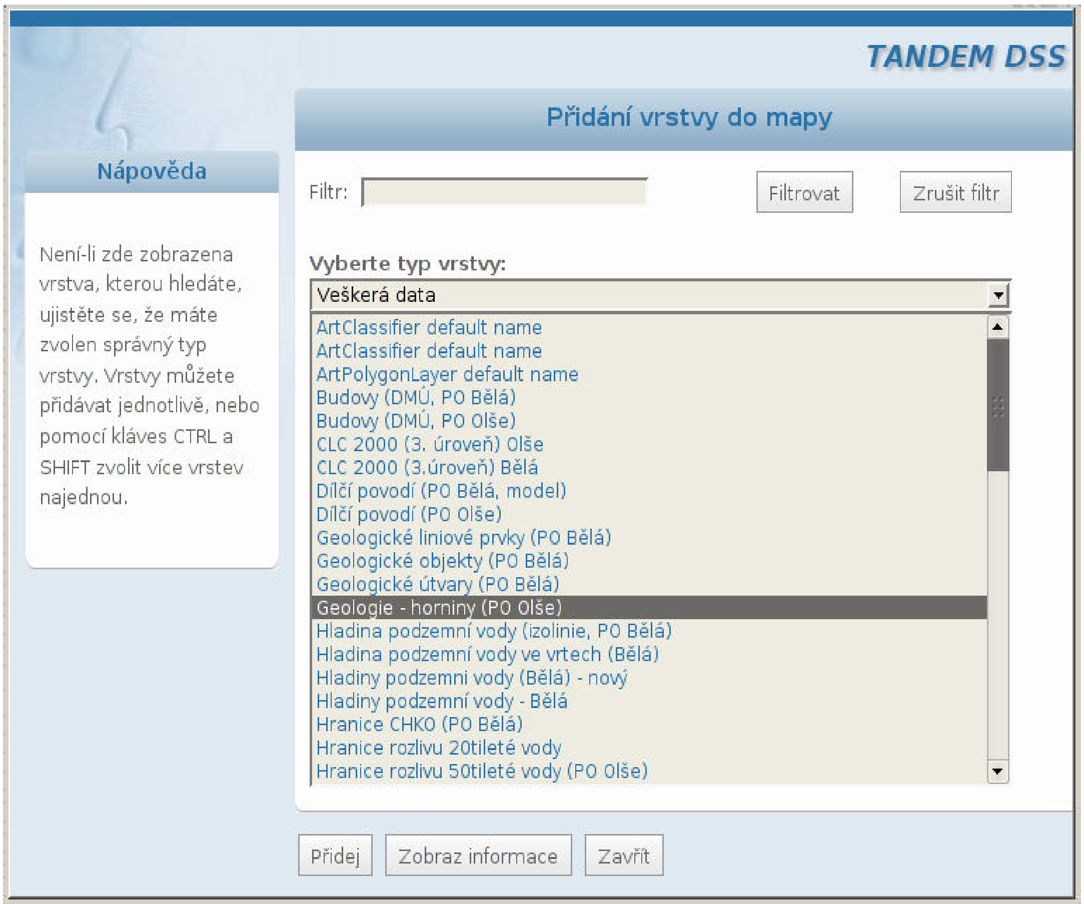

Fig.4 - Adding the layers to map

To show the information about the selected layer, use the Zobraz informace button.

- *change map composition*

The system allows to load many of pre-defined map compositions (fig. 5). It is possible to define the own composition by adding or removing another layers and save the composition from the menu by clicking the right mouse button over the selected layer and choose Ulozit mapovou kompozici item.

