Snow Profile Measurements and Their Use in Operative Hydrology

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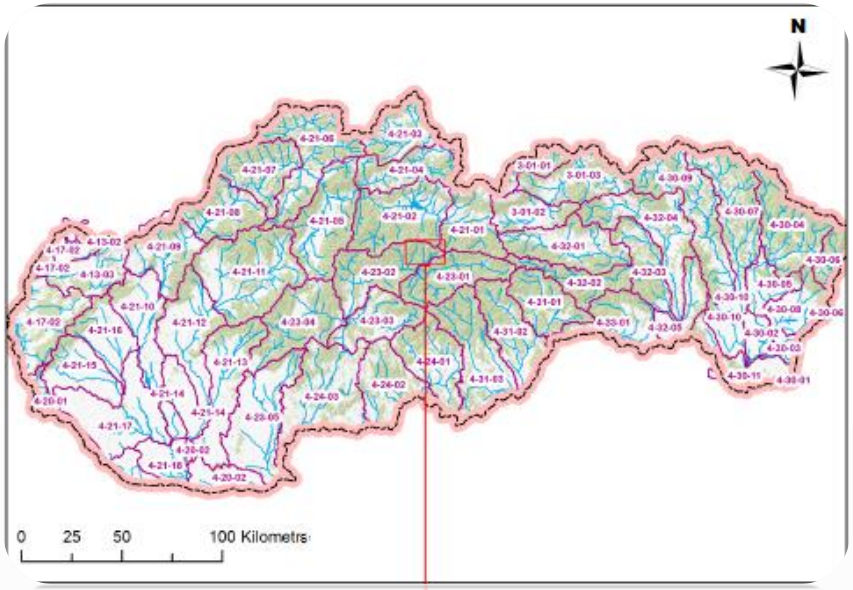
Snow campaign Slovakia, Tále, 15.2.2016

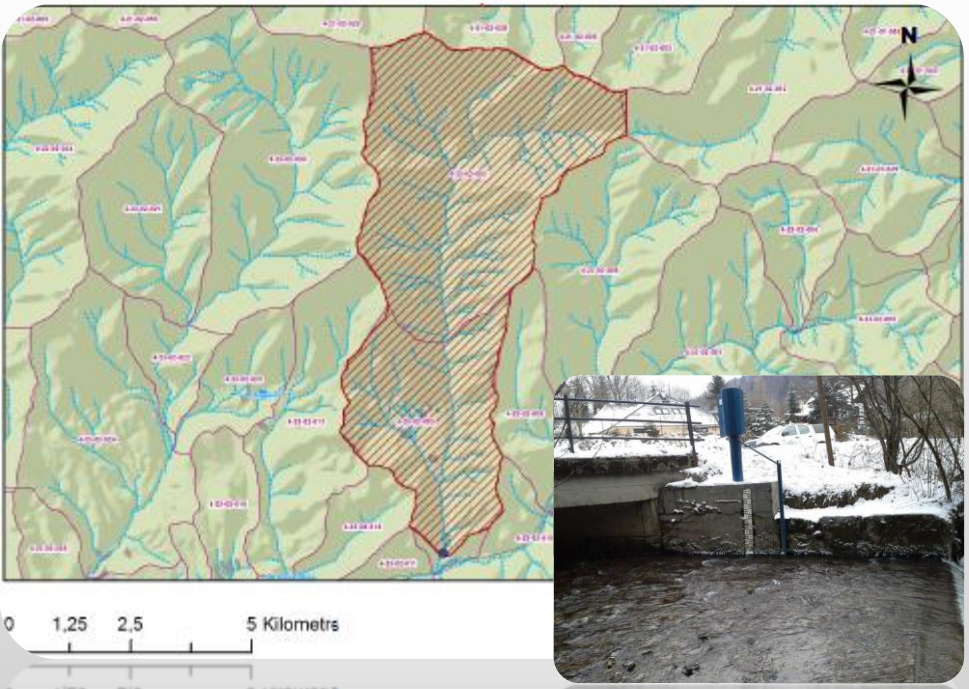
Bystrianka catchment

to hydro. profile Bystrá

- Catchment area: 36.01 km^2
- Mean elevation: 1180 m a.s.l.,
- Elevation range:

