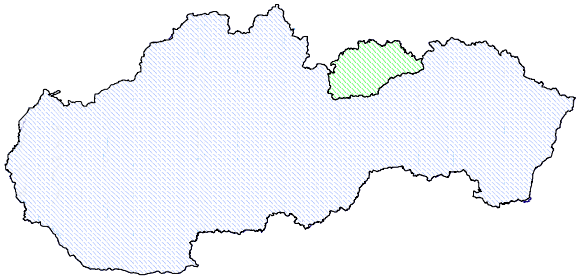
FACILITATING THE EXCHANGE OF EXPERIENCE OF CENTRAL ASIAN COUNTRIES
IN THE FIELD OF HYDROMETEOROLOGICAL SERVICES
Training Workshop, Bratislava, Slovakia, 10-11 November 2021

Monitoring of surface water and automatization of hydrological observations network, including in mountainous areas

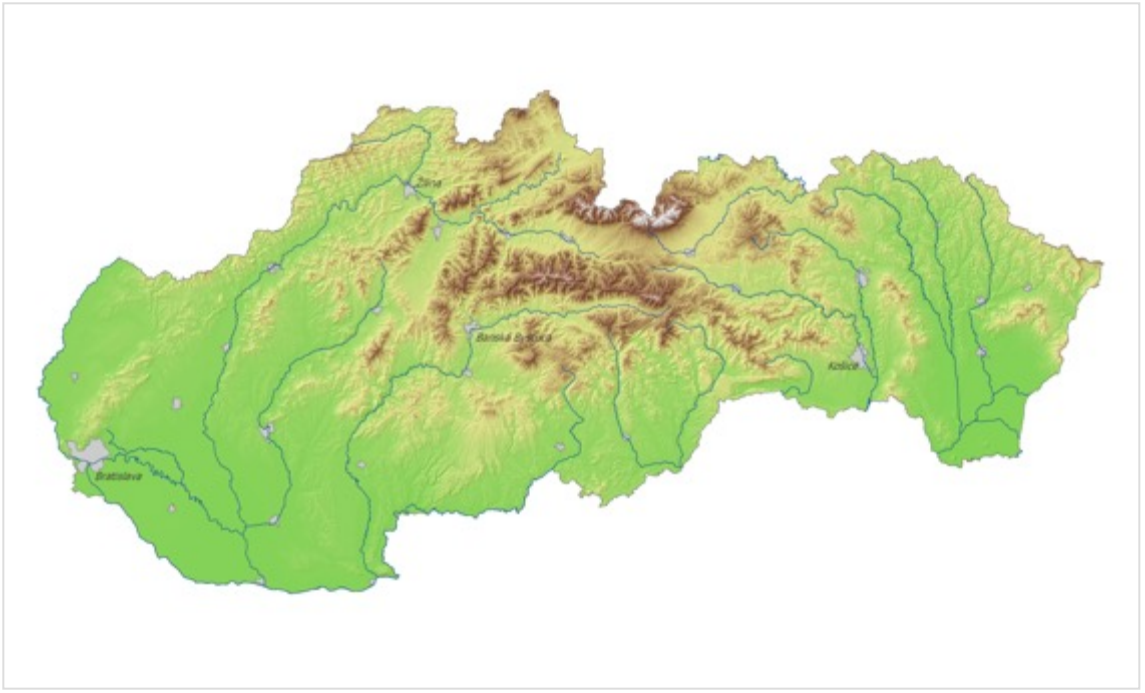
Ing. Lotta Blaškovičová, PhD.
Slovak Hydrometeorological Institute, Bratislava
Department od Surface Water Quantity

SLOVAKIA - BASIC GEOGRAPHICAL INFORMATIONS

Vistula – Baltic Sea



Danube and Tisza – Black Sea



AREA : 49 035 km^2

LOW ALTITUDE : 94 m. a.s.l.

HIGH ALTITUDE : 2655 m. a.s.l.

AVERAGE PRECIPITATION : 762 mm

AVERAGE TEMPERATURE : 7,4 ^{O}C

EVAPOTRANSPIRATION : 450 mm

GLOBAL OUTFLOW : 234 mm

Main sub-basins in Slovakia

SHMÚ main office (Bratislava) and regional offices in Banská Bystrica, Košice and Žilina

Hydrological monitoring network:

- monitoring of the quantitative components of the surface streams in Slovakia :
  - H - water stages
  - Q - discharges
  - T - water temperature
  - P - precipitation (mostly for verification of situation)
  - ice phenomenons
  - suspended sediments
- The groundwork of the monitoring is made by the observation, measurement, evaluation and interpretation of data, especially of the water stage regime and discharge regime of surface streams.
- The monitoring is provided exclusively by the Hydrological Service of Slovak Hydrometeorological Institute (Slovak abbreviation SHMÚ) by the hydrologic-station network.

Purpose of hydrological monitoring

knowledge about:

- water resources, its distribution in time and space
- risk of floods
- risk of droughts
- navigability of rivers

Useful for: flood protection, water utilization, water resource management, navigation, background for economic, political, ecological decisions, hydrological prediction, public information, etc.

