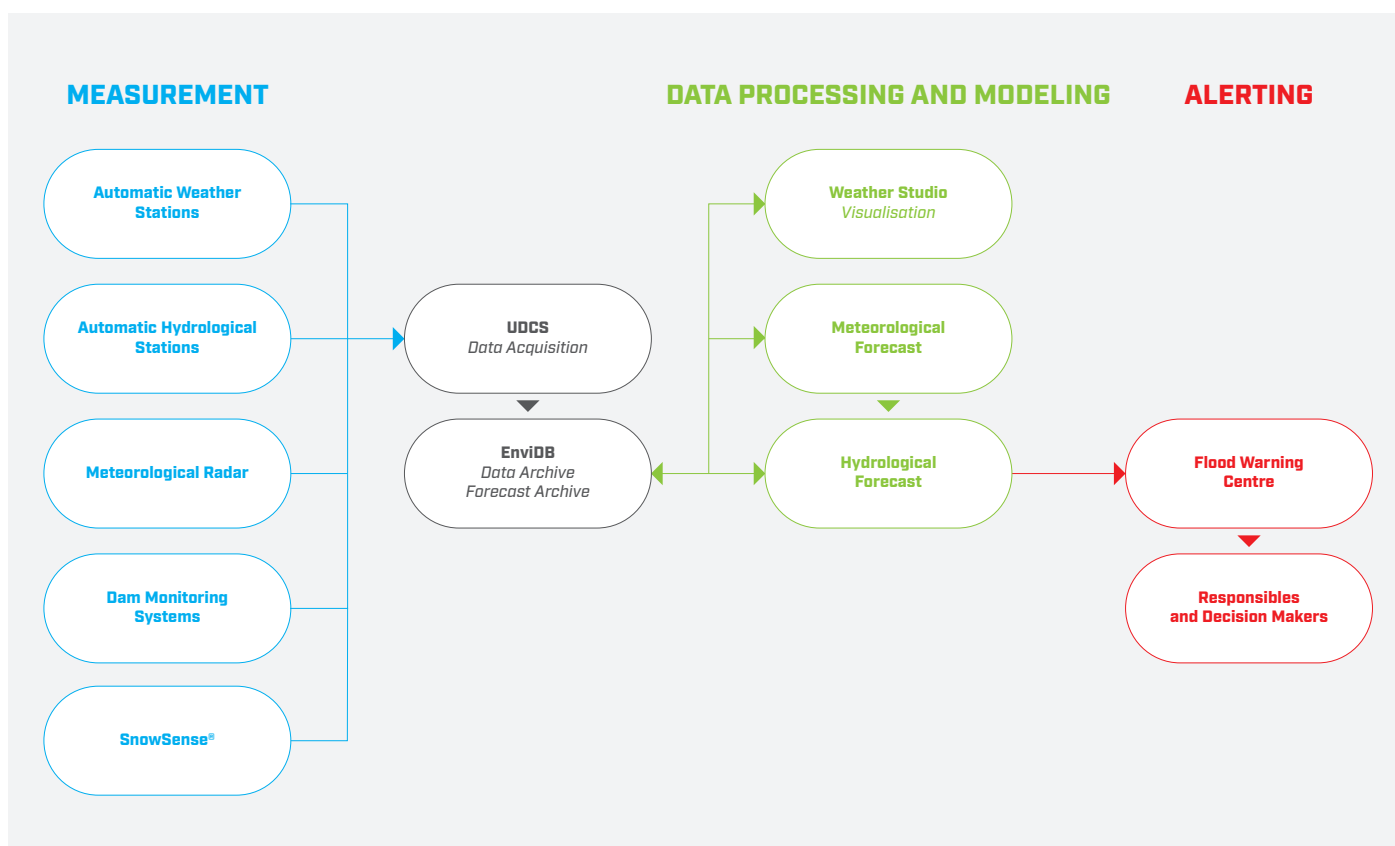


Hydrological Modeling and Forecasting

Hydrological modeling is an effective tool for simulation of hydrological processes with the fruitful outputs in many fields. Our system is modular-based and enables the user to use one, or multiple platforms to perform the required outputs. MicroStep-MIS fulfils the above mentioned goals by implementing various modeling tools:

