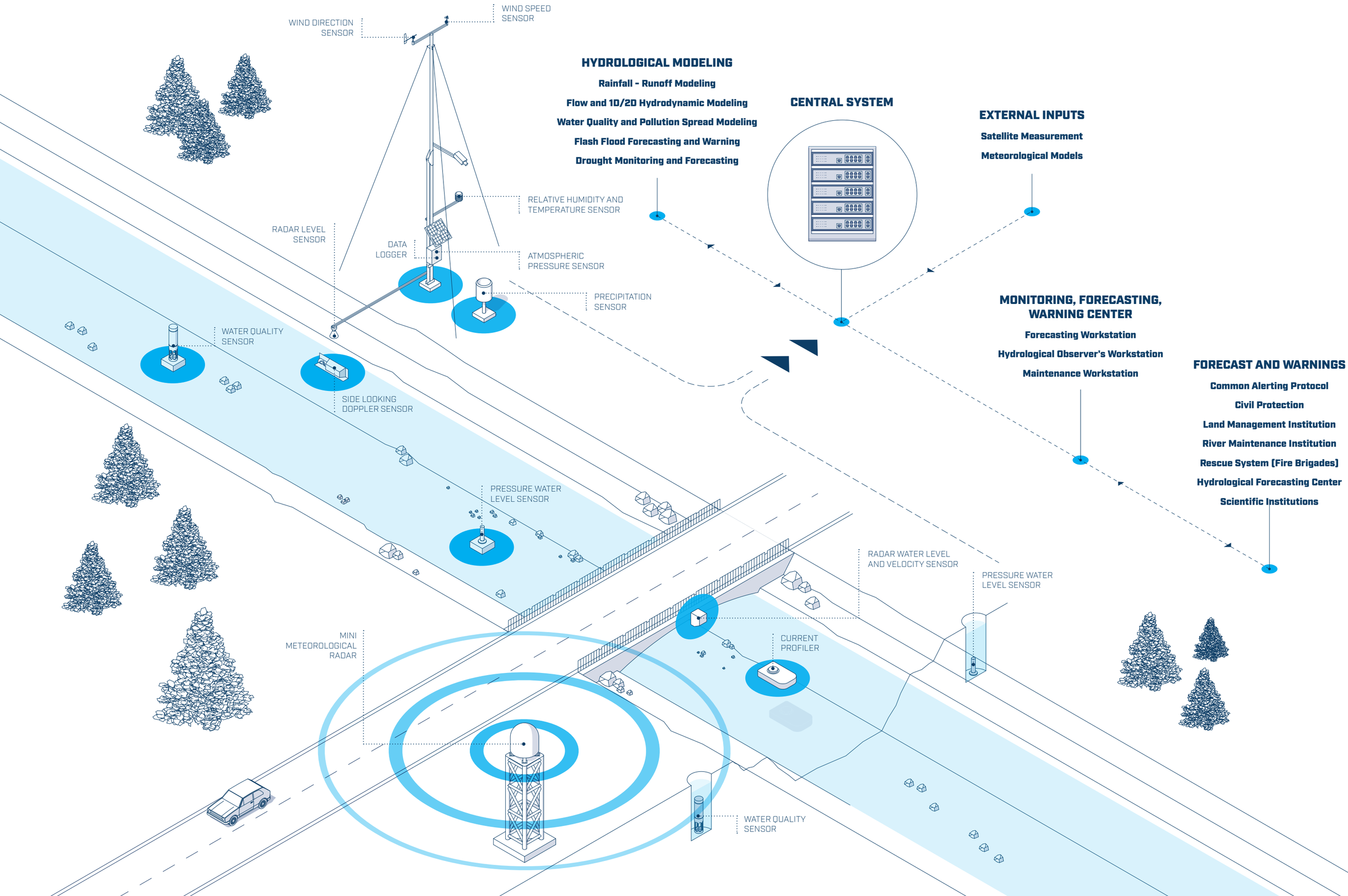
MicroStep-MIS

COMPLEX SOLUTIONS FOR THE REAL WORLD

HYDROLOGY AND FLOOD MANAGEMENT

30 YEARS OF EXPERIENCE

COMPLEX HYDROLOGICAL MONITORING AND MODELING SYSTEM



HYDROLOGICAL MODELING

Rainfall - Runoff Modeling

Flow and 1D/2D Hydrodynamic Modeling

Water Quality and Pollution Spread Modeling

Flash Flood Forecasting and Warning

Drought Monitoring and Forecasting

CENTRAL SYSTEM

EXTERNAL INPUTS

Satellite Measurement

Meteorological Models

MONITORING, FORECASTING, WARNING CENTER

Forecasting Workstation

Hydrological Observer's Workstation

Maintenance Workstation

FORECAST AND WARNINGS

Common Alerting Protocol

Civil Protection

Land Management Institution

River Maintenance Institution

Rescue System (Fire Brigades)

Hydrological Forecasting Center

Scientific Institutions

EXPERTS IN HYDROLOGICAL MONITORING

At MicroStep–MIS, we take pride in offering a diverse portfolio of products and services in the field of hydrological monitoring. Our comprehensive solutions cater to every aspect of water management, from data measurement, storage, and processing to leveraging modeling tools for flood, drought, and land management.

Our expertise extends to the entire lifecycle of hydrological stations, from manufacturing and installation to regular maintenance. With a strong focus on data management, we ensure meticulous quality control and provide software products that generate accurate hydrological outputs. These outputs include forecasts of water levels, discharge rates, flood warnings, and the creation of detailed flood maps.

At MicroStep-MIS, we go the extra mile by offering consultancy services and problem analyses to our valued clients. We understand that each hydrological system is unique, and our team of experts is dedicated to providing tailored support.

Water is a precious resource, and monitoring its movement, distribution, and quality is vital for environmental protection, disaster preparedness, and efficient water management. In regions facing excessive rainfall or drought, information about the water cycle and spatio-temporal water availability is crucial. That's why our solutions also encompass dam monitoring and decision support systems as well.

With MicroStep–MIS by your side, you can rest assured that your hydrological monitoring and flood management needs are in capable hands. Whether you require cutting-edge technology, reliable support, or insightful analysis, we are here to ensure the safety and sustainability of water resources.

CONTENT

EMPOWER YOUR WATER DECISIONS

Your all-in-one solution for hydrological monitoring and flood management, ensuring water safety, community and environmental protection and resilience for a sustainable future.

