

Drought monitoring, drought management and climate change

Pavel Šťastný

Co-authors: Valéria Slivová, Katarína Mikulová, Maroš Turňa

Slovak Hydrometeorological Institute, Bratislava

Training Workshop, Bratislava, 10 – 11 November 2021

Content of presentation

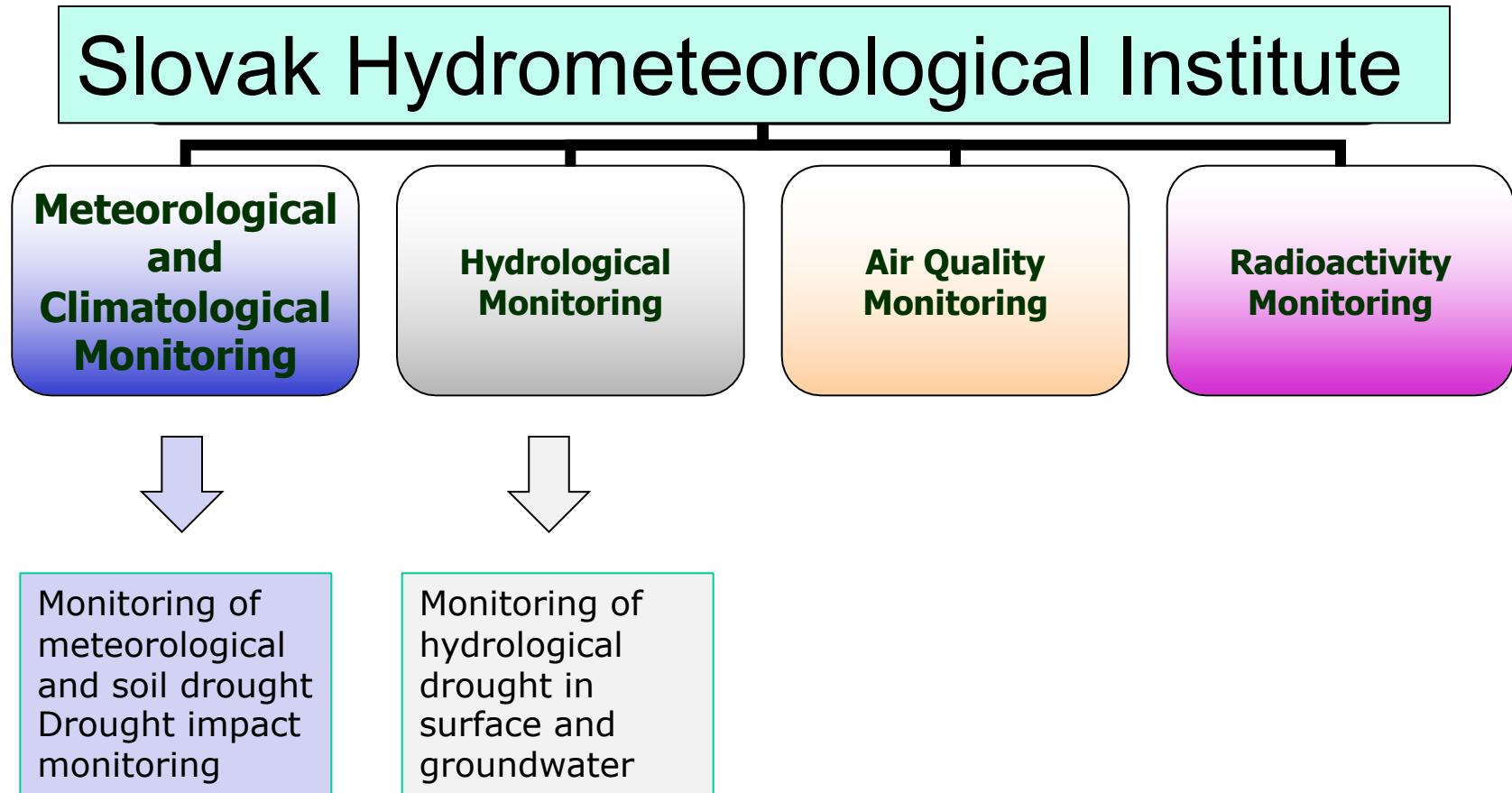
1. Drought monitoring at the Slovak Hydrometeorological Institute
2. Drought Action Plan: „VALUE IS WATER“- the drought management tool
3. DriDanube project - added value of the Interreg project in the field of the drought monitoring and management
4. Climate change impacts and projections in Slovakia