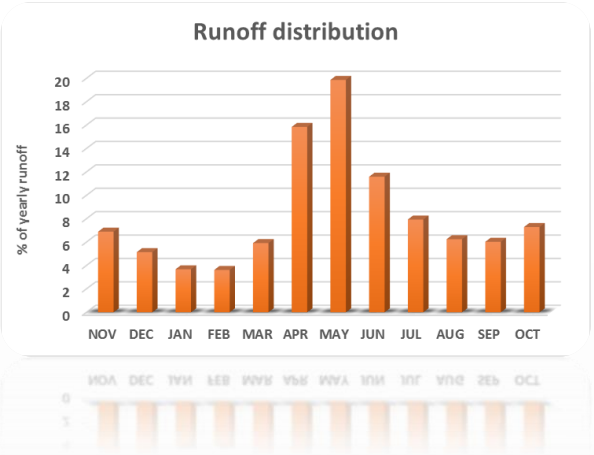
  max. 2043 m, min 578 m
- Distance from the mouth: 7 km





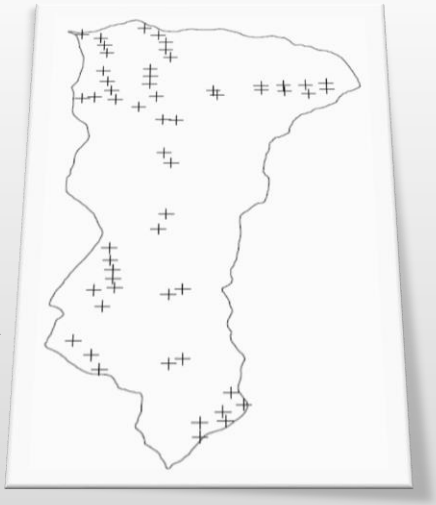
- Complex of crystalline rocks (mostly)
- Forest area: 78 %
- the upper forest border 1500 m a.s.l.
- Spruce tree (upper part) & mixed spruce and beech tree (lower part)
- Annual precipitation 1199 mm
  annual runoff 803 mm
  runoff coefficient 0.67

Bystrianka catchment



- Historical significance for development of snow hydrology in Slovakia

- Institute of Hydrology and Hydraulics, SAS
- 1962 - Representative basin in terms of creation snow water storage in mountain regions:
  - Considerable elevation range (578-2043 m a.s.l.)
  - Traffic availability
  - Accommodation
  - SHMU - hydrological observation devices
  - Avalanche Prevention Center - possible cooperation
- Experimental basin 1963-1992



Scheme of spatial distribution of snow courses in the Bystrianka catchment

Bystrianka catchment

- Weekly expeditions – the 1st one in March 1963
- 3 or 4 times per season:
  - the end of JAN - beginning of snow accumulation
  - the turn of FEB and MAR – maximum snow pack
  - the end of MAR - beginning of snowmelt
  - APR - snowmelt & runoff
- Topics
  - SD & SWE – point measurement, snow courses (points – distance)
  - measuring equipment (errors & assessment)
  - site's representativeness
  - comparison forest – open areas
  - SD & SWE changes depending on altitude
  - possibilities of stereophotogrammetry

Bystrianka catchment

- chemistry of snow pack & water quality

- Field standard (tutorial) –

  Measurement and assessment of snow water content in basin:

  100 m long snow course – 10 points SD – 1st, 5th, 10th point SWE

- 1992, MAY the 7th – last field trip

Snow hydrology in SHMU

Snow-melt runoff plays important role in runoff regime of Slovakian rivers. Although only 20-30 % (in average) of yearly precipitation totals accumulate in snow cover, more than 40 % of yearly runoff creates snow-melt runoff.

Demands of water authorities, stake holders - water supply (hydropower plants), flood protection

1982-1983 Vah river basin (dams); **1990-1991** Hron, Bodrog etc.

Snow hydrology in SHMU

- Snow water content is regularly calculated for 35 profiles in river basins of Váh, Hron, Ipeľ, Slaná, Poprad, Hornád, Bodva and Bodrog
- SHMU has obligation to provide the information about the water content in the snow cover to state authorities and administrators of river basins