10+

years of experience in hydrological monitoring

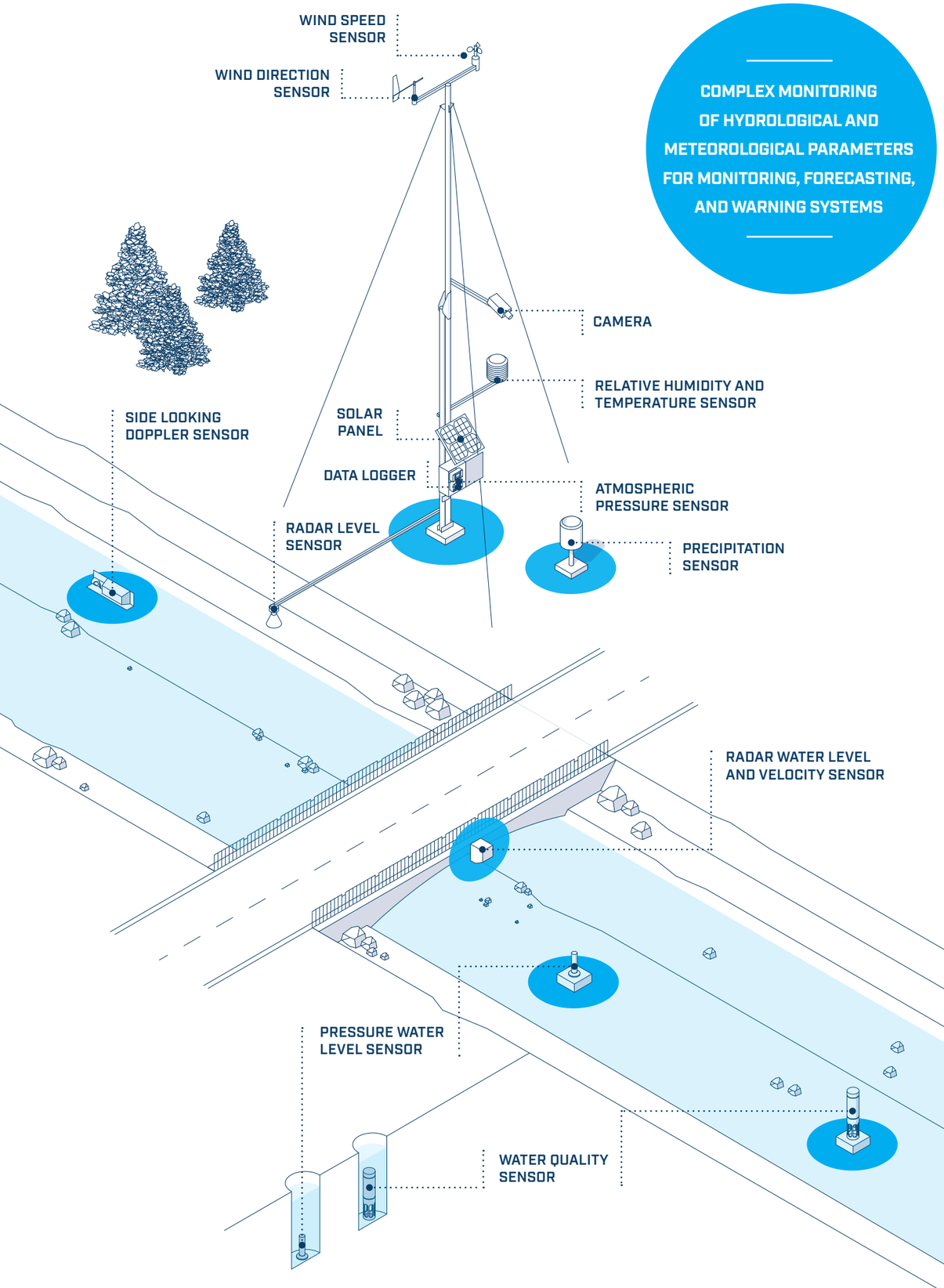
260+

installed hydrological and raingauge stations

20+

hydrology projects in 12 countries

FIELD MEASUREMENT SYSTEM



COMPLEX MONITORING OF HYDROLOGICAL AND METEOROLOGICAL PARAMETERS FOR MONITORING, FORECASTING, AND WARNING SYSTEMS

AMS 111 IV DATA LOGGER

The fourth generation of MicroStep-MIS data logger employs established modular design principles to offer enhanced performance and features, tailored to specific application requirements. Its easy and user-friendly configuration supports extensive system customization. The AMS 111 IV utilizes an ultra-low-power 32-bit processor and is capable of interfacing with even the most intricate array of meteorological and hydrological sensors.

WATER LEVEL MEASUREMENT

Submersible pressure transmitters **TSP** and **TSP-M** are intended for highly accurate water level measurements in surface water bodies such as rivers and lakes, as well as for measuring underground water levels. These sensors are known for their exceptional stability and accuracy, achieved through a combination of advanced piezoresistive metal sensor technology and transmitter design.

The **Radar Level Sensor** is utilized for non-contact water level measurement. It is installed above the water surface and employs impulse-radar technology to ascertain the water level.

DISCHARGE MEASUREMENT

The **RQ-30** is designed for the continuous measurement of discharge in rivers, open channels, and canals with known cross-section profiles. This innovative technology utilizes radar to measure velocity, water level, and discharge. It offers reliable and non-contact measurements without the need for structural modifications in the water.

Among the mobile systems, the **River Ray** is suitable for use in both low water conditions and rivers up to 40 meters in depth, making it versatile for accurate discharge measurements even during floods. **StreamPro** is intended for the measurement of velocity and flow, delivering results within minutes.

WATER QUALITY MONITORING

The **C4E** digital sensor is employed to measure conductivity or salinity, finding widespread application in urban wastewater treatment, industrial effluent treatment, surface water monitoring, and drinking water analysis.

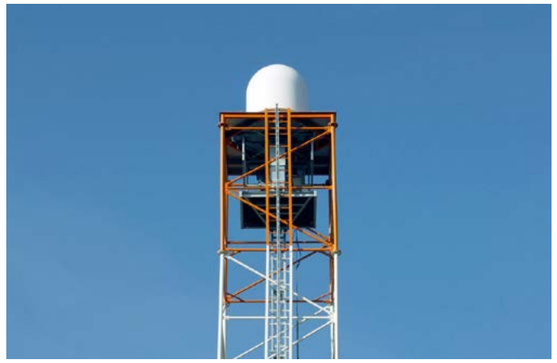
The **PHEHT** sensor, which measures pH, redox, and temperature, has been designed to operate effectively under challenging conditions. It can handle various scenarios, ranging from pristine mountain waters with low conductivity to wastewater with conductivity exceeding 200 mS/cm.

The **TRIPOD**, a multi-parameter probe, serves as a sophisticated tool that amalgamates the capabilities of both C4E and PHEHT probes. In addition to measuring parameters such as dissolved oxygen and turbidity, this versatile instrument finds wide-ranging applicability. It is well-suited for practical usage in research or routine monitoring across natural and artificial river bodies, groundwater, as well as wastewater systems and underground water reservoirs.

Mini Meteorological Radar MMR-116

The MMR-116 addresses the growing demand for water management tools and the detection of hazardous meteorological phenomena such as extreme precipitation or hail. Its compact size and affordability imply widespread use across various applications including watershed management, flood prevention, global warming adaptation strategies, operational weather forecasting, tourism, media, transportation, military, civil defense, aviation, and agriculture.

The MMR-116 is a uniquely designed portable X-band weather radar with extensive functionality integrated into a compact device. It offers real-time insights into weather situations and can detect precipitation ranging from 10 dBZ up to 200 km. The MMR-116 comes with software that displays meteorological spatial data in a user-friendly graphical format.



Radar tower | *This 20-meter radar tower features a convenient elevator designed to transport the radar equipment between the ground and the top of the tower, offering efficient installation and maintenance processes.*