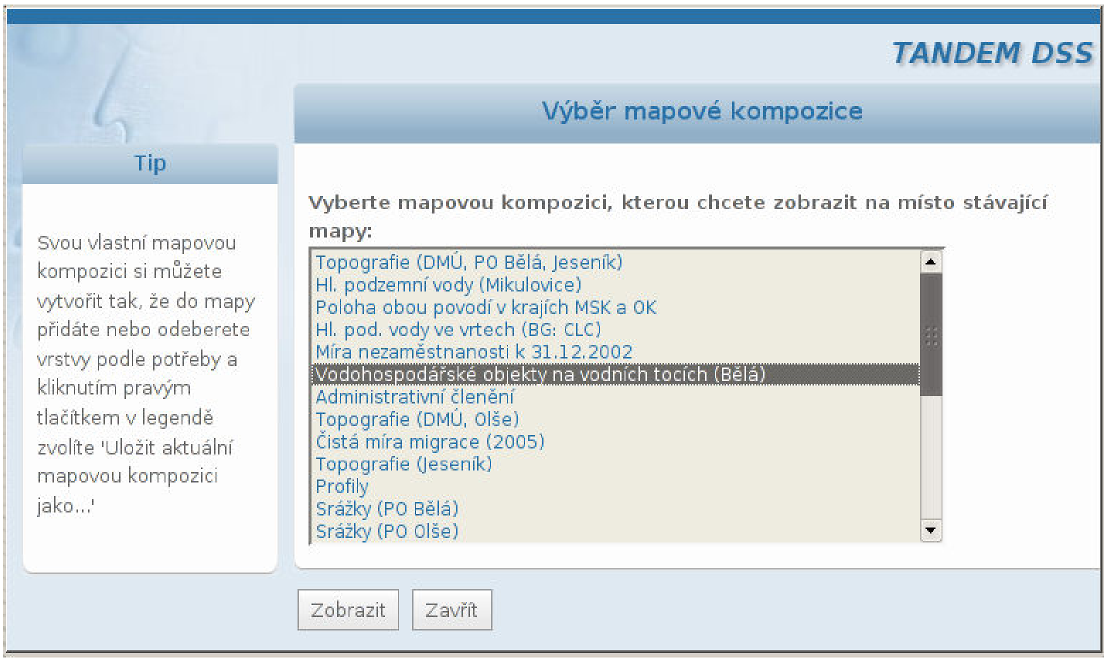

Fig.5 - Selection of map composition

- *area and length measurement*

It represents a common function to measure length of polylines and perimeter/area of polygons specified by an user cursor (fig. 6).

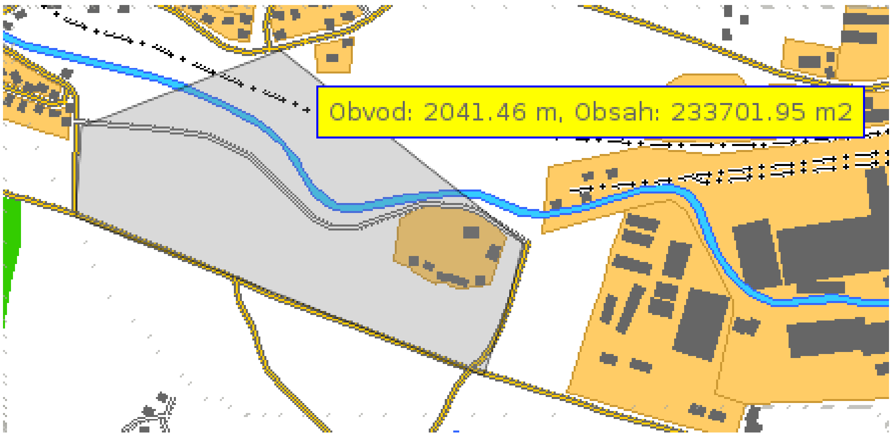

Fig.6 - Area measurement

- graph of precipitation

The tool can be invoke on any place in the map. The nearest measurment station is assigned and data from this station is displayed in the graph. The small window with the graph can be expanded by clicking (fig. 7).

Default setting of the graph (data for 1 month, automatic scale for vertical axe etc.) can be changed in the menu.