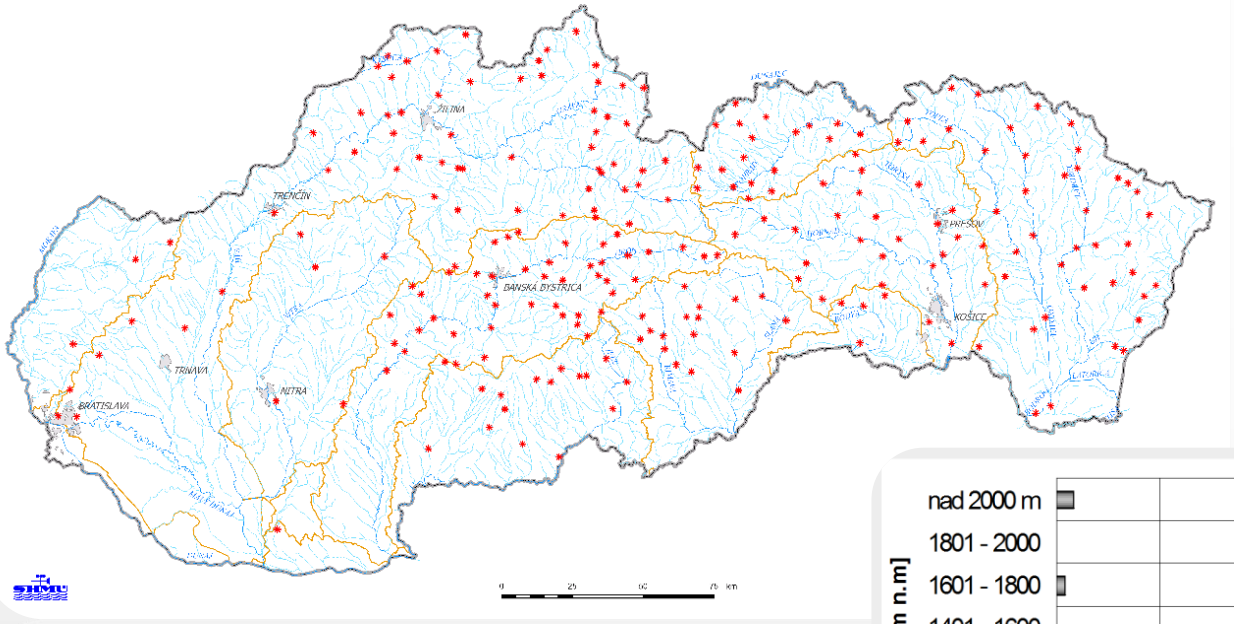
The Act No 666/2004 Collection of Articles about flood protection

Snow water storage

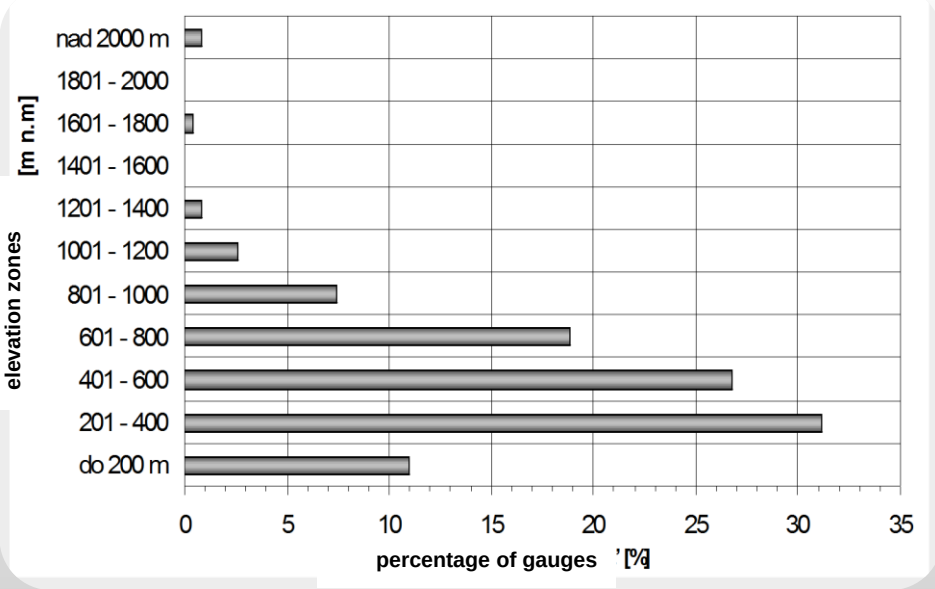
- basic input for processing of basin's snow water supply – **Snow Depth** (SD) and **Snow Water Equivalent** (SWE)
- on Mondays, from December to March/April, *real time* data from 238 gauges (volunteers – phone call, proffesional)
  - manual measurements using standard rain gauge or weighing snow gage (SWE) and graduated snow stakes (SD)
- **95 % of gauges up to 1000 m – question relating to** representativeness of network (availability in mountain terrain)