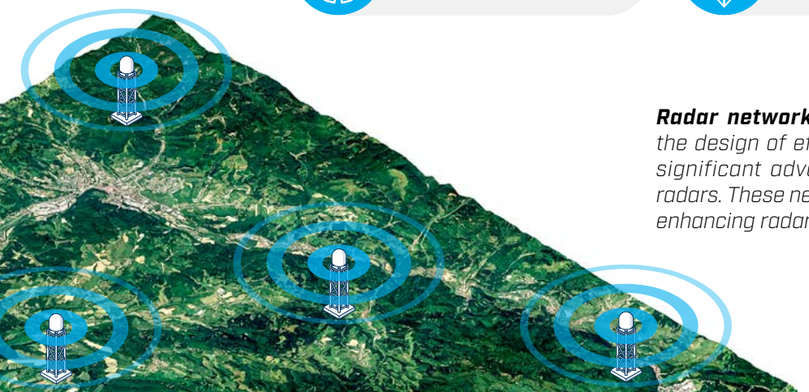
Powerful and compact

Low cost of ownership

Sophisticated nowcasting system

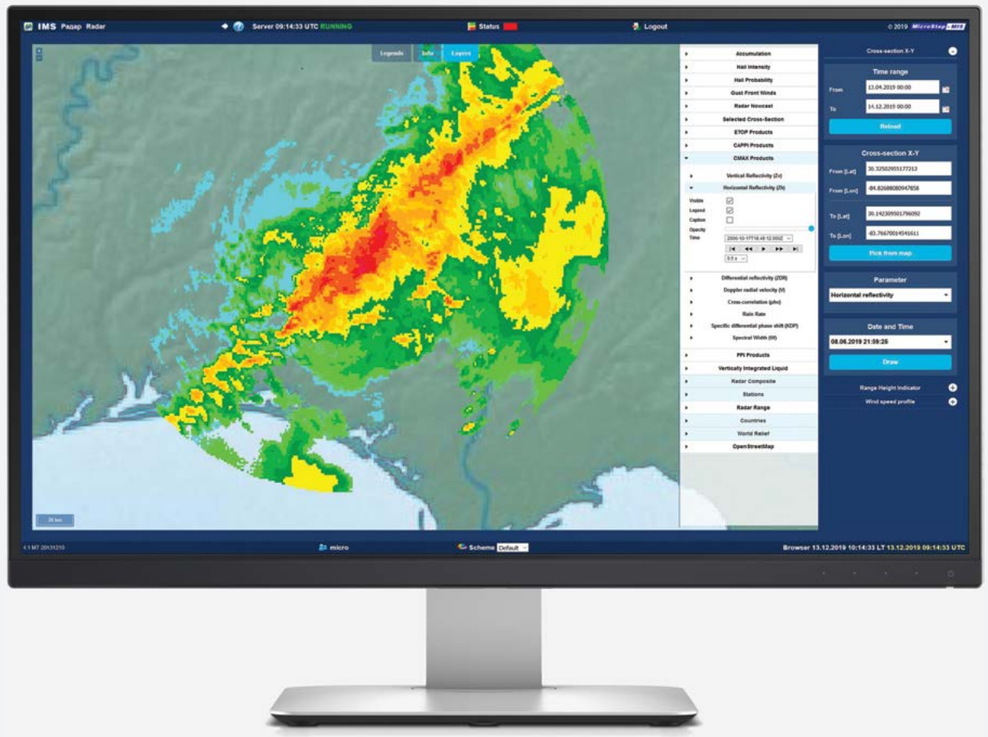
Integration capabilities

Network with a maximum coverage



Radar networks | *The capabilities of MMR-116 enable the design of efficient small radar networks, which offer significant advantages compared to single long-range radars. These networks provide an economical approach to enhancing radar coverage across the country.*

IMS4 Radar Studio Application Software



IMS4 Radar Studio is an exceptional tool designed for processing, analyzing, and visually presenting radar and lidar data obtained from standalone devices to multi-radar networks. The Studio provides hydrologists with a comprehensive array of functionalities, encompassing radar data collection, analysis, product generation, weather monitoring, nowcasting, and the detection of hazardous phenomena, facilitating early warnings.

Hydrological products

Rainfall intensity

Rainfall intensities are obtained on the basis of a transformation of the measured radar reflectivity values, using the Marshall-Palmer relationship.

VIL, water column sums

Vertically integrated liquid (VIL) is an estimate of liquid water in a vertical column (radar pixel). It is a rough characteristic of precipitation potential of the air mass, obtained from radar scans at different elevations.

QPE, rainfall accumulation

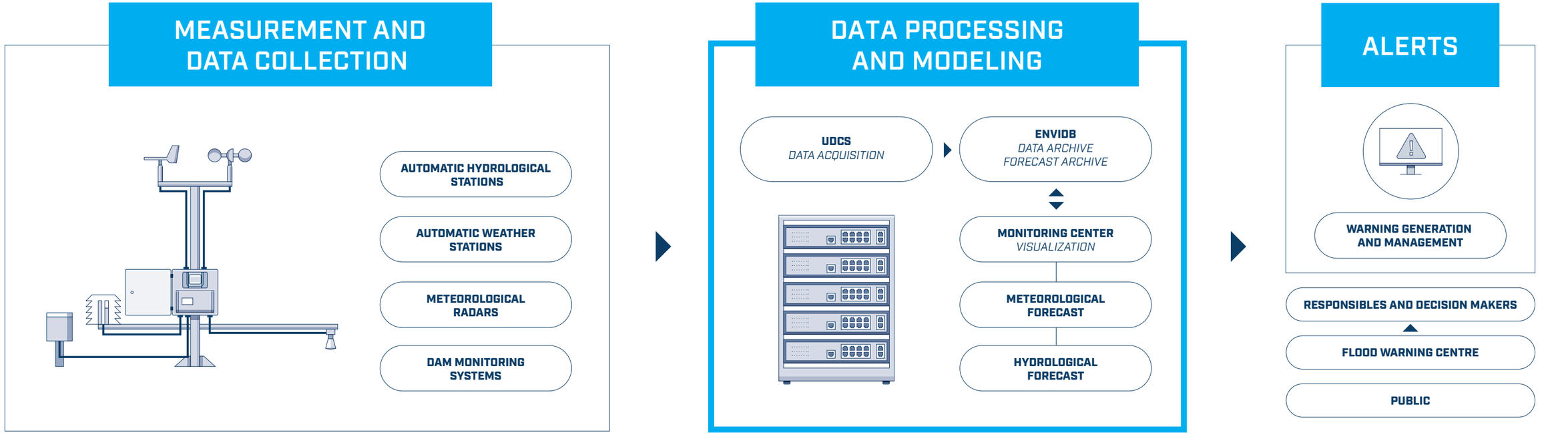
Radar-based quantitative precipitation estimation (QPE) is a method of approximating the amount of precipitation that has fallen at a location or across a region. Maps of the QPE usually utilize radar scans combined with rain gauge measurements and possibly with other sources such as satellites.

River basin statistics

Radar measurement allows for spatial analysis of the precipitation field over selected spatial units - watersheds. Values of average precipitation amounts for the basin are used as input for hydrological modeling and forecasting systems, or as direct input for a flash flood forecasting system.

COMPLEX HYDROLOGICAL MONITORING AND FLOOD MANAGEMENT SYSTEM

Integration of all hydrological data and metadata



Data Collection and Management of the Station Networks

Hydrological and meteorological data hold value only when they reach the end-users. In the realm of hydrological monitoring, the role of information and communication technologies has never been more crucial. Our system serves to facilitate data input, processing, verification, and storage.

The main advantage of our system lies in its complexity. Its full-duplex mode of operation allows not only the collection of data from stations but also remote station management, message distribution, and data switching between subsystems. The system supports a wide range of protocols and formats for communication with automatic weather, hydrological, and environmental stations, as well as for data distribution and exchange:

- LAN / WAN / VPN (Ethernet, WiFi, 3G/4G/5G)
- File transfer (various formats) – local, SMB, FTP, scp, sFTP
- TCP/IP protocols (MicroStep-MIS, MODBUS, PAKBUS)
- OPC-UA
- Satellite communication (Iridium, Eumetsat)
- Web service API (SOAP, REST)
- E-mail

In addition, the system seamlessly handles standard WMO codes, including SYNOP, METAR / SPECI, CLIMAT, GRIB, BUFR, CREX, and more. Moreover, it is adaptable to proprietary or national codes. The system supports the import, export, and processing of files from hydrological models.

The system fully supports the creation and processing of standard industry formats (OGC, WMO) and is open to supporting proprietary / national codes. Exporting data in hydrological model input data formats and importing model results is also supported. The supported data formats include, but are not limited to:

- WMO GRIB, BUFR, CREX
- OGC WaterML, NetCDF, OpenMI
- Text log files (user-configurable formats)
- Model outputs
- JPEG / PNG / other image formats, MPEG videos

Flooding across Slovakia after heavy rains, 2010 | *The Ondava River has flooded several villages along its banks. (Source: TASR)*

- Hydrological model input/output data files (HEC DSS files, HBV ASCII text files)

Comprehensive station network management is supported. The operator can manage station operational or historical data, station metadata, and station or sensor maintenance information.

The rating curve management module allows for the calculation of discharge from water level and vice versa, whether the dataset is measured data or forecasts. The module also contains historical and seasonal versions of rating curves. When coupled with IMS4 Warnings Suite, the system can automatically generate Common Alerting Protocol (CAP) alerts.

The system is highly scalable, ranging from embedded PCs to clusters of powerful servers and from smartphones to large panels.