Map of Slovakia



Training Workshop, Bratislava, 10 – 11 November 2021

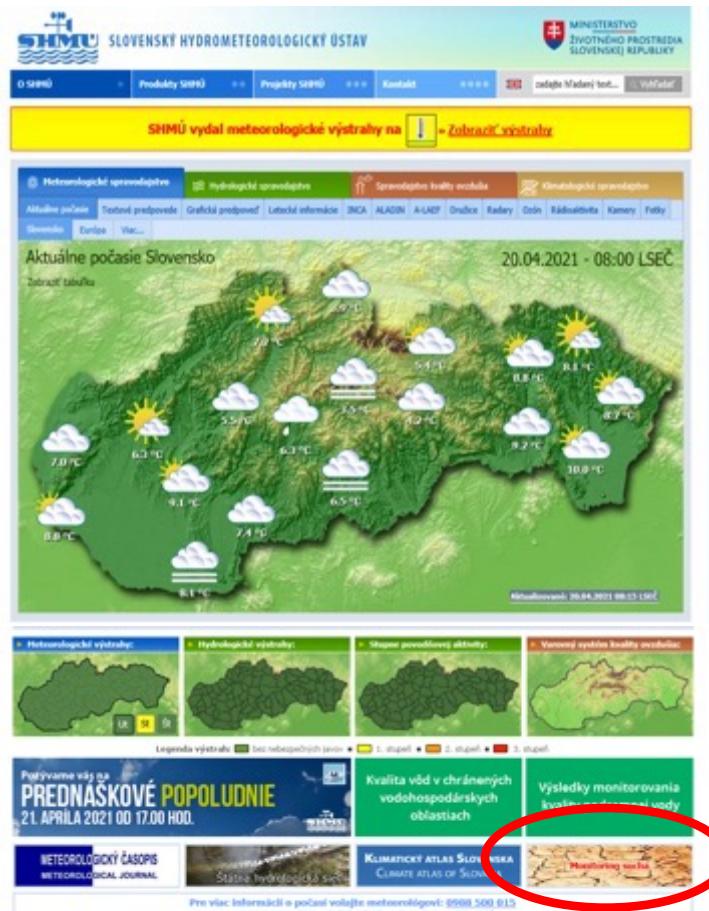
Meteorological and climatological monitoring system at SHMI including drought monitoring



Training Workshop, Bratislava, 10 – 11 November 2021

Monitoring of drought at Slovak Hydrometeorological Institute

- Available on: www.shmu.sk
- Regular monitoring started since 1915
- Co-operation with Czech Globe and Soil Research Institutions
- Meteorological drought
- Soil drought
- Hydrological drought
 - in surface water
 - in groundwater
- National drought impacts reporting network