- Complex rainfall – runoff models
- Models of parts of runoff generation process including specific snow-accumulation – snow melt / runoff models
- Hydrodynamic [1 - 2D] models
- Flash – flood modeling tools





Hydrological forecasting and warning



Land planning and development



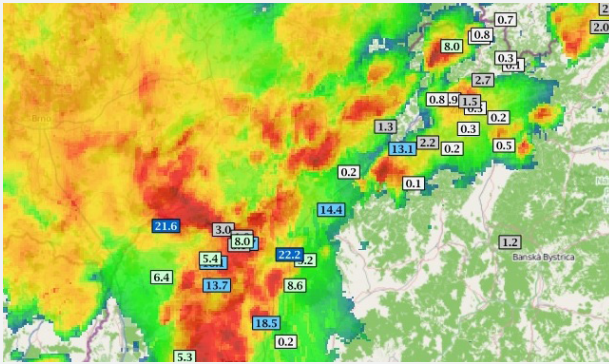
Country management



Research and studies

Simulations are provided in the form of studies, or in the form of the forecasting and warning system working in the real-time and providing hydrological forecasts to responsible institutions, decision makers and public.

Forecasting and warning system uses the real-time measured and forecasted values of precipitation and temperature. Analyses of snow cover and snow-melt processes are included in our systems too.



The combination of spatial radar and in situ station rain measurement - ideal input to the hydrological modeling system

System supports proprietary protocols and formats for communication with automatic weather, hydrological and environmental stations and data loggers, as well as for data distribution and exchange:

- OGC WaterML, NetCDF, OpenMI
- Ext log-files (user configurable formats)
- National and / or international formats (EURDEP, ANSI N42.42)
- NWP model outputs
- Dispersion model outputs
- Radar, satellite images
- JPEG / PNG / other image formats, MPEG videos
- HEC DSS files

System inputs

- **On-site monitoring** – meteorological, hydrological and snow measurement (SnowSense®) stations
- **Distant measurement** – meteorological radar measurement, precipitation field analyses, satellite measurement of precipitation and temperature
- **Weather prediction systems** - nowcasting of precipitation, NWP, storm cell tracking systems

Model overview

MicroStep-MIS uses rainfall – runoff models HBV, HYPE, HEC-HMS, SNOWMELT, hydrodynamic models (HEC-RAS), water quality models (HEC-RAS, HYPE) and other modeling techniques to realize client’s goals in many fields of human activity. Operative model system is modular based and customizable according to the client’s requirements (see the options below). The main goal is the satisfied stakeholder, satisfied user of the system.

Modular principle of our system

Model overview module

- Overview of model status
- Management of active / non active models
- Access to the model settings submodule
- Simple access to the result submodule

Model settings module

- Change the model settings
- Switch / change model inputs
- Select outputs
- Change connections of models

Model warning module

- Overview of warnings
- Setting of warning triggers
- Warning archive

Model results module

- Control the outputs of models
- Compare the results of various models

Model archive module

- Enables select and sort model outputs
- Selection keys based on date, location or type of situation

Other modules

- Maintenance
- Data inputs
- Map server, etc.