Hydrological Database

Modular system of the database

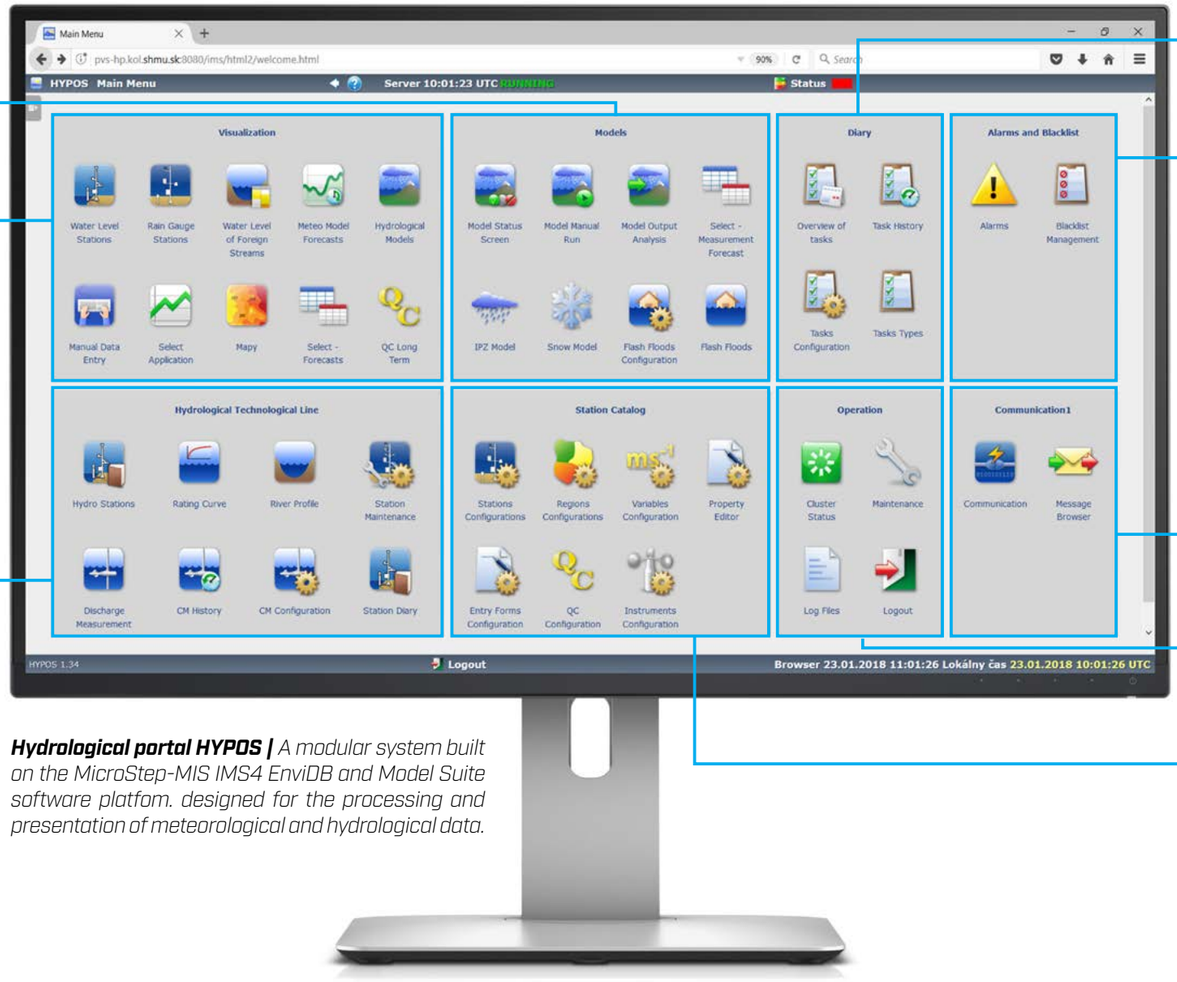
MODELING SYSTEM

VISUALIZATION MODULE

- Measured data
- Model results
- Tables, graphs, maps
- Relevant data highlighting
- Tool tips for detailed info
- Data query

INVENTORY MANAGEMENT MODULE

- Inventory information
- River profiles
- Rating curves
- Discharge measurements
- Station maintenance management
- Linked to Quality Manager



Hydrological portal HYPOS | *A modular system built on the MicroStep-MIS IMS4 EnviDB and Model Suite software platfom. designed for the processing and presentation of meteorological and hydrological data.*

DIARY MODULE

ALERTING MODULE

- Customizable alert rules (quantity, level)
- Popup window, SMS, E-mail
- Link to data inspection
- Link to Quality Control
- Acknowledgement
- Automatic warning creation tools
- Common Alerting Protocol
- Alert Dashboard

COMMUNICATIONS MODULE

OPERATION MODULE

SETTING MODULE

- Model run set up
- Trigger level management
- Alert management
- Station operation and data collection management

The hydrological (forecasting and warning) service relies on real-time data from meteorological and hydrological sources, in addition to historical archive data. The advantage of consolidating all of this data into a single database lies in the efficient and effective utilization of information.

The hydrological database consists of two main parts - meteorological and hydrological. It is populated with diverse data from various sources, formats, and time frames. The harmonization and organization of this broad spectrum of incoming data require data sorting and quality control (QC) to ensure appropriate formatting.

Data types stored in the database

Operative data

- Meteorological - station measurement (precipitation, temperature), distant measurement (radar data), combination of station and distant measurement
- Hydrological - water stage, discharge, water temperature

Static data

- Stage-discharge relation curve
- Cross-section profile
- Station meta data
- Service diary
- Discharge measurement diary

Map data

- Station data layer
- Forecast data
- Meteo data layer - gridded data (models, radars, satellite images)
- Geographic data (topographic data, soil properties data)
- Georeferenced CAP alerts

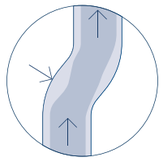
An essential advantage of the database lies in its modular architecture, providing end-users with the flexibility of detailed customization. Users can specify additional nonstandard input and output modules, which can be seamlessly integrated into existing or future installations.

The system operates on the IMS4 Application platform, enabling comprehensive processing, integration, and presentation of critical data types for flood warning and forecasting. These include meteorological and hydrological data, radar and satellite images, modeling results, and station metadata. The database ensures the quality of data storage through its industry-proven Oracle® database server, which is a global leader in database technologies.

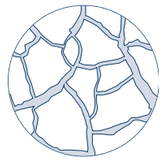
Hydrological Modeling and Forecasting

Our modeling systems cover a wide range of hydrological issues, including the transformation of rainfall into runoff, water attenuation in channels, the spread of pollution in channels, flood hazard and risk mapping, as well as drought modeling and forecasting. We employ a variety of models to address key tasks in hydrology, civil protection, and land management.

RAINFALL-RUNOFF MODELING
(HBV, HEC-HMS, HYPE)



FLOW AND HD MODELS
(HEC-RAS, HEC-HMS)



DROUGHT FORECASTING AND MONITORING

WATER QUALITY AND POLLUTION SPREAD MODELING
(HEC-RAS, HYPE)

FLASH FLOOD FORECASTING AND WARNING

RAINFALL–RUNOFF MODELING

Our models are tailored to meet the specific needs of flood and drought forecasting services, flood and river management institutions, as well as reservoir management. These models serve both research purposes and provide operational support 24/7. The system includes regular updates and forecast assessments.