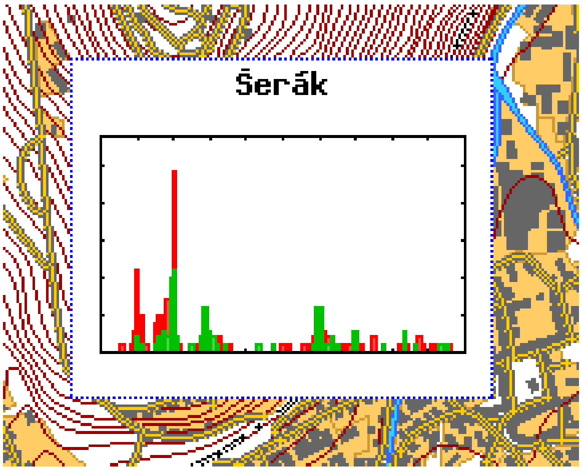

Fig.7 - Small picture of percipitation graph

- *hydrograph*

The tool can be invoked on any place in the map, but of course preferrable close to water line. The appropriate measurment profile is assigned and data from this profile is displayed in the graph. The small window with the graph can be expanded by clicking (fig. 8).

Default settings of the graph (time interval, automatic scale for vertical axe etc.) can be changed in the menu.

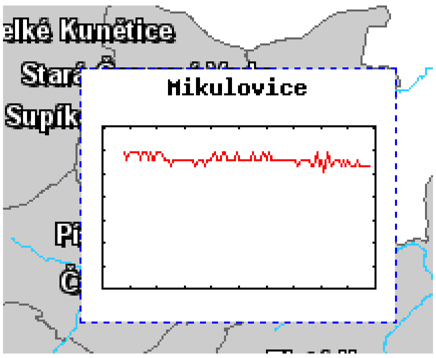

Fig.8 - Popup window of hydrograph

- *water table query*

In the part of the region, groundwater flow model is established. It is possible to visualise the water table, but it is also possible to make a query through a specific icon - what is a water depth (water table) in this place. The quality of the result strongly depends on the quality of groundwater modelling. (fig. 9)

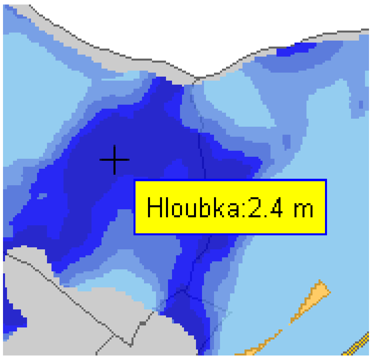

Fig.9 - Result of the water

3 Sidebar

The left sidebar displayes additional informations, such as the actual weather, weather forecast and other.
Actual weather displays an actual weather conditions in the five stations (nearest airports) (fig. 10).

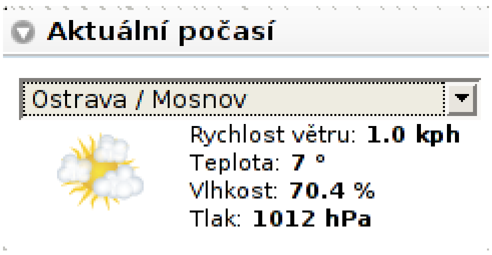

Fig.10 - Actual weather condition

Next field *Weather forecast* displays the text informations about the weather forecast for whole Czech Republic. Data comes from the Czech Hydrometeorological Institute (www.chmi.cz).

In the *Profiles*, user can get information about a hydro-profile. Results are displayed in the form of standard information sheet. Simultaneously, the map is pan and zoom to a location of the profile.

4 Menu

All the tools are located in the menu. The menu is not clickable, but sensitive to movement of the cursor over a name from menu, when the menu expands.

- *import and export layers*

Import and export are significant functions of the system. The supported formats of data are raster file, Web Map Services (WMS) and Web Feature Services (WFS).
Import is used to load data to project database. After the data import it is possible to add the layer to the map, define the attributes user, show the attributes table, make an attribute query for the selected layer or define its style.

- *symbology*

Symbology of the layers is essential for visualisation of the layer.
During the process of style definition, it is needed to specify name of the class, symbology package, feature selection, labelling, classificator transparency, scale of visibility and more (fig. 11).