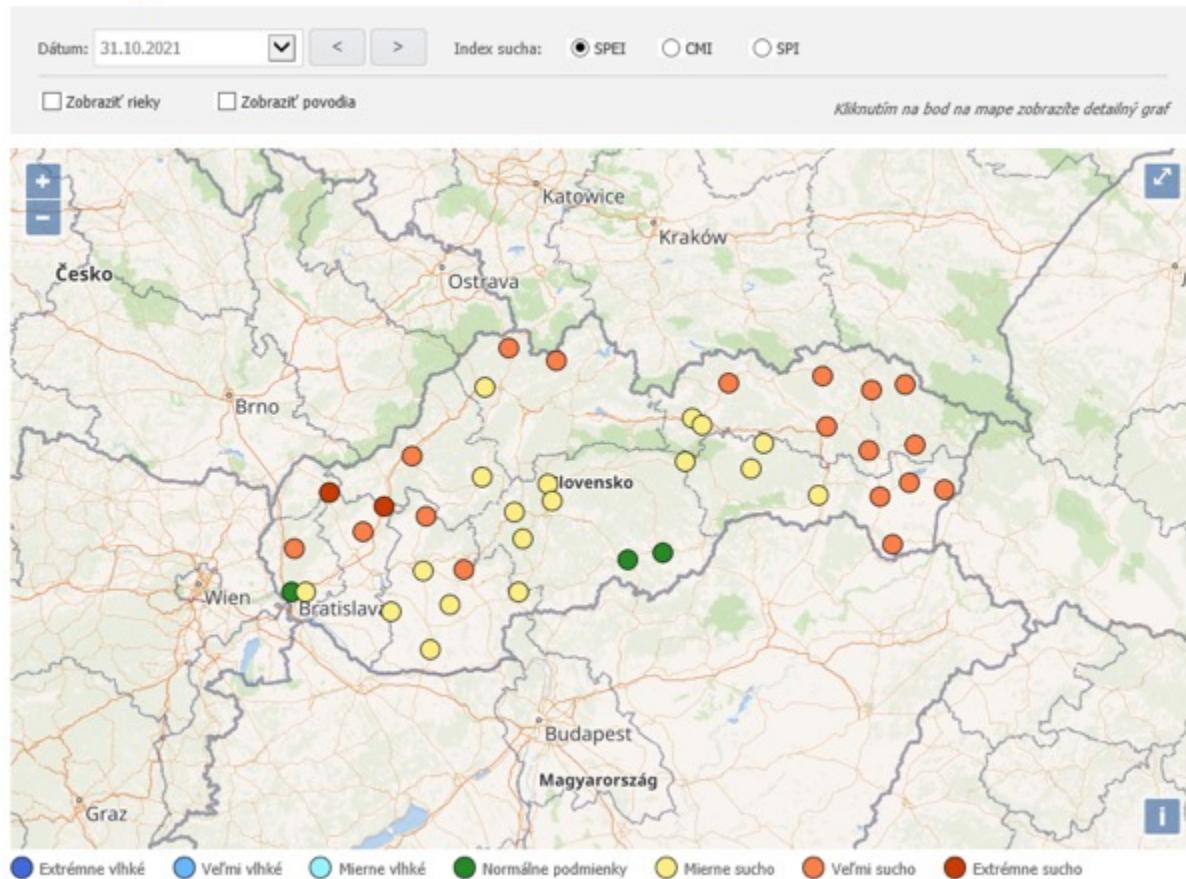
Training Workshop, Bratislava, 10 – 11 November 2021

Monitoring of the meteorological drought

- In operation from March 2015
 - In year 2015 and 2016 from March till September
 - From March 2017 continuously
- **41** meteorological station involved
- Update every Monday on www.shmu.sk
- **SPI – standardized precipitation index**
- **SPEI - standardized precipitation and evaporation index**
- **CMI – crop moisture index**

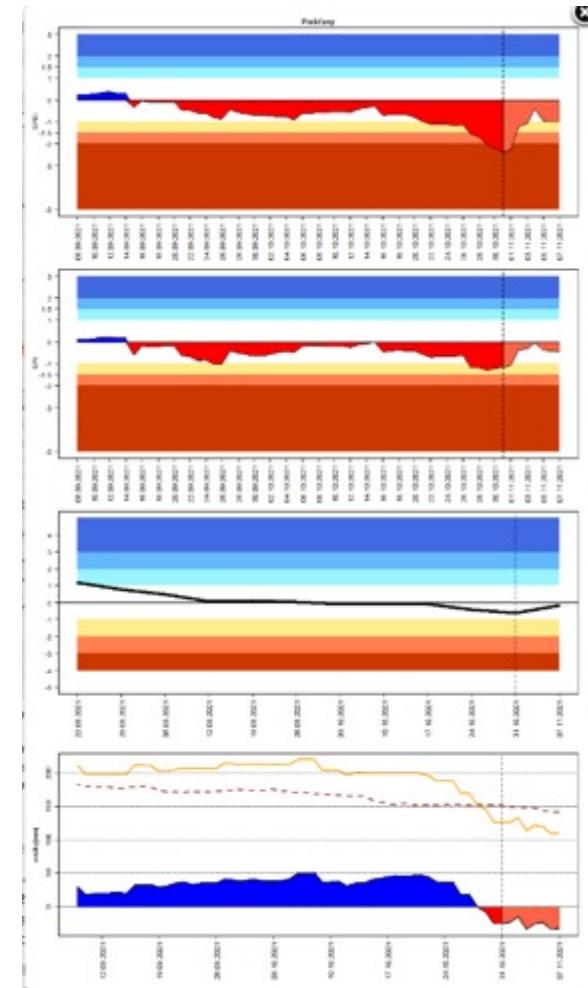
Monitoring of the meteorological drought

Meteorologické suchô



Monitoring suchô prebieha prostredníctvom troch indexov suchô - SPEI, SPI, CMI, ktorých priebeh je znázornený v grafoch.