Inputs to the system:

- NWP (Numerical Weather Prediction) data, either deterministic or ensemble-based
- Remote sensing data, including radar and satellite measurements
- Ground-based station data, such as precipitation and temperature readings, obtained from monitoring systems
- Inputs from other hydrological models and forecasting tools

Model outputs:

- Scenarios depicting discharge patterns over specific time intervals or for designated periods
- Scenarios illustrating water volume changes within defined time frames
- Simulations of various hydrological processes, including base-flow, interception, evapotranspiration

FLOW AND HYDRODYNAMIC MODELING

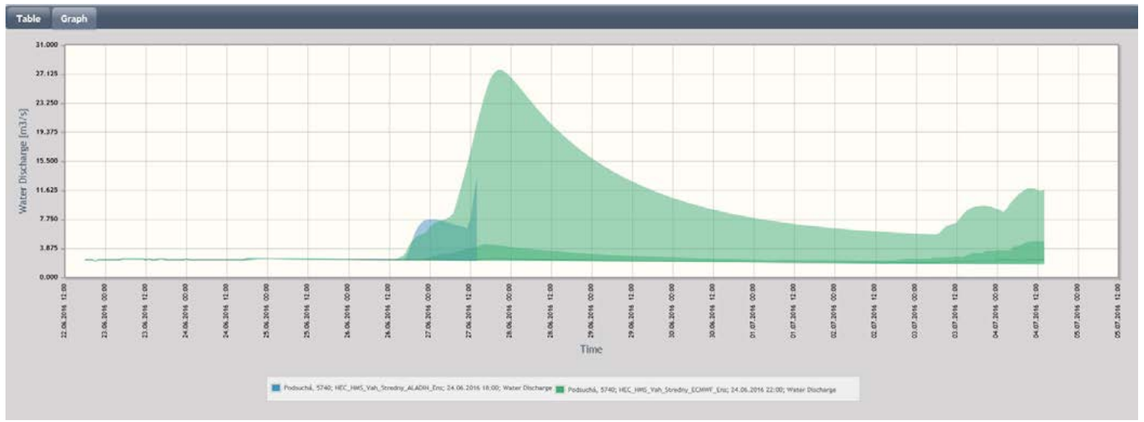
Our modeling capabilities encompass the attenuation of flood waves, analysis of backwater effects, design of channel infrastructure, and the mapping of flood hazards and risks. These models serve both daily operational needs and research purposes, with the option to connect to rainfall-runoff models.

Inputs to system:

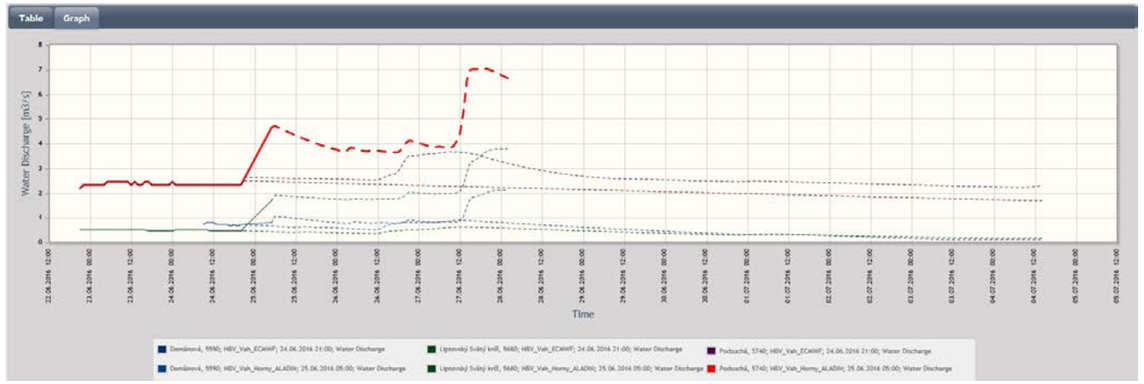
- Static data, including channel parameters, DEM (Digital Elevation Model) data, land use information, and unique discharge values
- Dynamic data, represented by discharge hydrographs, whether measured or modeled

Outputs:

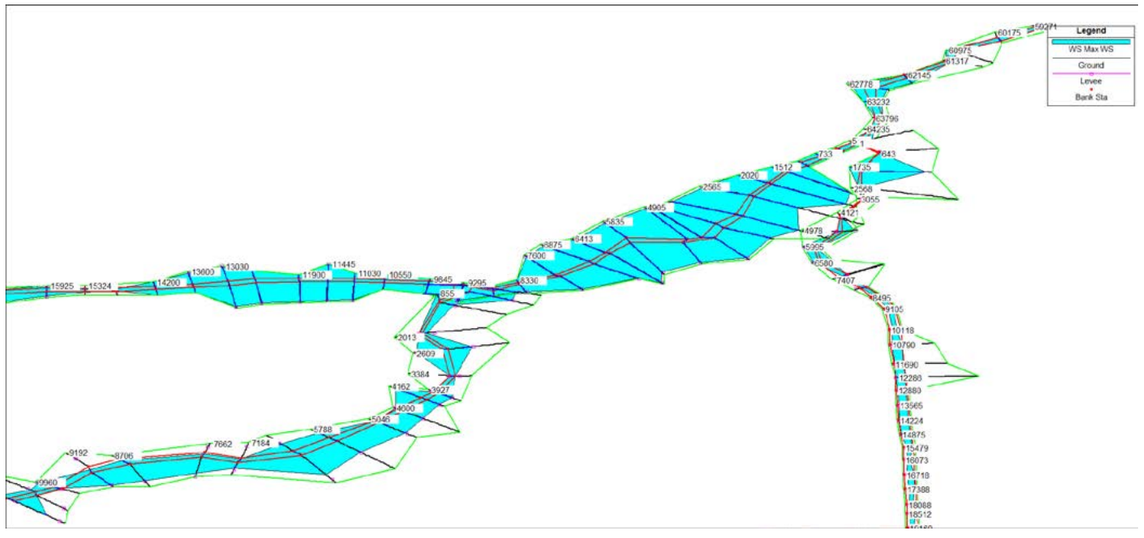
- Water level predictions for specific locations and times
- Maps showing the extent of flooded areas, depths of inundation, and flow velocities in affected regions
- Simulations of flow under various conditions, such as ice barriers, bridge effects, and the presence of in-line or lateral structures



The Rainfall-Runoff Ensemble Model *in the hydrological forecasting system provides customizable output options. Users can set statistical parameters, which can then be visualized, including ensemble forecasts and probability intervals.*



A deterministic forecast *generated by a hydrological model is presented in a user-friendly overview, which allows for overlaying and analyzing different model runs, forecasting profiles, and various models on a single graph.*



Maximal extend of flooding computed using ***1D hydrodynamic model HEC-RAS***

WATER QUALITY AND POLLUTION SPREAD MODELING

These models enable solutions in various areas, including sediment transport, temperature, nutrients, and pollution modeling. They can be used primarily for research purposes but are also suitable for daily operational use, offering both steady and unsteady flow analyses.

Simulation modes:
- Temperature model
- Meteorology datasets
- Nutrient elements value

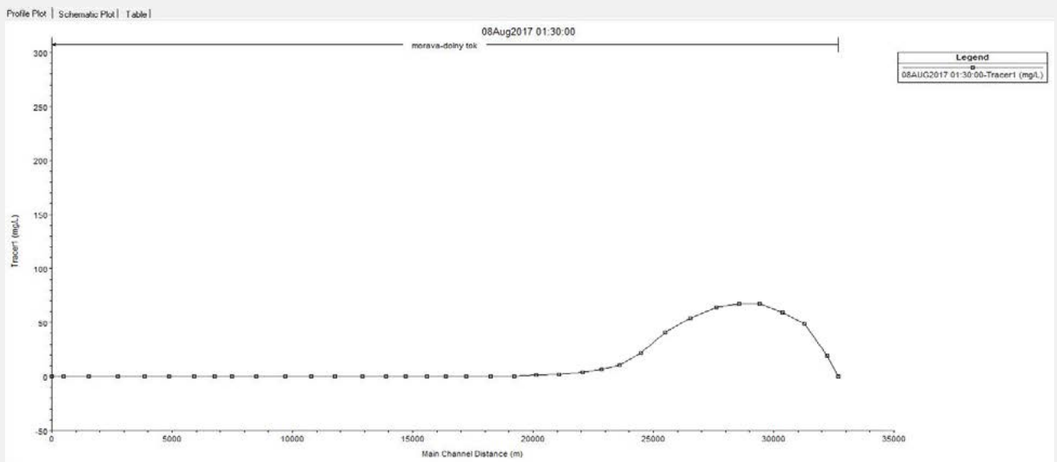
State variables included in Nutrient Model:
- Dissolved Nitrite Nitrogen (NO2) (mgN/L)
- Dissolved Nitrate Nitrogen (NO3) (mgN/L)
- Dissolved Organic Nitrogen (OrgN) (mgN/L)
- Dissolved Ammonium Nitrogen (NH4) (mgN/L)
- Dissolved Organic Phosphorus (OrgP) (mgP/L)
- Dissolved Orthophosphate (PO4) (mgP/L)
- Algae (A) (mgA/L)
- Carbonaceous Biological Oxygen Demand (CBOD) (mgBOD/L)
- Dissolved Oxygen (DOX) (mgDO/L)

FLASH FLOOD FORECASTING AND WARNING

Early flood warning system is based on the assessment of flood potential in the country, analysis of precipitation patterns, and saturation of watersheds using the Antecedent Precipitation Index (API). The system plays a key role in detecting the exceedance of retention value thresholds and can generate automatic hydrological warnings.