- Data from snow cover network is supplemented by the data from ***snow courses expedition*** regularly performed in mountain terrain (altitudes above 1000 m)
- Simple linear relationship between SWE and altitude of stations
- **Snow water supply info**: http://www.shmu.sk/sk/?page=1&id=mim_sneh

Snow cover network



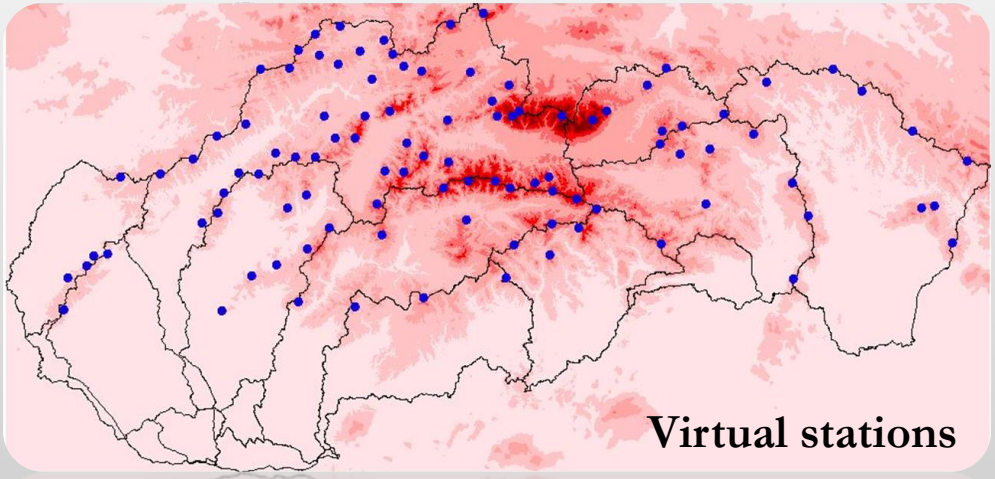
Distribution in space



Distribution according to altitude

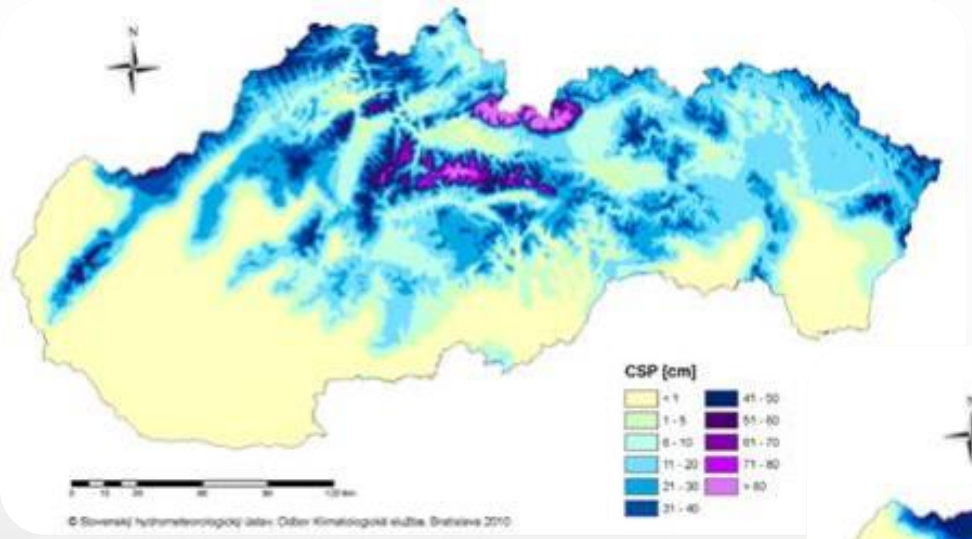
Weekly maps of SD and SWE

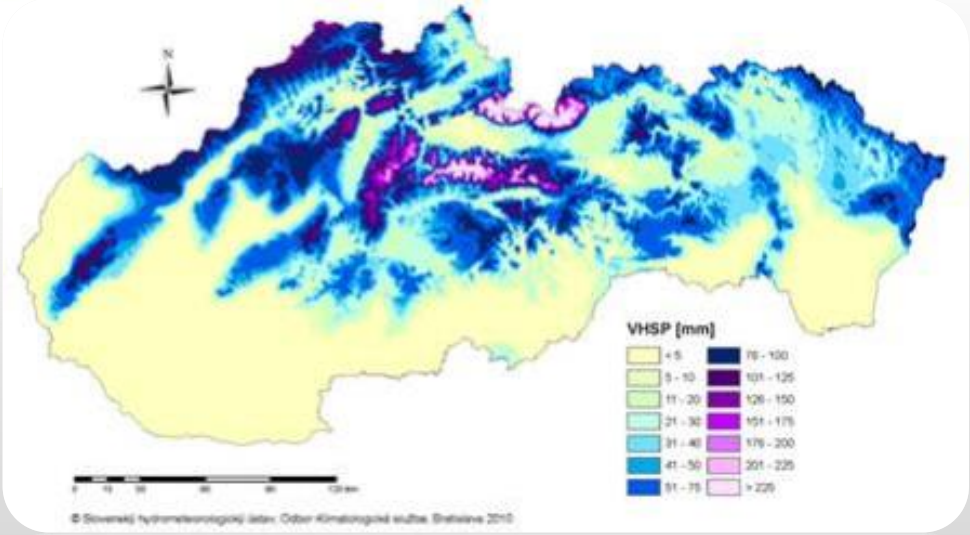
- created by Division of climatology
- processing of snow cover characteristics in GIS gives info about distribution in time and space
- data from network of snow gage stations (238) + virtual stations (>100, in mountain regions, values are determined by regression model or expertise estimation)