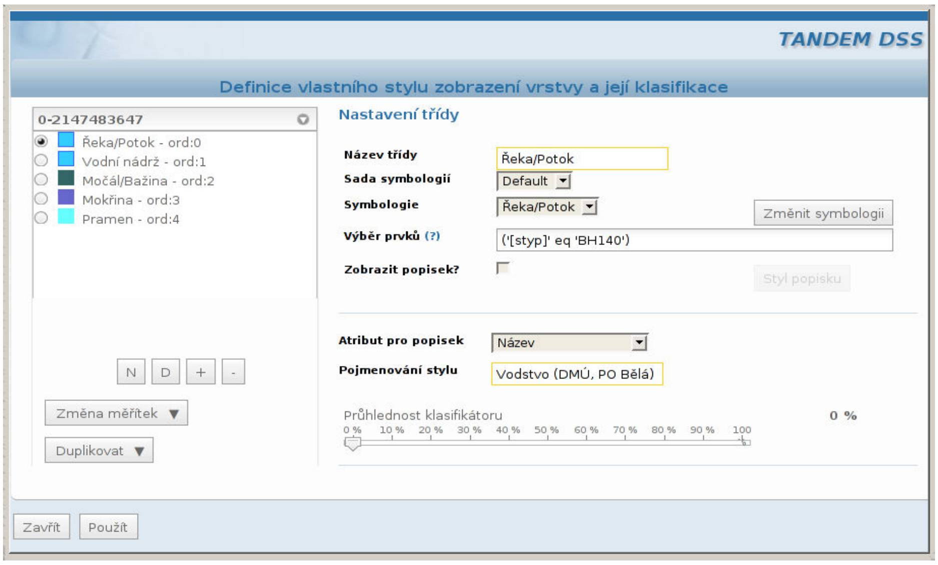

Fig.11 - Own style definition of selected layer

Optionally new symbols can be specified. It is possible to set the Background color, Foreground color, Border color, Size, Mminimal size, Maximal Size, Shift in the X and Y direction, Minimal width to draw, Minimal size of the symbol, Angle and Symbol (fig. 12).

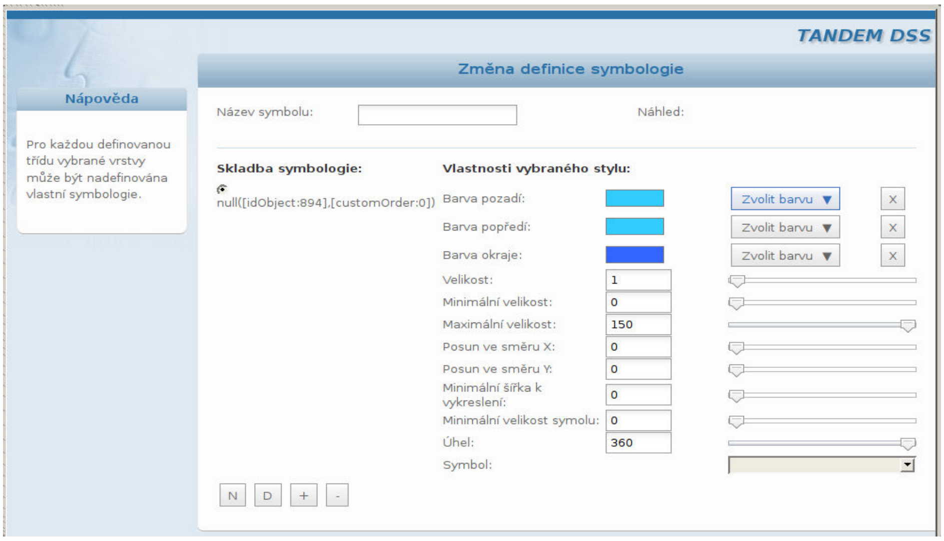

Fig.12 - Change of the symbology window

More advanced feature of the system are hidden in the menu „modules", where additional modules are accessible. Except of precipitation and discharge graph described earlier, there are precipitation radar (data from CHMU, included animation), meteorological model GFS (fig. 13), interpolation procedure for precipitation and access to ModFlow.