Map of the stations with drought intensity



Course of drought indices

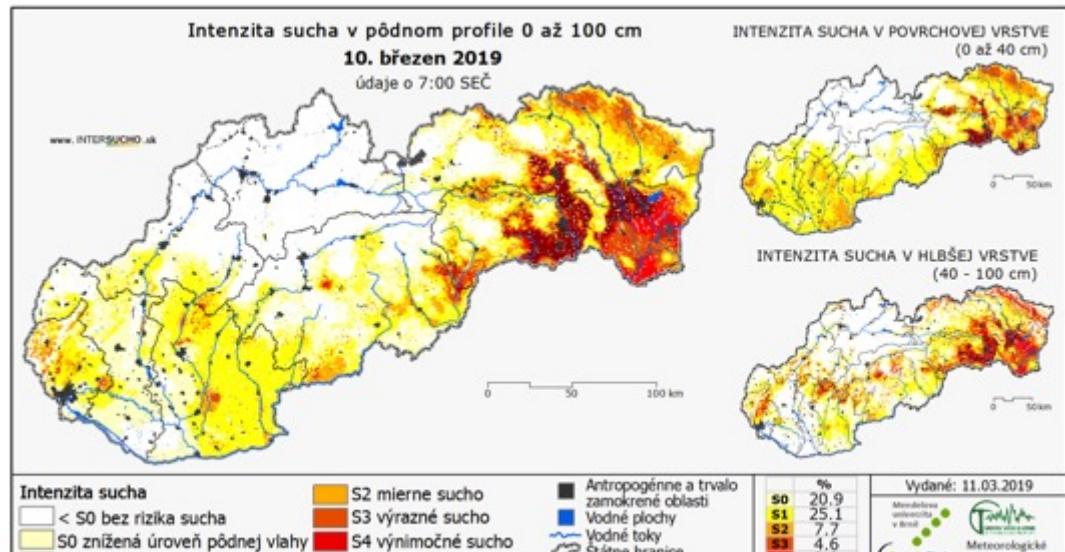
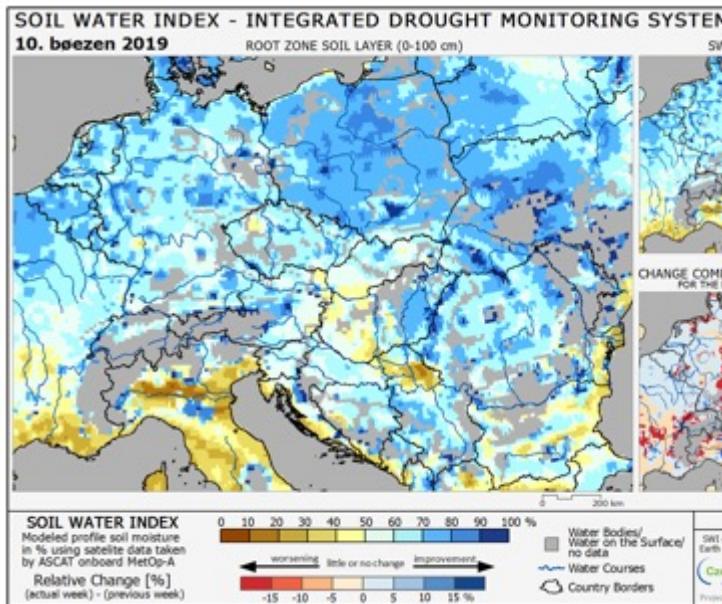
Training Workshop, Bratislava, 10 – 11 November 2021

Monitoring of the soil drought

- In operation from September 2015
- Update every Monday on www.intersucho.sk
- Modelled drought conditions are actual for last Sunday 07:00 a. m
- Short comment on drought intensity, duration, spatial distribution
- Products
 - Intensity of drought – comparison of the actual soil humidity with the reference period 1961 – 2010
 - Relative saturation of the upper soil profile
 - Deficit of the soil water in mm
 - Cumulative stress
 - Forecast of the drought intensity and relative saturation for next 10-days period
 - Vegetation conditions based on satellite images