View mode: <input type="radio"/> Classic <input checked="" type="radio"/> Icons <input type="radio"/> Small icons		● All ○ Active ● Inactive ● Not OK ● Wa				
Id + Download	Model	Active	Status	Next run	Last run status	Last run
Extrapolacia_Motova	čakanie na nasledovné spustenie 23.01. 10:00 UTC			23.01.2018 11:00		23.01.2018 10:00
HBV_Hron_Ala	čakanie na vstupné predpovede: ALADIN 2018-01-23 06:00:00.000 UTC, Updating - AR korekcia: vypnutý, Updating - korekcia: vypnutý			23.01.2018 10:00		22.01.2018 10:00
HBV_Hron_Ala_ens	čakanie na nasledovné spustenie 23.01. 16:00 UTC, Updating - AR korekcia: vypnutý, Updating - korekcia: vypnutý			23.01.2018 17:00		23.01.2018 05:00
HBV_Hron_Ecm	čakanie na nasledovné spustenie 23.01. 19:00 UTC, Updating - AR korekcia: vypnutý, Updating - korekcia: vypnutý			23.01.2018 20:00		23.01.2018 08:00
HBV_Hron_Ecm_ens	čakanie na nasledovné spustenie 23.01. 20:00 UTC, Updating - AR korekcia: vypnutý, Updating - korekcia: vypnutý			23.01.2018 21:00		23.01.2018 09:00
HEC_Hron_hor_ZO_Ala	čakanie na vstupné predpovede: ALADIN 2018-01-23 00:00:00.000 UTC			23.01.2018 04:00		22.01.2018 10:00
HEC_Hron_hor_ZO_Ala_ens	čakanie na nasledovné spustenie 23.01. 16:00 UTC			23.01.2018 17:00		23.01.2018 05:00
HEC_Hron_hor_ZO_Ecm	čakanie na nasledovné spustenie 23.01. 19:00 UTC			23.01.2018 20:00		23.01.2018 08:00
HEC_Hron_hor_ZO_Ecm_ens	čakanie na nasledovné spustenie 23.01. 20:00 UTC			23.01.2018 21:00		23.01.2018 09:00
HEC_Hron_hor_I_Ala	čakanie na vstupné predpovede: ALADIN 2018-01-23 00:00:00.000 UTC			23.01.2018 04:00		22.01.2018 10:00
HEC_Hron_hor_I_Ala_ens	čakanie na nasledovné spustenie 23.01. 16:00 UTC			23.01.2018 17:00		23.01.2018 05:00
HEC_Hron_hor_I_Ecm	čakanie na nasledovné spustenie 23.01. 19:00 UTC			23.01.2018 20:00		23.01.2018 08:00
HEC_Hron_hor_I_Ecm_ens	čakanie na nasledovné spustenie 23.01. 20:00 UTC			23.01.2018 21:00		23.01.2018 09:00
HEC_Hron_dol_I_Ala	čakanie na vstupné predpovede: Q HEC_Hron_hor_I_Ala 23.01. 03:00 UTC Banská Bystrica, 7160			23.01.2018 04:00		22.01.2018 10:00
HEC_Hron_dol_I_Ala_ens	čakanie na nasledovné spustenie 23.01. 16:00 UTC			23.01.2018 17:00		23.01.2018 05:00
HEC_Hron_dol_I_Ecm	čakanie na nasledovné spustenie 23.01. 19:00 UTC			23.01.2018 20:00		23.01.2018 08:00

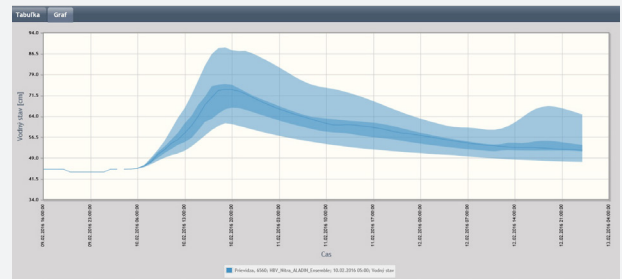
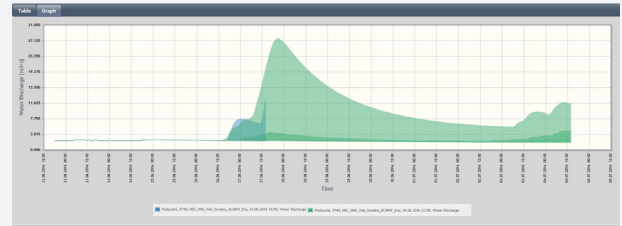
Model status module: the overview of active models and model runs