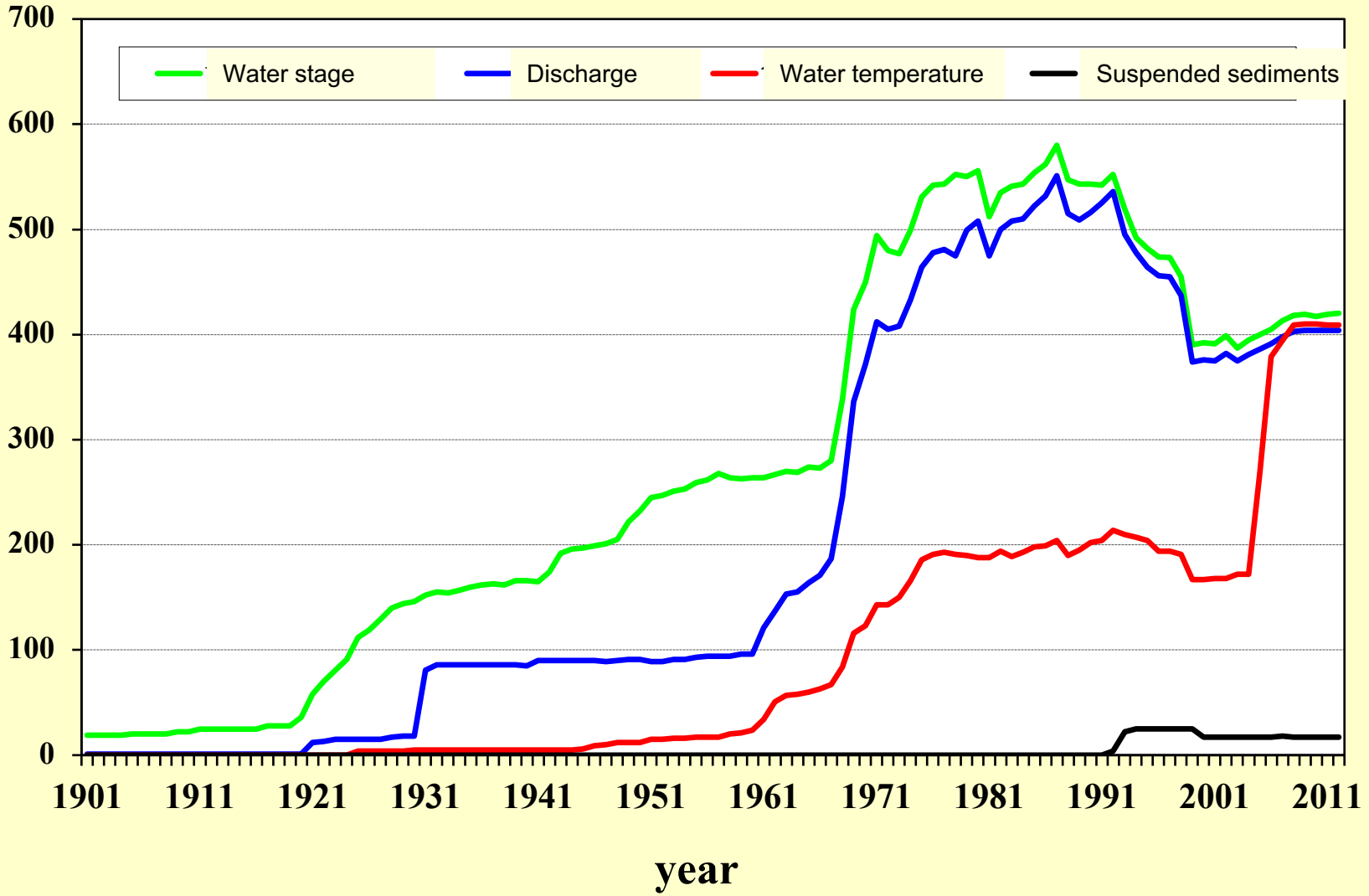
Surface water monitoring network design

Basic principles of selection of streams and profiles:

- Main rivers, important profiles in large cities, industrial centres, international borders
- Streams and profiles representing different hydrological regime types
- Profiles representing natural hydrological regime (problem in lowlands, lower parts of rivers - anthropological impact)
- Profiles monitoring effect of important water constructions (tributaries to water reservoirs, profiles under dams, etc.)