Inputs:
- Static - country parameters, including Digital Elevation Model (DEM), soil data, land cover information
- Dynamic - measured precipitation amount from various sources such as station measurements, distant measurements (radar and/or satellite precipitation estimates), combined precipitation field
- Forecasting / now-casting of precipitation field

Outputs of system - text, tables or maps of:
- Text-based alerts and warnings
- Tables displaying grid cells with exceeded retention potential
- Maps highlighting settlement units at risk
- Identification of catchments and counties affected by flash flood risks



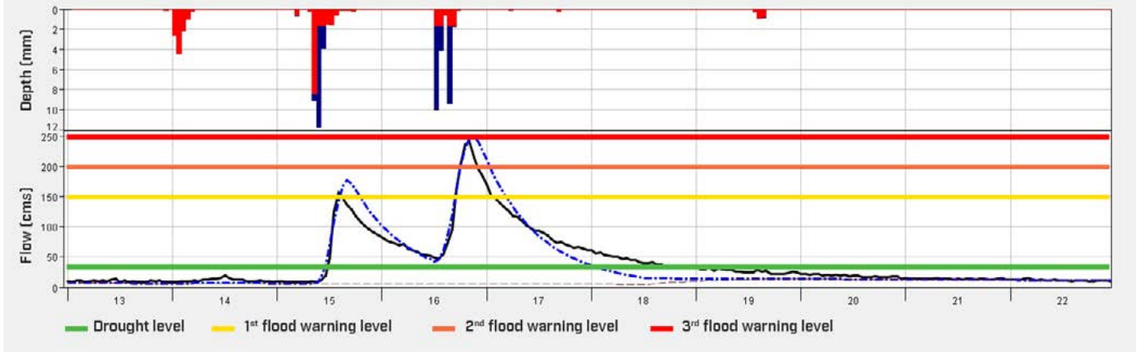
Output of pollution spread modeling | *The spatial development of average concentration of pollutant in certain river profile*

DROUGHT MONITORING AND FORECASTING

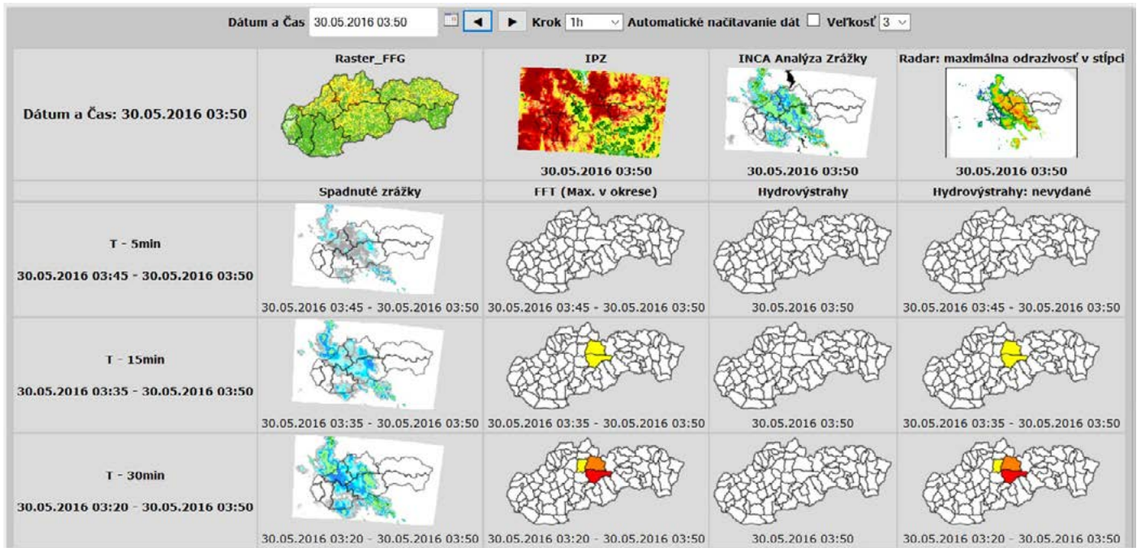
These systems have primarily been developed to meet the needs of the agricultural sector, water management, and land management. They rely on data from Automatic Weather Stations (AWS), Automatic Hydrological Stations (AHS), and the outputs of Numerical Weather Prediction (NWP) systems.

Key factors:
- Exceedance of drought index values for specific regions
- Decrease in the water level below the estimated threshold level in monitored water bodies.

Inputs, outputs, and forecasting Tools:
The tools and methods used for drought simulation and forecasting are quite similar to those employed in rainfall-runoff modeling. Hydrological drought monitoring is conducted through the measurement of water levels and discharge in channels, reservoirs, or wells, using dedicated water level and discharge measurement stations.

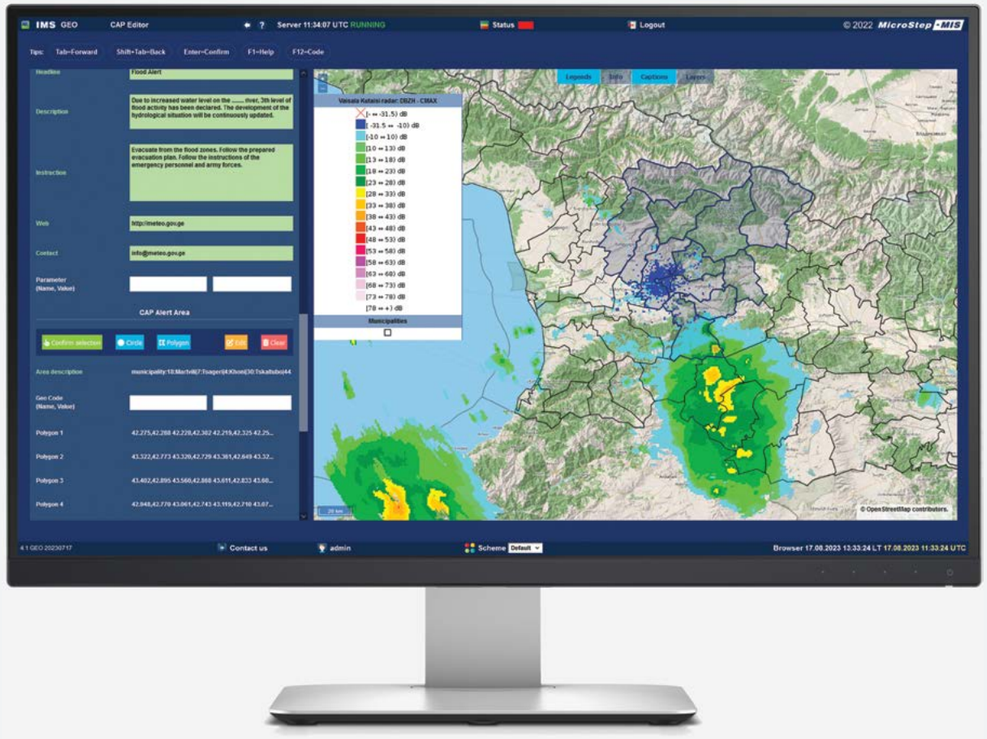


Drought monitoring and forecasting *utilize the same instruments as flood monitoring, specifically rainfall-runoff models. However, it requires the inclusion of a drought threshold level in addition to the trigger levels.*