Fields of usage of our hydrological modeling

Outputs of hydrological modeling provided by our modeling systems can be used in many fields of human activity including public safety, land and crisis management:

Prediction of water level and discharge for selected profiles in rivers / channels – rainfall – runoff models

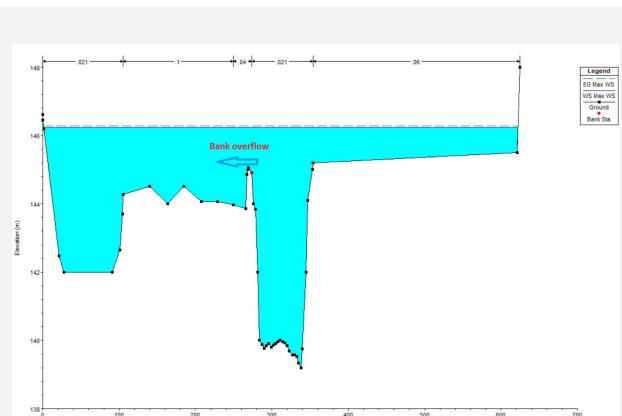
uses measured (in situ or distant-spatial measurements) and predicted meteorological data (nowcasting, NWP models). Flow models and / or connection to hydrodynamic models are possible. Modeling outputs are dedicated mainly for operative hydrological forecasting / warning centers, but can be used for research purposes as well.



Hydrological ensemble forecast for selected river profile

Prediction of possibility of exceeding of the river / channel banks and prediction of possible affected areas

– 1D hydrodynamic models enable the user to provide the simulation of the flow of the water in river channels. The output of this activity is the simulation of the transformation of the flood wave in the channel and simulation of reaching of selected trigger values of water level in selected profiles. These simulations are usable mainly for operative hydrological forecasting / warning centers, as well as for bank and channel design studies.



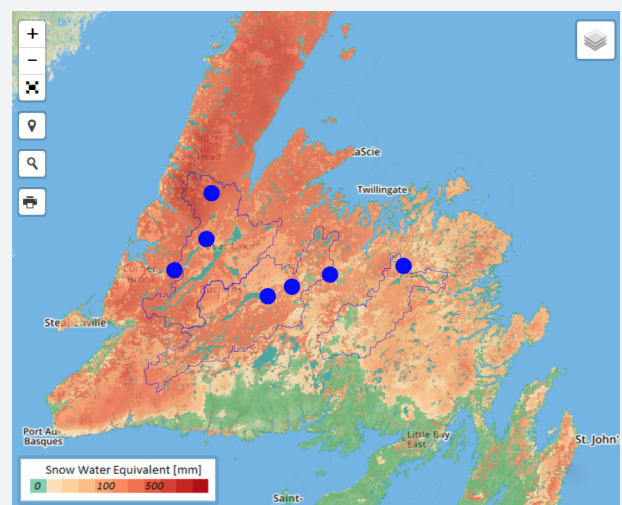
The simulation of the bank overflow in Hydrodynamic 1D model

Snow-melt and runoff simulation and forecasting

- use of SnowSense® platform enables us to perform studies of snow accumulation and snow melting processes, as well as provides snow-melt and runoff generation predictions in the real-time. The platform is applicable mainly in the field of operative hydrological management, water management operations and studies.

Maps of flood hazard and flood risk, estimation of flood prone areas

– 1D and 2D hydrodynamical models provide simulation of the flow in the channel, of the possibility of overflowing of channel capacity and of the inundation of river bank areas. The output of the simulation are the maps for different flood scenarios with the simulation of the extend of flooding, water depth and water velocity. These maps are necessary for the optimization of the land management and identification and elimination of flood hazard in the country.



Monitoring of snow water equivalent and modeling of snow melting and outflow - the SnowSense® system

Simulations of the Impact of climate change / land use changes / country management changes on hydrological cycle and its elements

- creation of comparative studies of the impact of the climate change / land use change / country management change on the processes in the watershed from interception and evapotranspiration, to runoff creation and

runoff amounts in space and time. Rainfall – runoff and HD models are used here.