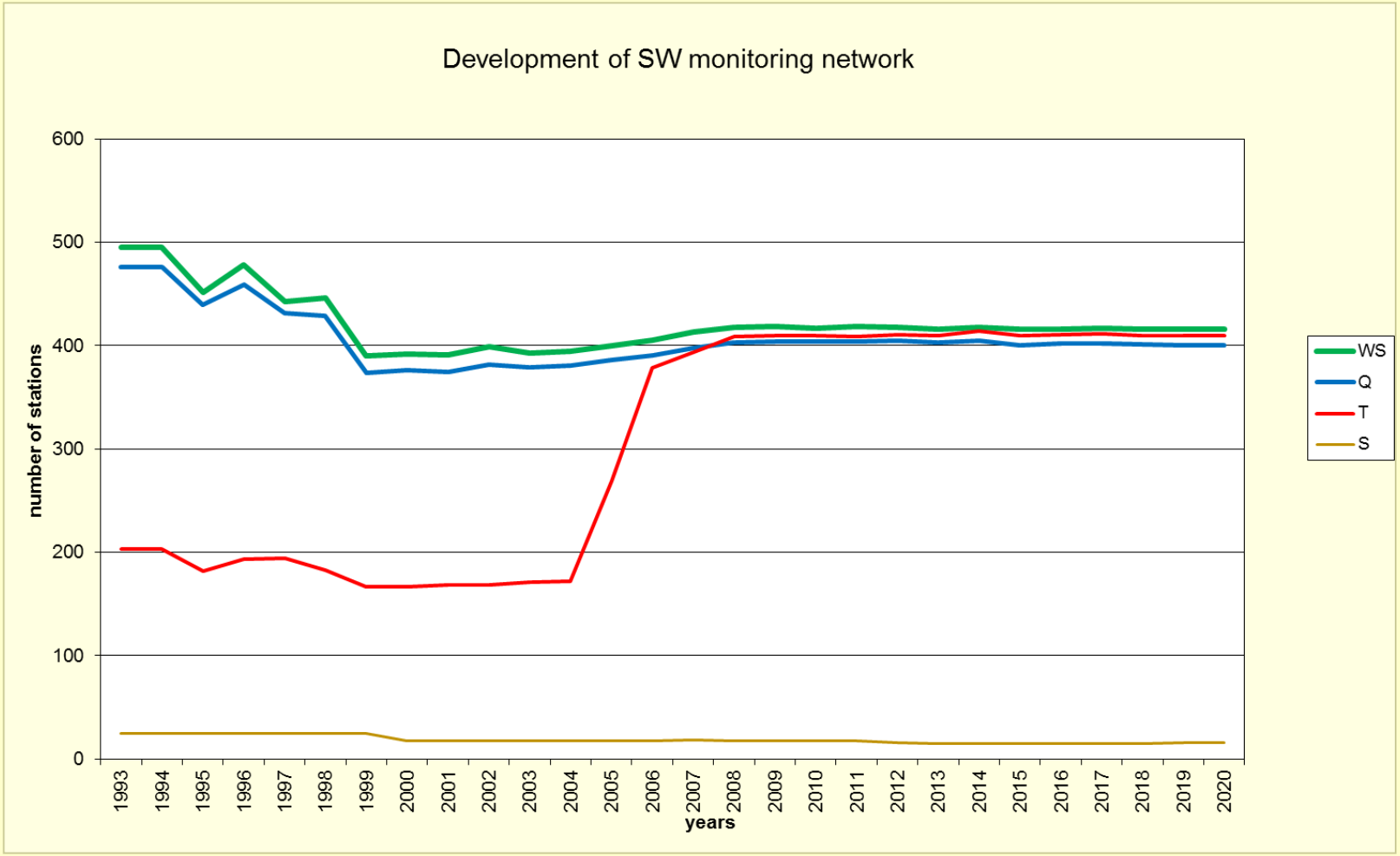
Basic technical rules have to be followed as well (streight part of river, appropriate cross profile, access, etc.)