Monitoring of the soil drought

Map of the soil water index



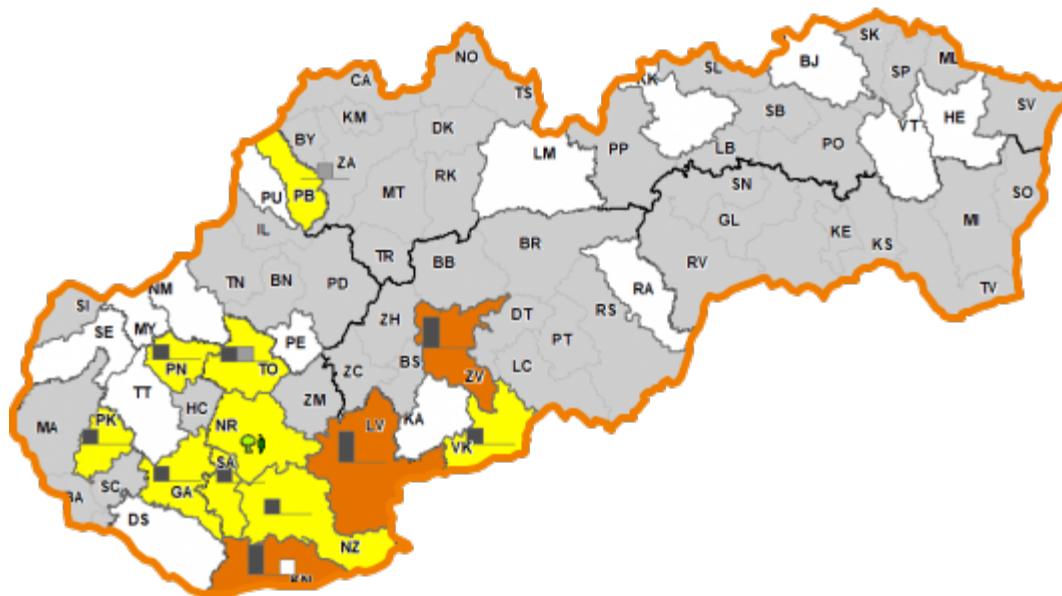
Map of the drought intensity in the upper soil layer 0 -100 cm (0 – 40 cm, 40 – 100 cm)

Training Workshop, Bratislava, 10 – 11 November 2021

Estimated drought impacts on main crop yields

National drought impacts reporting network

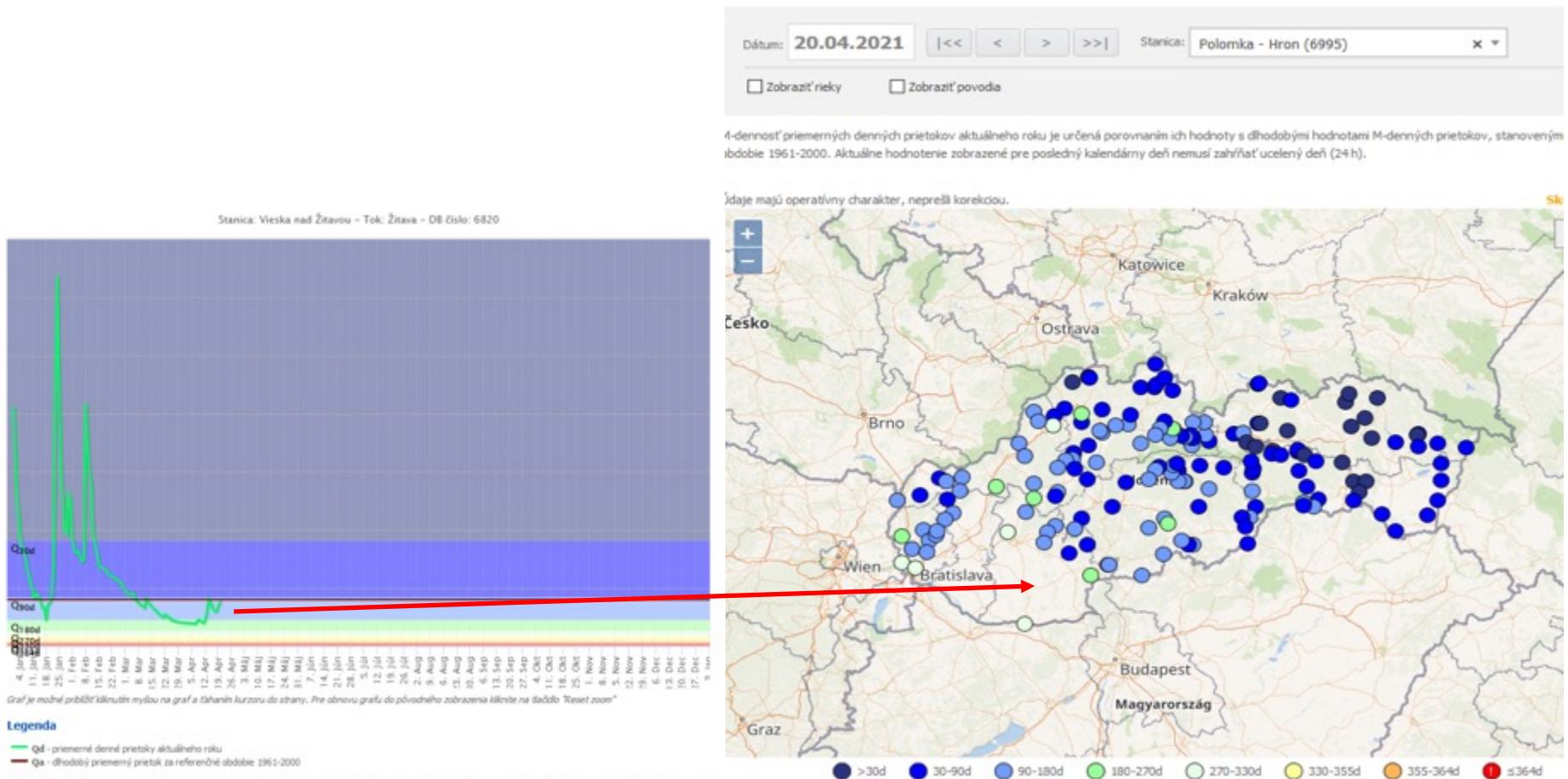
- *150 active reporters*
- *Weekly reports*
- *Crop, vine, forests etc.*