Simulation of processes in channels - uses 1D - 2HD models for simulation of effects of construction of objects in channels such as bridges, weirs, in-line or lateral structures. Parameters of water flow water level, water flow direction and water velocity) are simulated and the possibility and intensity of backwater effects can be estimated too. These studies are used mainly in construction and designing processes.

Water temperature, Water quality / pollution dispersion simulation - using of 1D HD models, or special moduls of rainfall – runoff models for simulation of dispersion of pollution in the water channels. The output of the simulation is the time and spatial pattern of dispersion of pollutants and nutrients in the channel.

Flash flood simulation / forecasting / warning systems – are based on analyses of spatial and temporal pattern of precipitation intensity and duration and assessment of exceeding of the trigger values of the watershed retention capacity. Usage of measured / nowcasted / forecasted precipitation and automatic warning generation module can be included.

Pluvial flooding simulation and forecasting – is based on assessment of exceeding of trigger values for precipitation in urban areas. Capacities of sewage / waste water system, streets network and ponds areas scheme are included in the assessment. Usage of measured / nowcasted / forecasted precipitation is possible. Automatic warning generation module can be included too.

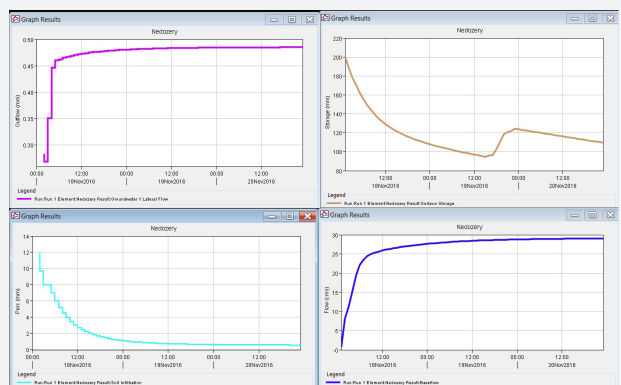
Drought monitoring – consists of monitoring, modeling and prediction of the effects of the expected impact of the climate change. We use rainfall- runoff models for estimation of the influence of changed climate trends on the parts of the hydrological cycle.

Integrated Monitoring System

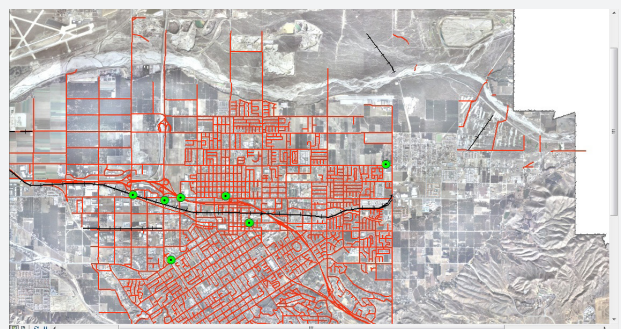
Forecasting module is a part of the IMS4 – Integrated Monitoring System which has been in development since 1994. The 4th generation of the system is set up for 24/7 operation and has more than 200 installations in various countries of Europe, Middle East, Asia and Africa. The system is customized for needs of customer and available in appropriate language version.



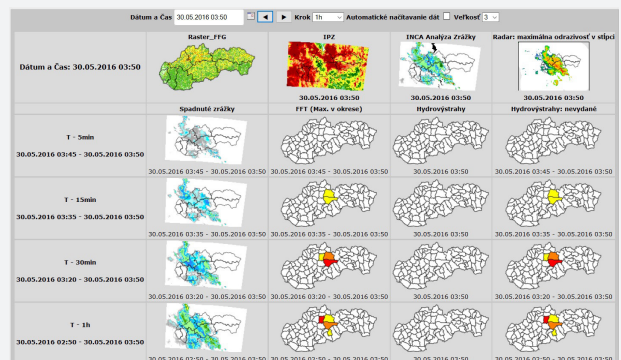
Estimation of flood prone areas and modeling of pluvial flooding in the urban area