Development of SW monitoring network



Development of SW monitoring network 2

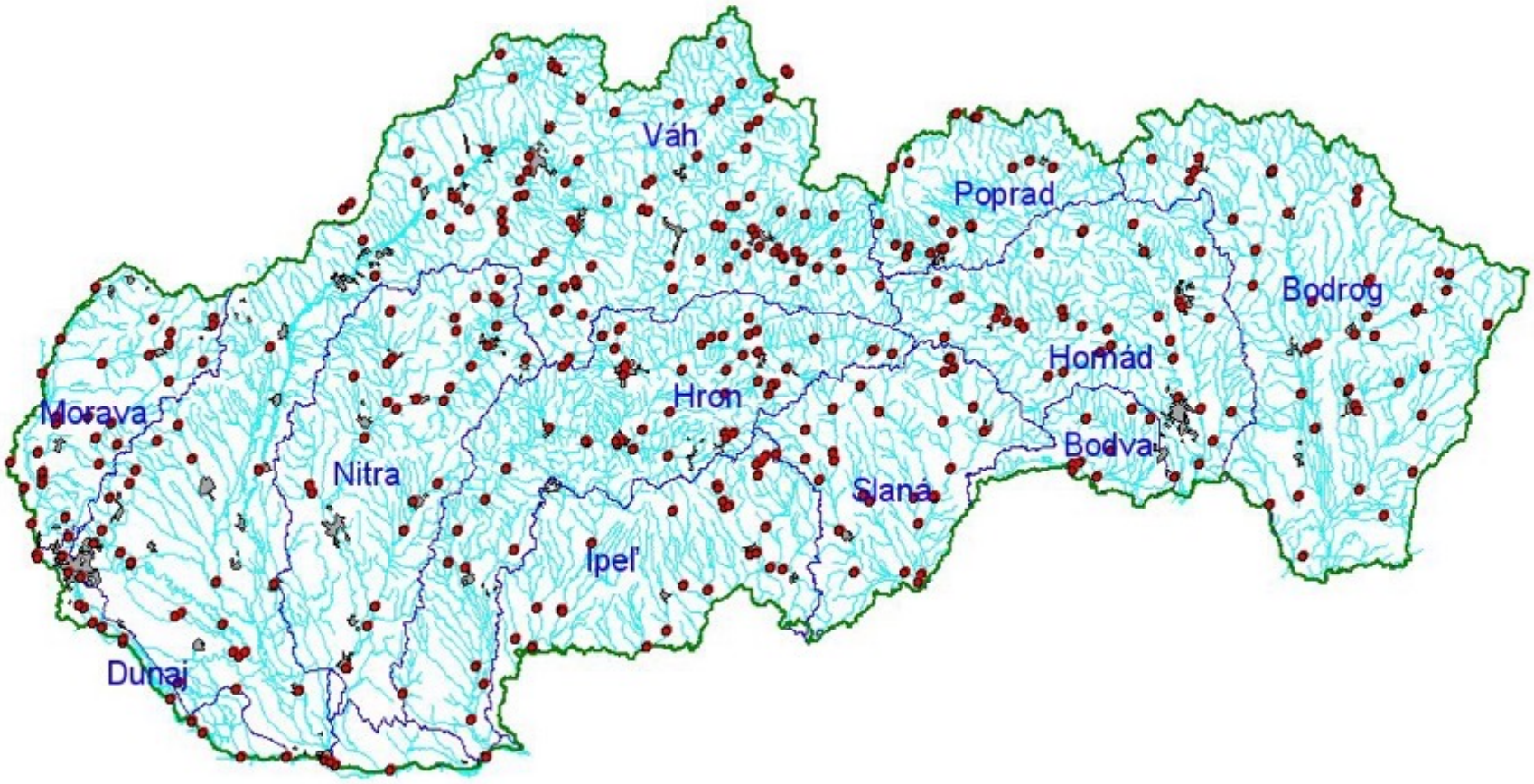
SLOVENSKÝ HYDROMETEOROLOGICKÝ ÚSTAV
SLOVAK HYDROMETEOROLOGICAL INSTITUTE



Period of observation

- Danube in Bratislava – station with longest period of observation in Slovakia (146 years water stage observations, 121 years discharge data)
- 6 stations with period of observation 100 years or more
- 56% of hydrological stations - period of observation > 50 years
- 17% of hydrological stations includes discharge data series shorter than 30 years
- even these shorter data series give very useful information about the character of the runoff regime and are used for prolonging of discharge data series on the base of correlation relations

Monitoring network – surface water quantity



• Number of stations (water stage measurements):	416	(1WS/117 km^2)
• nearly all stations on-line (except of few in border zone)	412	
• Stations with discharge measurements:	400	
• Stations with water temperature measurements:	410	
• Stations with measurements of suspended sediments	16	

Frequency of measurements

- Water stage – 1 hour / 15 min intervals (automatic stations – pressure sensors, digital recording, online data)

- Discharge – same as water stage
(evaluated from water stage records using rating curves,
direct measurements, hydrological balance)

- Water temperature – 1 hour intervals (automatic stations, digital recording)

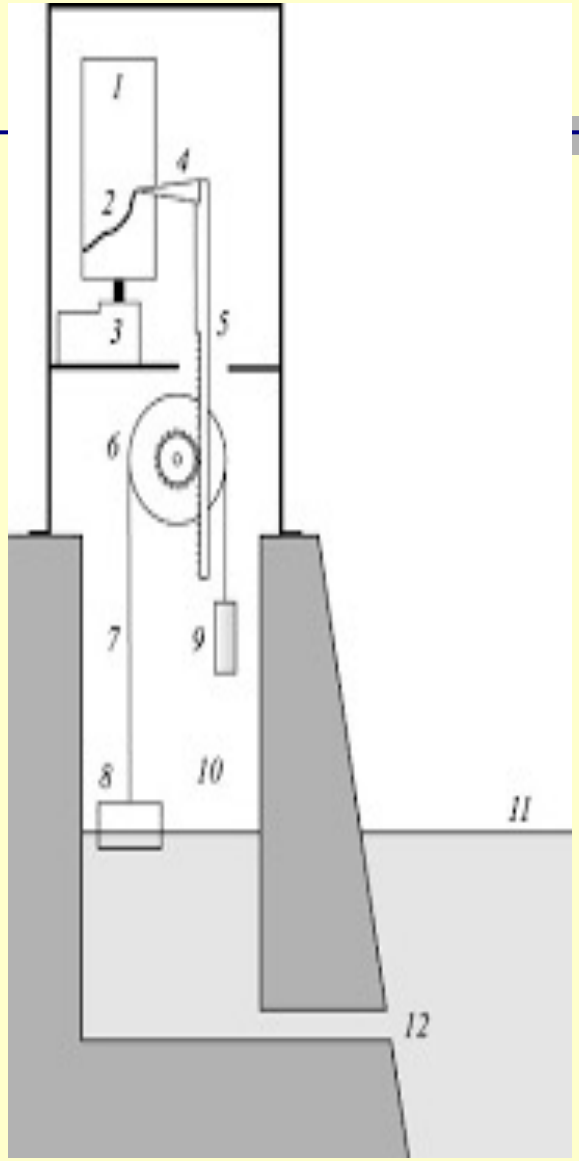
- ice phenomenon – daily in winter season – visually by observer, video cameras on selected profiles