Map of the districts with indicated drought impacts

Monitoring of hydrological drought in surface water

- On-line update
- Actual water discharges are compared with the m-day discharge limits for the estimation of drought intensity



Discharge course

Map of the stations with hydrological drought intensity

Training Workshop, Bratislava, 10 – 11 November 2021

Monitoring of hydrological drought in groundwater

- Online monitoring of groundwater drought started at 2017 (7 boreholes)
- The number of monitoring objects has been increased every year
- Actual groundwater level/ spring yield in boreholes or springs are compared with monthly statistical limit values for the estimation of drought intensity
- Reference period 1981 – 2010

Actual online monitoring objects: 100

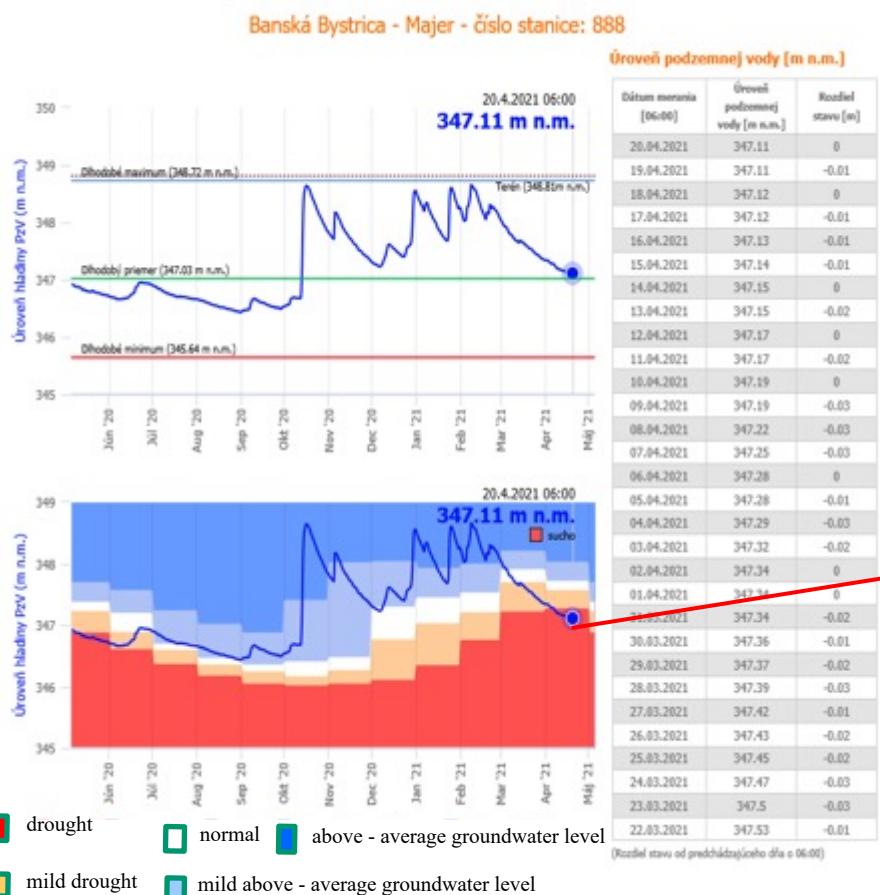
**- 68 boreholes
- 32 springs**



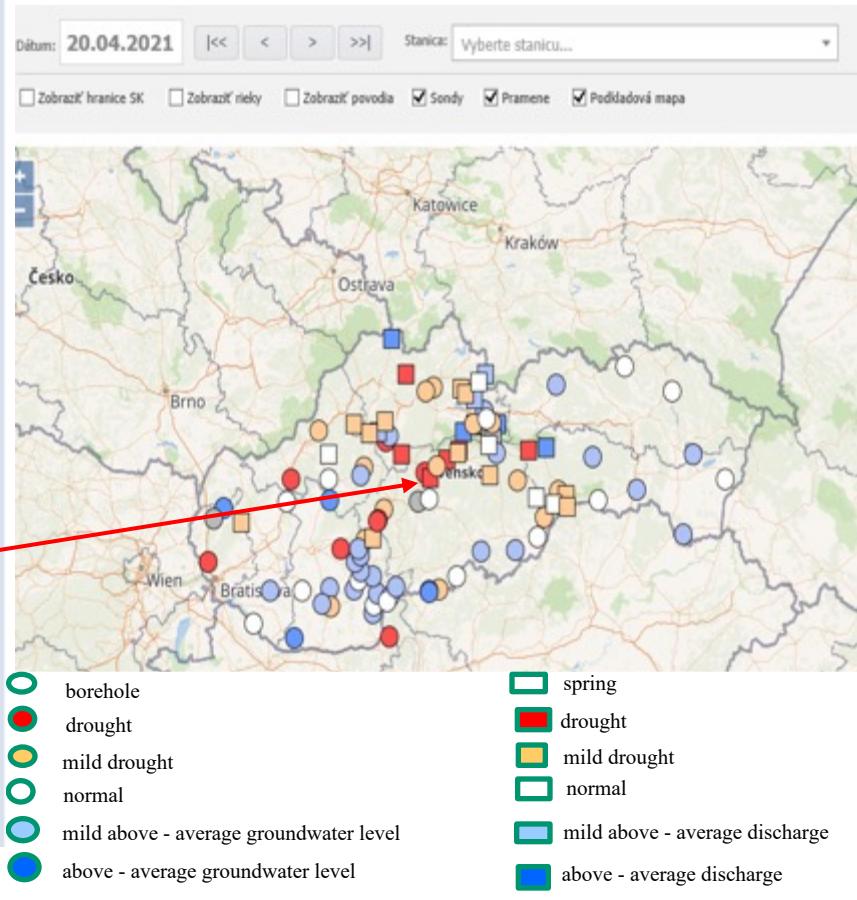
Training Workshop, Bratislava, 10 – 11 November 2021

Monitoring of the hydrological drought in groundwater