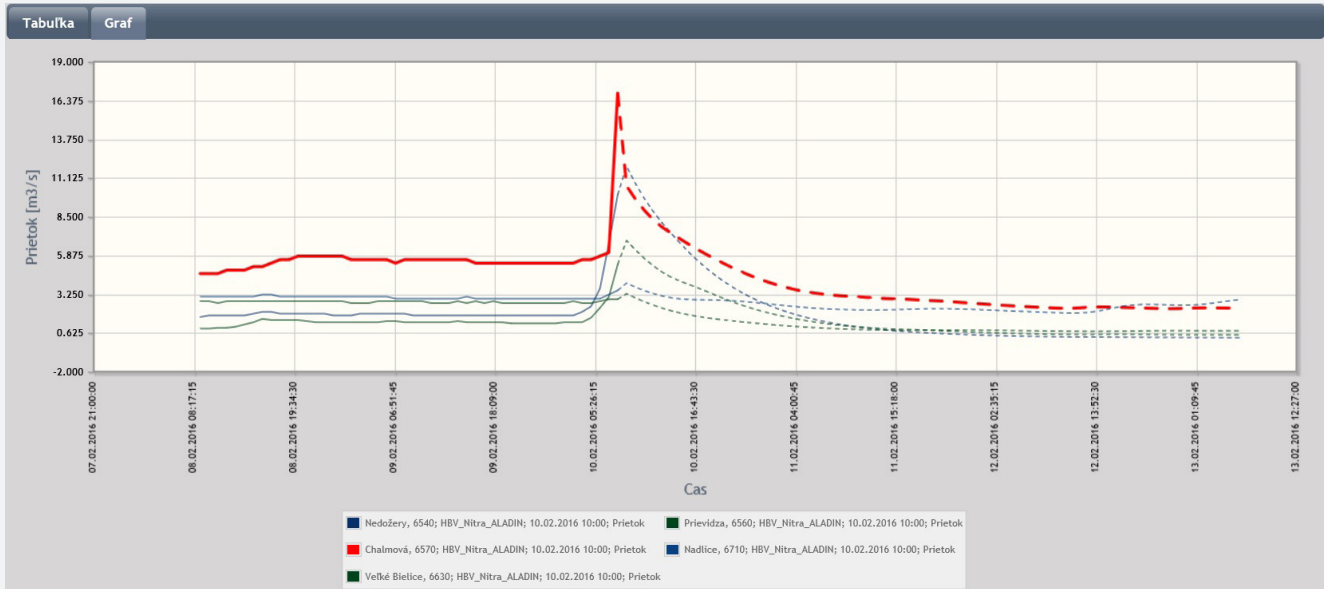
The outputs of rainfall - runoff modeling - simulation in parts of the hydrological cycle



Modeling of pluvial flooding in the urban area



Flash flood warning system for Slovakia



Hydrological forecast: outputs of simulation in the form of a graph. Combination of various models, model runs, forecasting profiles is available