- suspended sediments – daily samples taken by observer, control measurements and whole profile measurements by SHMI

Process of automatization in surface water monitoring equipment

- 1st observations on Danube in Bratislava in 1823 (irregularly by observer)
- 1876 start of regular observations
- After World War I. continual observations by limnigraphic devices (float devices with mechanical transmission)
- In the beginning of 90-ties – first automatic devices with pressure sensores and digital recording (Hydrus II)
- Since 1992 unification – devices type MARS (reliability, better price, longer operating life)

Float devices with continual recording by pen



LG 501 – Metra Blansko

Vodomerná stanica Bratislava - Dunaj

OTT device

MARS 2 – Automatic registration device with pressure sensor

VS Bratislava - Dunaj

Process of automatization in surface water monitoring equipment – cont.

- Since type MARS 5 started the era of automatic devices with remote transmission of data
- First connections were by fixed telephone lines
- Later supplemented by data transmission by GSM or satellite transmission
- First the devices with remote data transmission were installed on the important main rivers, later the number was gradually increasing, rapid increase in the period 2018-2020
- Actually all stations are equipped by remote transmission of data, except of few smaller ones

Discharge measurements

- Discharges evaluated from monitored data of water stages by use of rating curves, direct measurements, assessment of balance along the river and in the catchment,
- Update of rating curves needed regularly in all water-gauging stations (unstable river channels, changing cross-profiles after high flows, vegetation during summer season),
- Frequency of measurement varies – optimum at least 6 times a year, at high flow, medium flow as well as at minimum discharges,
- On internationally important rivers according to bilateral agreements (joint measurements)

Direct discharge measurements

- Basically two types of devices used:
  - Rotating element current meters
  - Ultrasonic (ADP) devices (first in 2005)
- Using of devices
  - By wading in the stream
  - From bridge
  - From boat

Rotating elements current meters

ADP devices

RDI River Ray
(depth: 40cm – 60m)

ADP devices

ADCP RDI Stream Pro
(depth: 7 cm – 6 m)

Specific problems of water-gauging stations in mountain areas

Higher altitudes associated with colder weather

- usually more snow in winter time
- more difficult access,
- ice phenomena occurrence,
  - partial to complete freezing of flows (pressure flow under ice),
  - difficulties in quantification of discharges,
  - ice congestion in the stream,
  - difficult maintenance - cleaning of staff gauge from snow and ice,
  - damage of staff gauge by ice flow - need for more frequent maintenance

High snow cover

SLOVENSKÝ HYDROMETEOROLOGICKÝ ÚSTAV
SLOVAK HYDROMETEOROLOGICAL INSTITUTE

Ice flow

SLOVENSKÝ HYDROMETEOROLOGICKÝ ÚSTAV
SLOVAK HYDROMETEOROLOGICAL INSTITUTE

Specific problems of water-gauging stations in mountain areas...cont.

Large longitudinal slope of streams

- high flow velocities, turbulent flows
- difficulties with hydrometring, during high flows often only indirect discharge measurement possible,
- unstable river channels, changes of cross profiles - frequent change of measuring curves,
- high transport of bottom material - stones and rocks of large dimensions - damage of the water-gauging station during floods, sometimes even destruction of station

Turbulent flow during high flow in mountain streams (north Slovakia, river basin Váh)

Water-gauging station
Horáreň Hluché – Palúdžanka
before (up)
and after (right) the flood in 2010

Specific problems of water-gauging stations in mountain areas... cont.