- method: 3D interpolation with influence of topography – regularized spline with tension (GIS environment - GRASS)
- ***from maps of SWE operative hydrology calculates <u>snow water supply</u> using map algebra in GIS***



Example: maps of SD and SWE 22.2.2010

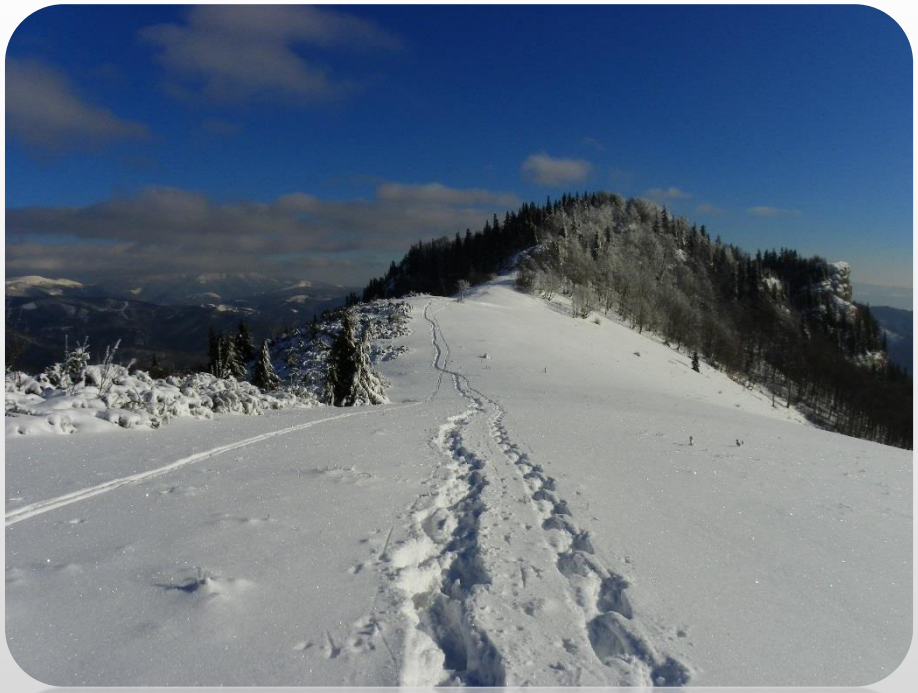
http://www.shmu.sk/sk/?page=1&id=klimat_tyzdennemapy&produkt_id=0





Hydrological modelling

- For successful **snow-melt runoff forecasting** the info about snow water storage over the basin is necessary.
- For forecasting, study purposes or creating snow-melt runoff scenarios we use conceptual rainfall-runoff model HBV – simulation processes of snow accumulation and snow-melt runoff



From snow courses expedition