Station	Model	Runtime	Valid	Manual	Ensemble	Parameter	Comment	22.06.2016 18:00	22.06.2016 19:00	22.06.2016 20:00	22.06.2016 21:00	22.06.2016 22:00	22.06.2016 23:00	23.06.2016 00:00
Liptovský Svätý kríž, 5680	HBV_Vah_ECWF	24.06.2016 21:00	No	Auto	deterministic forecast	Water Discharge	HBV_Vah_Horny_ECWF	0.508	0.508	0.508	0.508	0.508	0.508	0.508
Liptovský Svätý kríž, 5680	HBV_Vah_Horny_ALADIN	25.06.2016 05:00	No	Auto	deterministic forecast	Water Discharge	HBV_Vah_Horny_ALADIN	0.508	0.508	0.508	0.508	0.508	0.508	0.508
Podsuchá, 5740	HBV_Vah_ECWF	24.06.2016 21:00	No	Auto	deterministic forecast	Water Discharge	HBV_Vah_Horny_ECWF	2.314	2.314	2.314	2.180	2.314	2.314	2.314
Podsuchá, 5740	HBV_Vah_Horny_ALADIN	25.06.2016 05:00	No	Auto	deterministic forecast	Water Discharge	HBV_Vah_Horny_ALADIN	2.314	2.314	2.314	2.180	2.314	2.314	2.314
Podsuchá, 5740	HEC_HMS_Vah_Stredny_AL	24.06.2016 18:00	No	Auto	ensemble minimum	Water Discharge	HEC_HMS_Vah_Stredny_AL	2.314	2.314	2.314	2.180	2.314	2.314	2.314
Podsuchá, 5740	HEC_HMS_Vah_Stredny_EC	24.06.2016 18:00	No	Auto	ensemble minimum	Water Discharge	HEC_HMS_Vah_Stredny_EC	2.314	2.314	2.314	2.180	2.314	2.314	2.314
Podsuchá, 5740	HEC_HMS_Vah_Stredny_EC	24.06.2016 22:00	No	Auto	ensemble minimum	Water Discharge	HEC_HMS_Vah_Stredny_EC	2.314	2.314	2.314	2.180	2.314	2.314	2.314
Podsuchá, 5740	HEC_HMS_Vah_Stredny_EC	24.06.2016 22:00	No	Auto	ensemble percentile: 25 %	Water Discharge	HEC_HMS_Vah_Stredny_EC	2.314	2.314	2.314	2.180	2.314	2.314	2.314
Podsuchá, 5740	HEC_HMS_Vah_Stredny_EC	24.06.2016 22:00	No	Auto	ensemble percentile: 50 %	Water Discharge	HEC_HMS_Vah_Stredny_EC	2.314	2.314	2.314	2.180	2.314	2.314	2.314
Podsuchá, 5740	HEC_HMS_Vah_Stredny_EC	24.06.2016 22:00	No	Auto	ensemble percentile: 75 %	Water Discharge	HEC_HMS_Vah_Stredny_EC	2.314	2.314	2.314	2.180	2.314	2.314	2.314
Podsuchá, 5740	HEC_HMS_Vah_Stredny_EC	24.06.2016 22:00	No	Auto	ensemble maximum	Water Discharge	HEC_HMS_Vah_Stredny_EC	2.314	2.314	2.314	2.180	2.314	2.314	2.314

Hydrological forecast: outputs of simulation in the tabular form

The forecasting module can be connected with the real-time system of data collection, database and warning module. IMS4 Model Suite is a complex system for supporting forecasters as well as crisis managers. Its application ranges from regular daily forecasting to decision support in emergency.

Model outputs

Outputs are available in the form of tables, graphs or maps. Older outputs are available in the results archive for later analyses.

The user can compare / analyze:

- Results of many models / model runs for 1 profile
- Results of model for more profiles
- Results of various model runs for many profiles

It's the matter of user decision, if the results have to be visible in the form of tabs, or graphs. All results are available in the map server as well.

Map server

Publication of the spatial data uses open standards. We are implementing the Web Map Service, the maps are created in the variety of formats.:

- Connection to the traditional GIS architecture such as ESRI ArcGIS
- Topographic / geographic data
- Station data layer
- Forecast layer
- Meteo data layer – gridded data (NWP, meteo radar, satellite images)
- Hydrological station layer
- "Movie" mode

Warning generation

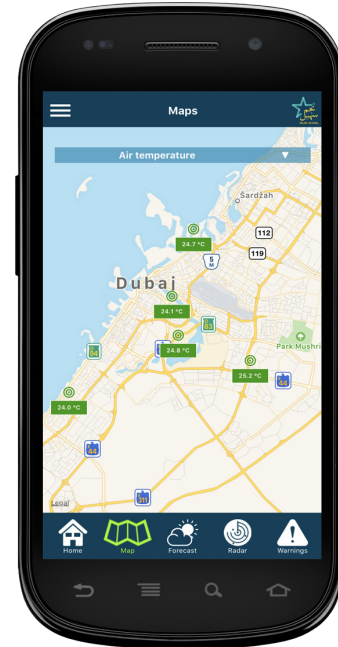
Automatic warning generation is one of the main features of our monitoring and forecasting system. The warning is primarily generated as the output of modeling system for the system operator and the information for public is available too.