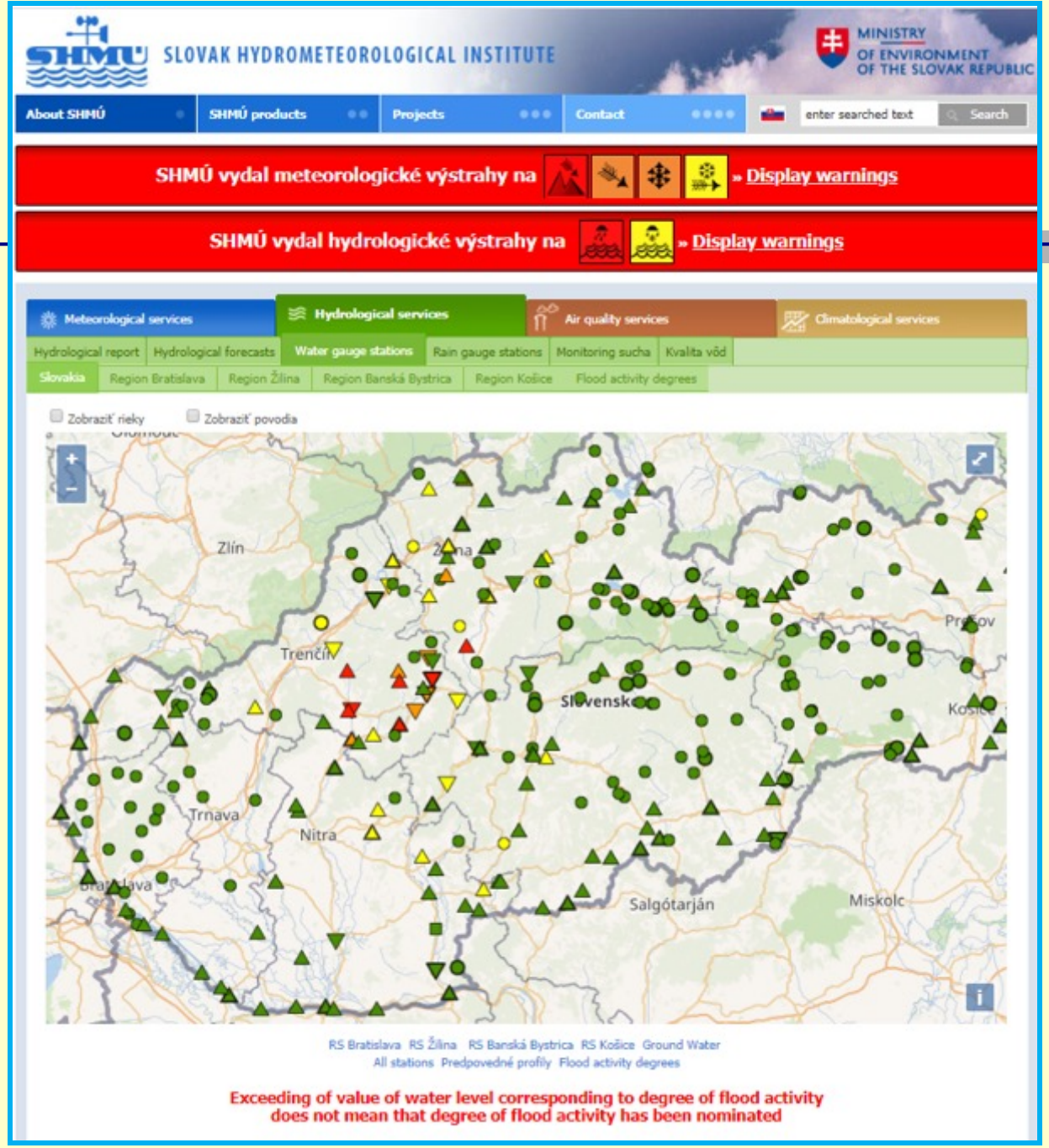
- Occurrence of wild animals - risk of attack by bears or wild boars

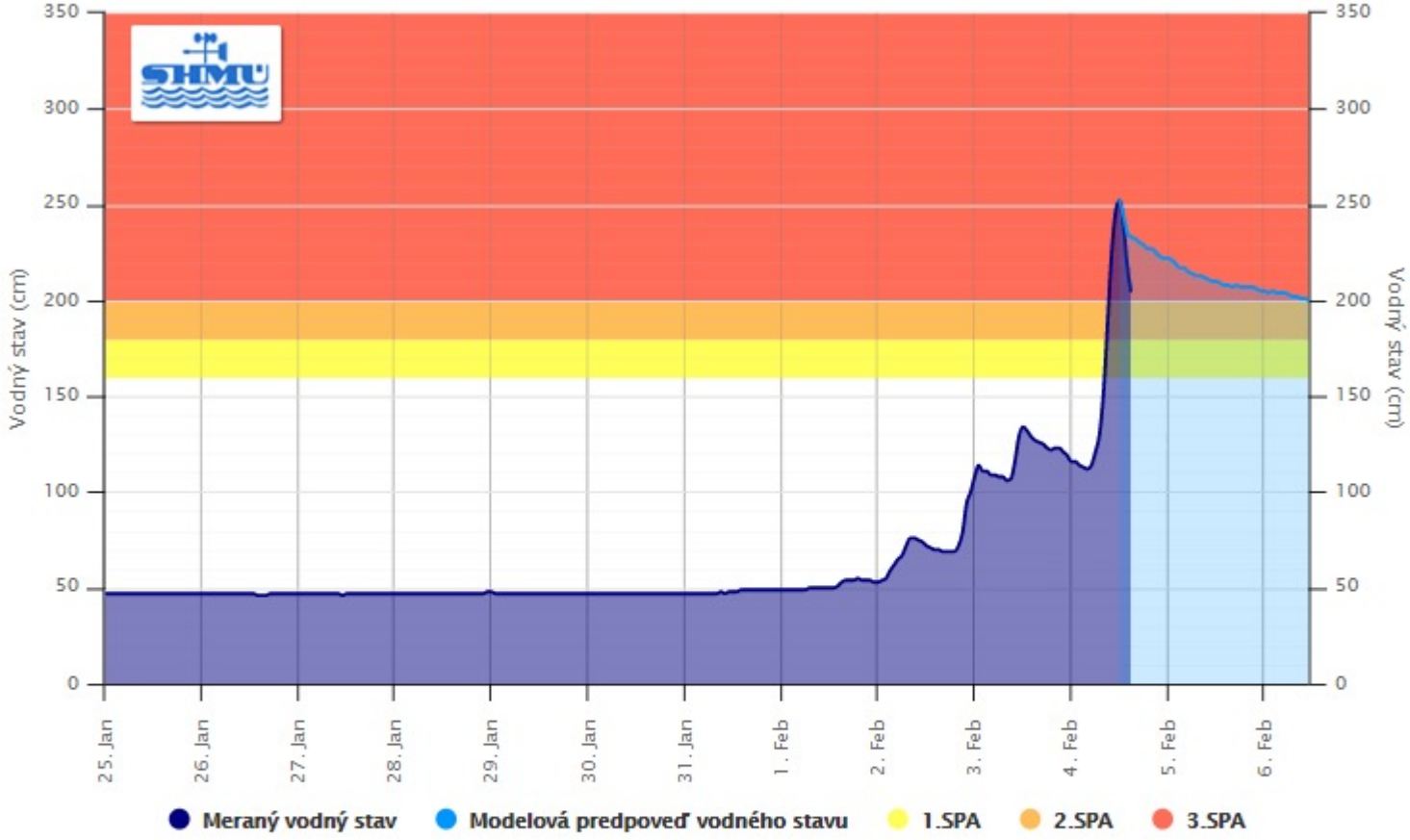
This does not mean that there are no problems in the lowlands parts of the rivers:

- greater depths, widths, discharges - more demanding and more time consuming measurements,
- overgrowing of streams by vegetation,
- changes in cross profiles by sedimentation
- muddy river beds
- higher human impact on flow regime (abstractions/discharging/manipulations on water reservois... upstream of monitoring sites)

Automatic monitoring stations - benefits

- On-line data immediately available
- Possibility of actual evaluation and on-line presentation of operative data for:
  - Actual hydrological situation
  - Flood warnings
  - Drought monitoring

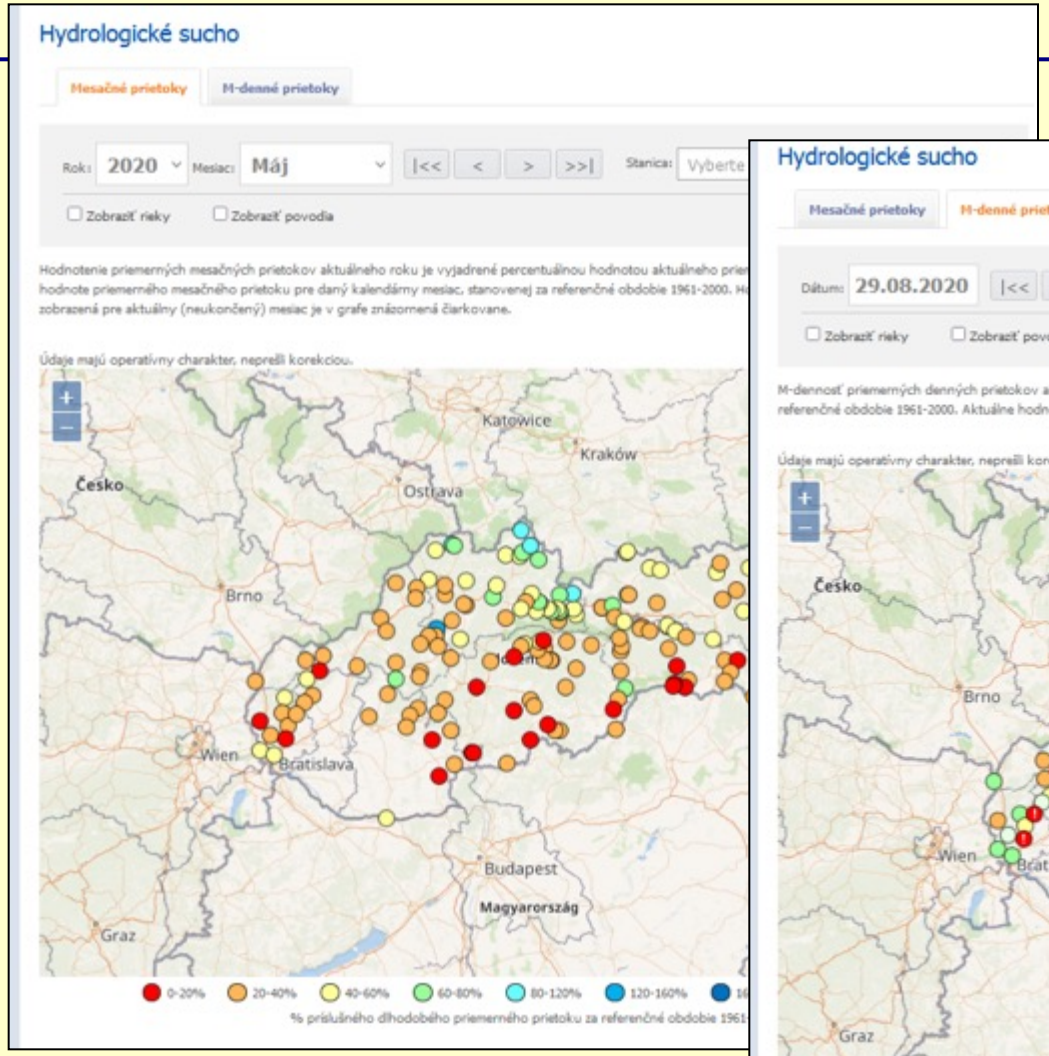

SLOVAK HYDROMETEOROLOGICAL INSTITUTE
MINISTRY OF ENVIRONMENT OF THE SLOVAK REPUBLIC
About SHMÚ
SHMÚ products
Projects
Contact
enter searched text
Search
SHMÚ vydal meteorologické výstrahy na
» Display warnings
SHMÚ vydal hydrologické výstrahy na
» Display warnings
Meteorological services
Hydrological services
Air quality services
Climatological services
Hydrological report