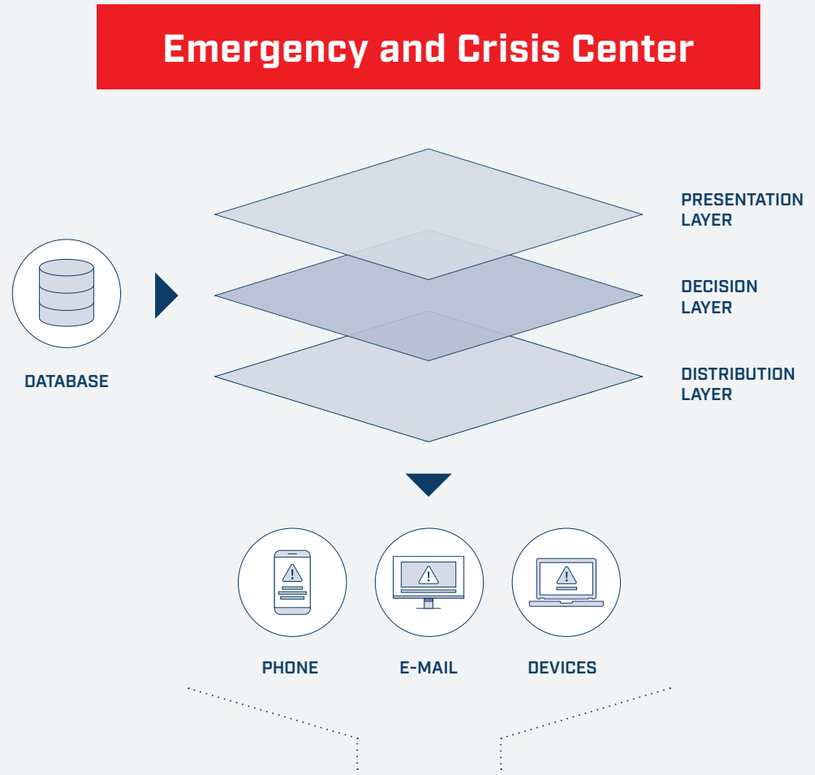


Proposal for a Flash Flood Forecasting System | *The system detects precipitation levels exceeding defined thresholds within specific time intervals.*

Hydrological Warning and Flood Mitigation



The CAP Graphical editor *offers comprehensive capabilities for inputting all attributes of a CAP Alert. It also features a user-friendly interface for defining affected areas and overlaying additional meteorological information.*



The system collects data from hydrological, weather, and environmental monitoring sources. It supports various data types and offers tools for decision-making in civil protection. This includes visualization and scenario tools. The system generates and distributes warnings, and it's adaptable for international data sharing.

The Warning Editor app lets forecasters swiftly create warnings through a user-friendly interface. They choose the warning type, affected regions, and validity period.
The system comprises:

- **Presentation ayer** displays real-time data and forecasts to operators.
- **Decision layer** creates warnings and selects recipients.
- **Distribution layer** shares warnings with recipients and presents them.

This system, incorporating the Common Alerting Protocol (CAP), enhances hydrological monitoring, flood warning, and mitigation by providing standardized communication, rapid alert generation, and seamless coordination among stakeholders.

DAM MONITORING AND DECISION SUPPORT SYSTEM

The dam itself is a system comprising technical objects and natural elements, even though it's created by human activity. The interaction between these technical and natural elements presents challenges in monitoring, forecasting, decision support systems, and warnings.

Typically, but not always, a single entity holds the entire chain of responsibilities, including monitoring, control, and decision-making for the dam. As a result, a robust decision support system is essential for ensuring dam safety and optimal operation. The Dam Monitoring and Decision Support System is one of the MicroStep-MIS product portfolio components.

THE SYSTEM COLLECTS DATA FROM:

1. Technical monitoring of the dam

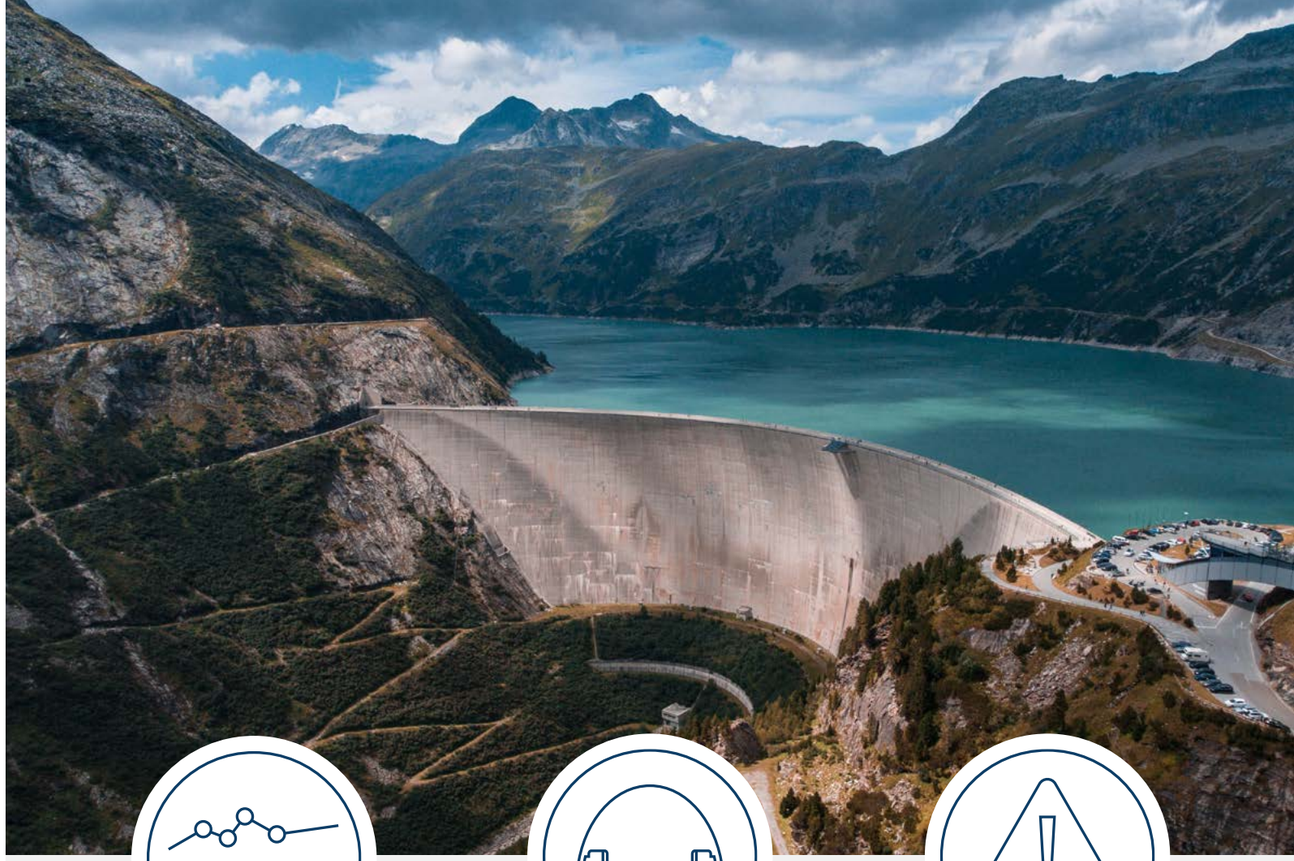
1.1 Stability of the dam slopes and dam objects via accelerometers, strain-gauges, inclinometers, and settlement sensors. Camera monitoring is highly encouraged.
1.2 Pressure sensors to monitor dam seepage processes.
1.3 Seismometers for dam safety assessment.

2. Technical elements associated with the dam

2.1 Levees and by-pass channels via piezometers (groundwater level measurement), water level measurement in open channels and pipes.
2.2 The stability of the levees via similar measurement tools as for the stability of the main dam object.

3. Weather and water bodies

3.1 Weather information via weather station – temperature, precipitation, humidity, atmospheric pressure, wind parameters
3.2 Water surface parameters via water level stations and buoys – the water level in the dam, the temperature of the water, wave parameters, currents in the reservoir.
3.3 Water parameters of all important inflows and outflow(s) of the dam reservoir.



FORECASTING

The operator needs advanced data on upcoming conditions in the area. Weather and hydrological shifts can impact both the dam's state and reservoir conditions, affecting strategic choices.