The warning information for the operator is more specified and enables the operator to access the forecasting system in order to control the conditions of a warning message creation. The warning information for public is more general, but still enables the stakeholder / receiver get all the necessary information.

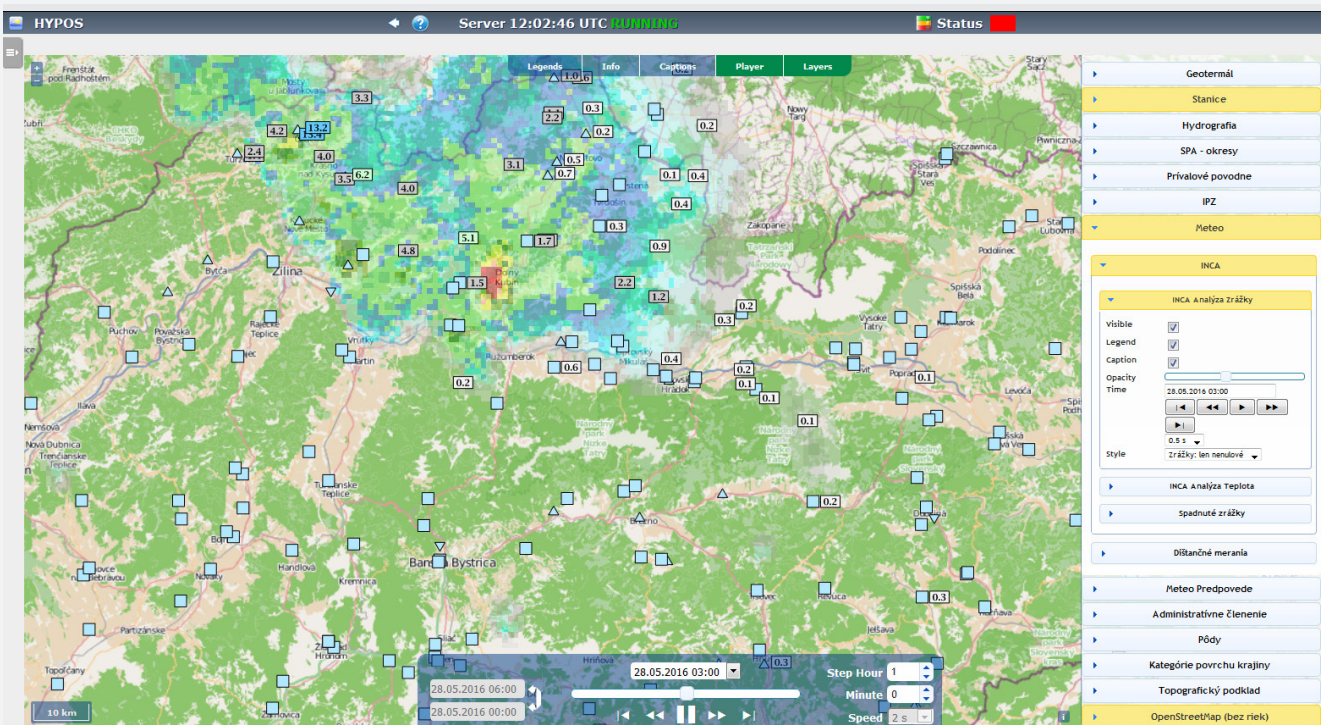
The warning information consists of:

- Specification of a type of warning
- Specification of a level of warning
- Specification of location of warning
- Specification of a time of the warning validity
- Additional information

MicroStep–MIS supports provision of warning information via all widespread used platforms such as email, SMS, text notification for mobile platform, etc.



Customization of monitoring and warning system for cell phones



Map Server: free layer selection and video mode are included



ISO Quality Certified Company

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