Visual representation of actual online situation in groundwater



Groundwater operational daily data and drought assessment



Map of the stations with drought intensity

Training Workshop, Bratislava, 10 – 11 November 2021

Drought management

H₂ODNOTA JE VODA (Value is Water) – an Action Plan

An action plan to address the consequences of drought and water scarcity in the Slovak Republic

Time frame: 2018-2025

Measures:

- *Preventive measures for different sectors* (including science and education)
- *Operational measures* (including the extention of the monitoring network)
- *Crisis measures* (for longlasting drought mainly)



Training Workshop, Bratislava, 10 – 11 November 2021

DriDanube - Drought risk in the Danube Region an Interreg project



2017 – 2019,
10 countries
from Danube Region

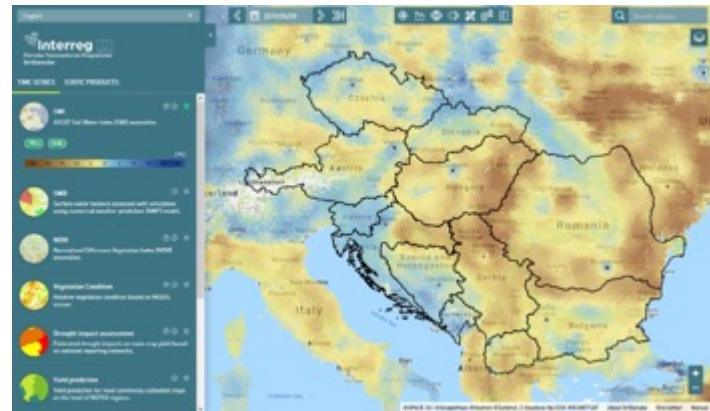


The main objective of DriDanube project was to increase the capacity of the Danube region to manage drought related risks.