Weather predictions include temperature, precipitation, humidity, pressure, and wind for the dam region and watershed. Hydrological predictions require precipitation and temperature data. Forecasts encompass the dam's watershed up to its profile. Various hydrological models, such as rainfall-runoff, flow, and 1D hydrodynamic models, predict inflow using a connected real-time network.

DECISION-SUPPORT

The DSS ensures timely, accurate decisions by providing operators with comprehensive, user-friendly data. This includes safety and stability information for the dam, current meteorological and hydrological conditions, and future forecasts presented through graphs, tabs, and maps.

Operators oversee water levels, inflow, and outflow forecasts, with the system advising actions for all monitored parameters, including dam components. The continuously accessible database includes an archive for reference. Decisions prioritize dam and population safety, as well as optimizing reservoir use.

WARNING

Dam alerts from monitoring and the Dam Decision Support System come in two forms: internal (for operators) and external (for the public).

Internally, alerts inform operators of critical events, including safety threshold breaches for dam and reservoir parameters, monitoring weather conditions, technical failures, and operator-selected alerts.

Externally, users define alerts, primarily for those near reservoirs, encompassing high water levels, outflow, potential hazards, and dam failure risks. Alerts are disseminated via sirens, SMS, email, and media for rapid communication.

RESEARCH AND DEVELOPMENT

Rainfall nowcasting

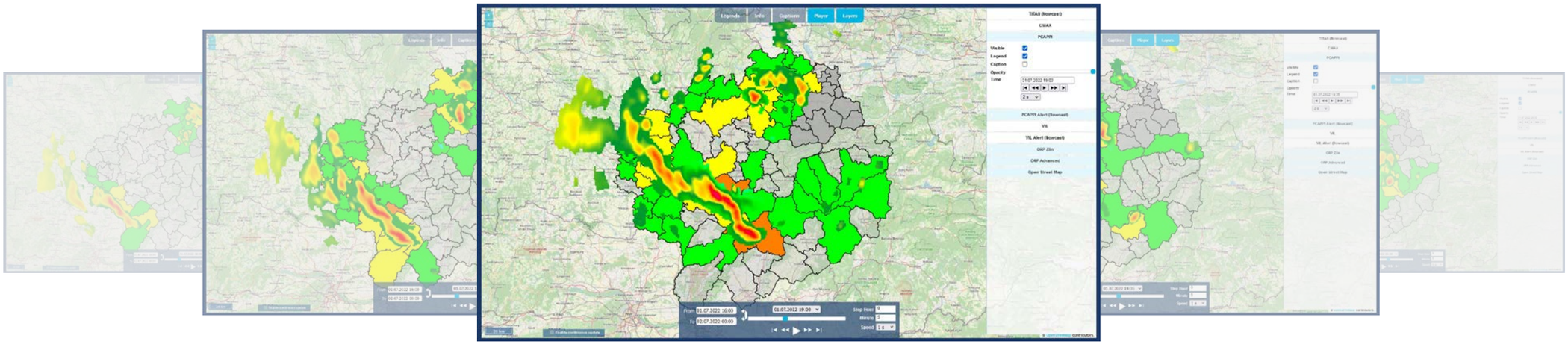
Atmospheric precipitation is an essential input for hydrological models. Forecasting its occurrence as accurately as possible, both from spatial and temporal perspectives, presents a challenge not only for experts but also provides substantial assistance in implementing preventive measures in the event of a high probability of extraordinary torrential rains and subsequent flash floods.

For this reason, MicroStep-MIS is dedicated to developing nowcasting methods for short-term precipitation forecasting. The company utilizes several well-known radar echo extrapolation algorithms to predict rainfall within time horizons ranging from tens of minutes up to one hour. Furthermore, our innovative approach involves not only the individual adaptation of these algorithms but also their advantageous combination through machine learning methods and artificial intelligence.

Based on this concept, we recently successfully concluded a research project focused on forecasting convective precipitation in the Zlín region, Czechia. The distinctive features of our approach include: (1) the nowcasts are not pixel-based but are associated with individual administrative units, and (2) they are expressed using a 4-class system of qualitative classification ('0' indicates no convective event, ..., '3' signifies an extremely intense convective event).

We are currently pursuing these research objectives (i.e., enhanced rainfall nowcasting with the aid of novel AI approaches) within the framework of other scientific research projects supported by the Slovak Research and Development Agency and the Horizon Europe Framework Programme.

A cold front passing across South Moravia on July 1, 2022. Screenshots below show the horizontal slice across radar reflectivities at the level 2000 m (CAPPI product), and its transformation into a ***qualitative nowcasting*** *within the administrative units of the region, indicated by green/yellow/orange/red alerts.*



CONSULTANCY SERVICES

An essential phase in the implementation of the newly installed hydrological warning system involves the configuration of system parameters, setting threshold values for issuing warnings, and establishing a daily monitoring routine for measured values, along with a maintenance schedule. Since untrained personnel in the country where the system was installed lacked experience with such technology, they required guidance from seasoned experts.

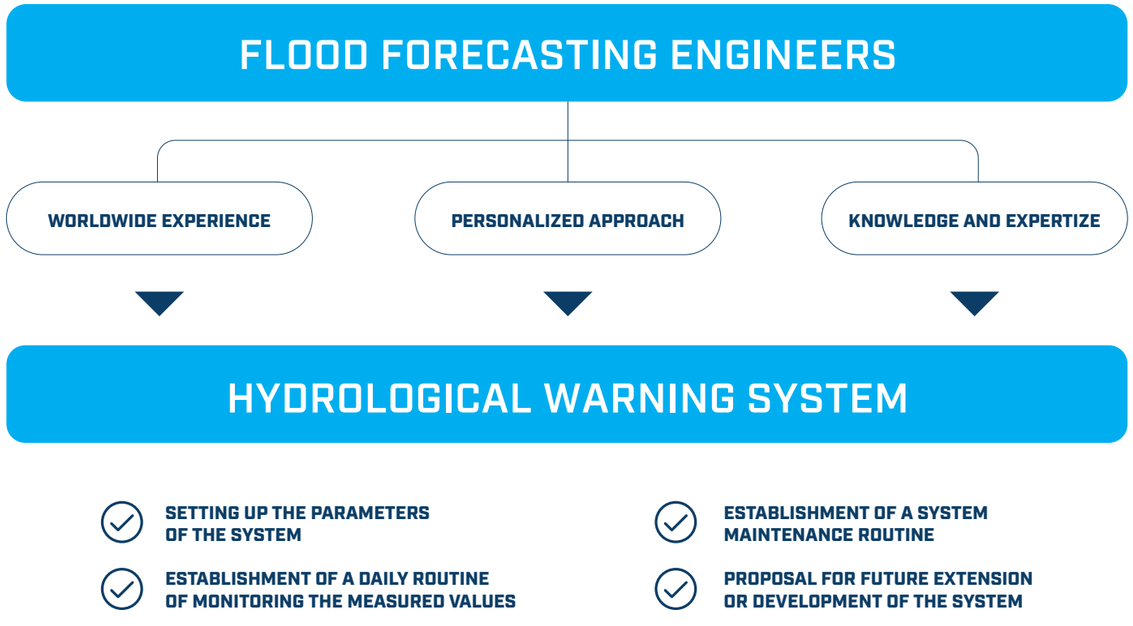
MicroStep-MIS experts undertook the role of “flood forecasting engineers” during the period from 2017 to 2019 in KSA. The local authorities decided to install a warning system comprising rain gauges, water level, and discharge monitoring stations, but they had no prior experience in operating such a system.

In this regard, our experts managed the daily operations of the system, including checking measured values, ensuring data quality, identifying invalid data, monitoring station statuses, and conducting on-site station inspections when necessary.

Understanding that our involvement would be shorter than the anticipated operational duration of the system, we also assumed the roles of tutors and administrators. We established criteria for data quality checks, station measurement quality, and warning levels for the local staff to follow.

We provided comprehensive training to the local team, covering daily system operations, handling potential issues, classifying and analyzing precipitation and runoff events, and implementing station maintenance routines.

We take pride in the success of our mission, as the system now operates smoothly in full operational mode without requiring our continuous interference or daily support.



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