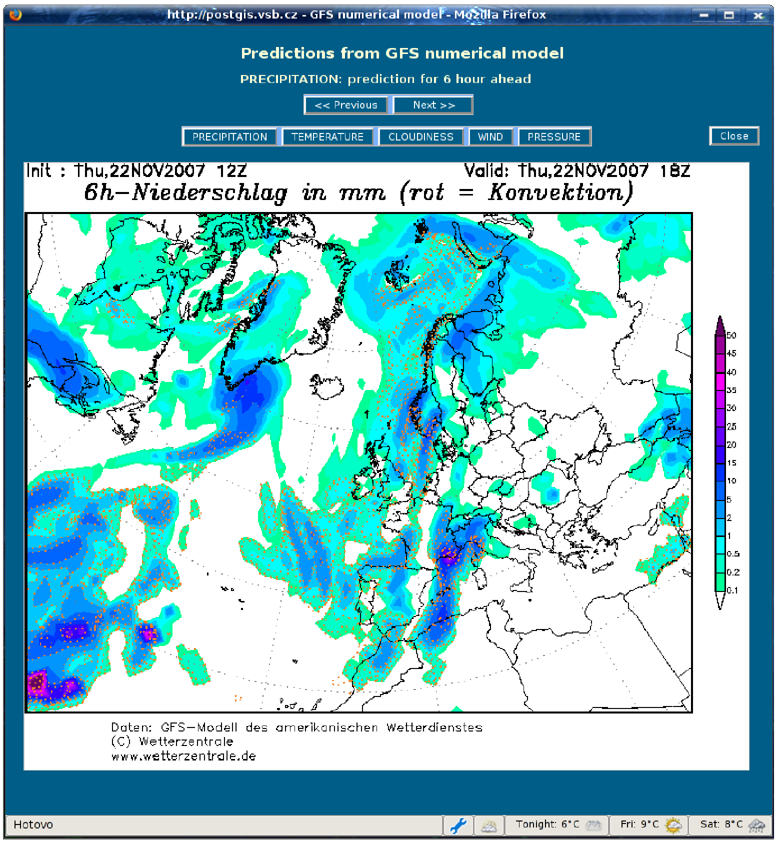

Fig.13 - GFS model

5 Conclusion

In the frame of TANDEM project the prototype of web-based hydroinformation system called Tandem DSS (T-DSS) was established. The finalisation of the prototype is undertaken at the end of 2007. The prototype is intended to support an adaptive and integrated water management.
In previous publication an architecture concept and discussion of advantages and disadvatages of web services application were made. In this paper we concetrated to present GUI of the system and indicate some features of the system from the enduser's point of view.
Except of many standard functions which are typical for map servers and its clients, the T-DSS prototype offers a set of interesting specific features and advanced functions.
Some of them represents improvement of mapping tools like improvement of cursor query or selection of map composition by filtering.
Others are more related to water management – identification of nearest stations/profiles in the country, displaying their data, forecasting meteo ad hydro situation (using services of CHMU, GFS and HEC-HMS rainfall-runoff modelling).
The menu of available tools is not closed yet. It is anticipated to add possibility to predict a water shortage in water courses (time to anticipated decreasing the water level under the sanitary threshold) and also integrate the groundwater modelling interface to be able e.g. to predict the impact of new or changed withdrawal object in the area.

6 Acknowledgement

The project is supported by the Czech Ministry of Industry and Trade ("Modular System Research and Development for Integrated Water Management Application Creation", FT-TA2/009). Data and related services are provided by the courtesy of Czech Hydrometeorological Institute.

References

1. Gijsbers, Brakkee, Brinkman, Gregersen, Hummel and Westen. *The org. OpenMI. Standard interface specification*. HarmonIT Document Series C, 2004. pp 1-69.

2. Horak J., Unucka J., Stromsky J., Marsik V., Orlik A. TRANSCAT DSS architecture and modelling services. *Control & Cybernetics, vol 35, No.1 (Geographic Information Systems and Decision Support: New Approaches and Applications)*. Warsaw 2006. pp.47-71. ISSN: 0324-8569.

3. Josef Stromský, Antonín Orlík, Markéta Hanzlová. Návrh integrovaného hydrologického informačního systému s využitím webových služeb. *In Proceedings of GIS Ostrava 2007*. Ostrava 2007. ISSN 1213-2454, 20 pages.

4. Horák J., Orlík A., Stromský J. *Web services for distributed and interoperable hydro-information systems*. Hydrol. Earth Syst. Sci. Discuss. 4 1879-1891, 2007.

5. World Wide Web Consortium: Web Services. http://www.w3.org/2002/ws/