Hydrological forecasts
Water gauge stations
Rain gauge stations
Monitoring sucha
Kvalita vôd
Slovakia
Region Bratislava
Region Žilina
Region Banská Bystrica
Region Košice
Flood activity degrees
Zobraziť rieky
Zobraziť povodia
Zlín
Trenčín
Slovensko
Trnava
Nitra
Salgótarján
Miskolc
RS Bratislava RS Žilina RS Banská Bystrica RS Košice Ground Water
All stations Predpovedné profily Flood activity degrees
Exceeding of value of water level corresponding to degree of flood activity
does not mean that degree of flood activity has been nominated

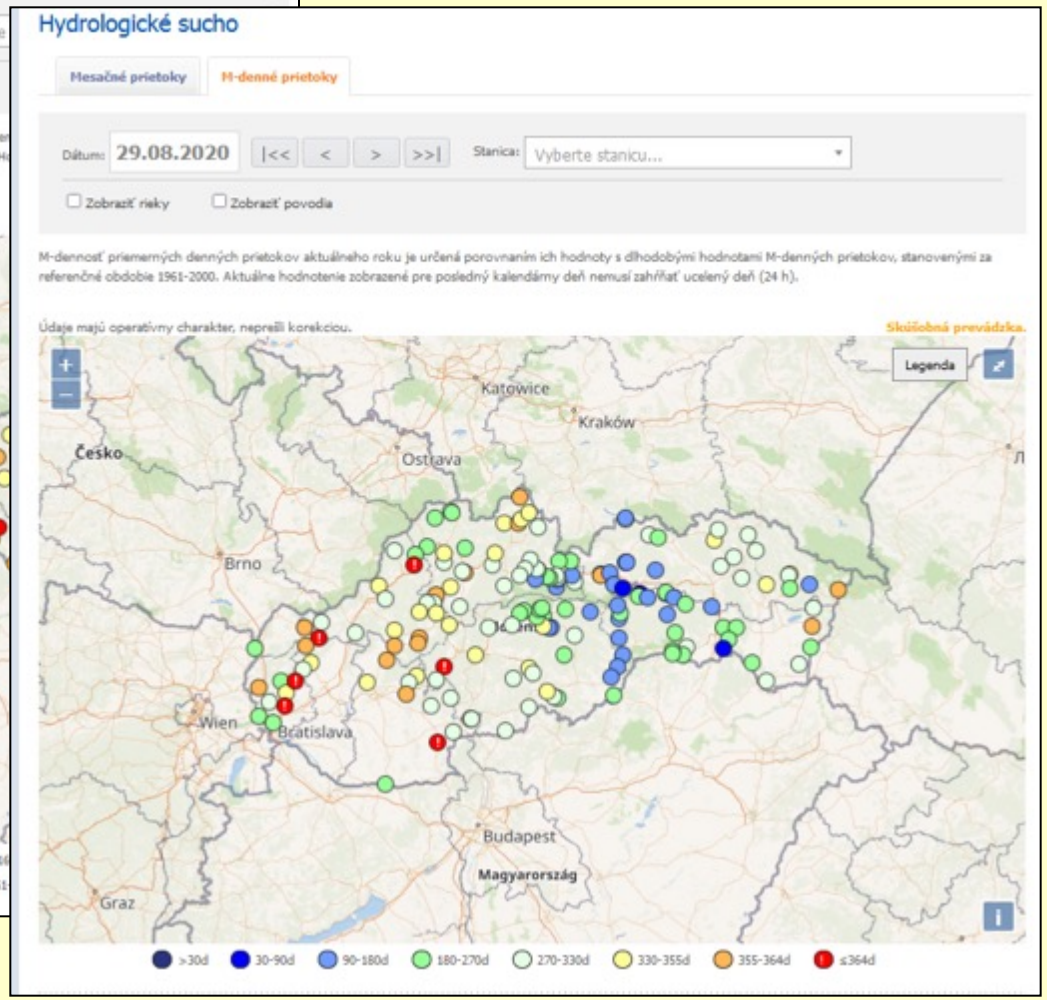


Údaje majú operatívny charakter, neprešli korekciou.

Čas merania	Vodný stav [cm]	Teplota vody [°C]
4.2.2020 14:45	205	4.9
4.2.2020 14:30	209	4.9
4.2.2020 14:15	212	4.9
4.2.2020 14:00	217	4.9

Hydrological Drought Monitoring





SLOVENSKÝ HYDROMETEOROLOGICKÝ ÚSTAV
SLOVAK HYDROMETEOROLOGICAL INSTITUTE

Thank you for your attention

SLOVENSKÝ HYDROMETEOROLOGICKÝ ÚSTAV
SLOVAK HYDROMETEOROLOGICAL INSTITUTE