<http://www.interreg-danube.eu/approved-projects/dridanube>

Drought Watch
innovative and interactive tool for drought experts, meteorologists, water managers, farmers and decision makers to monitor and detect droughts with a web interface:

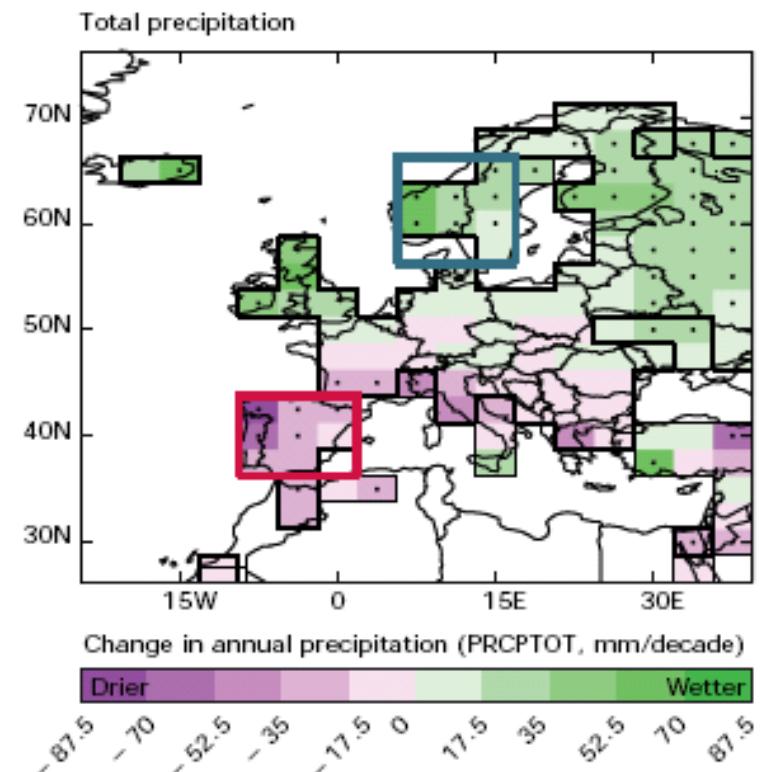
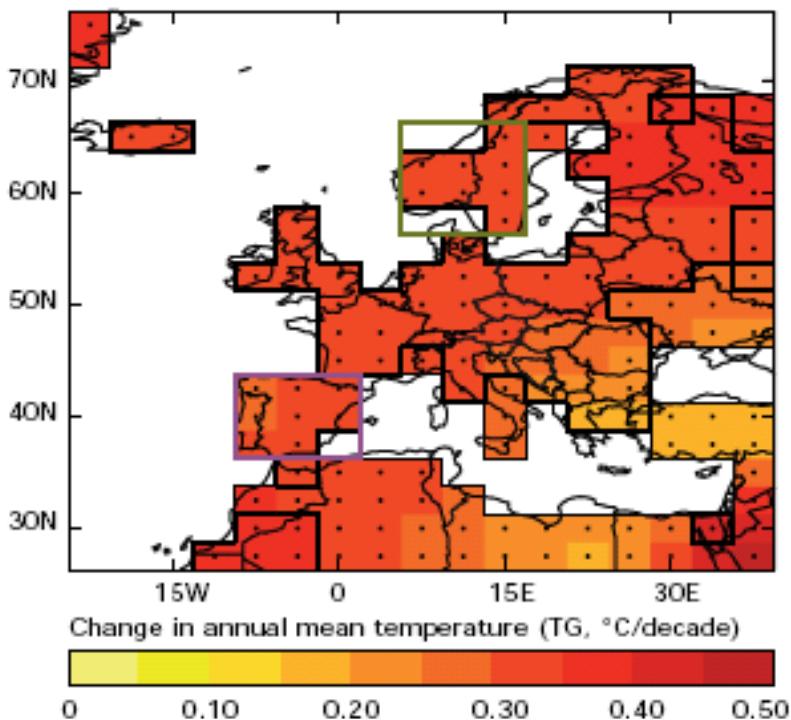
<http://www.droughtwatch.eu/>



Training Workshop, Bratislava, 10 – 11 November 2021

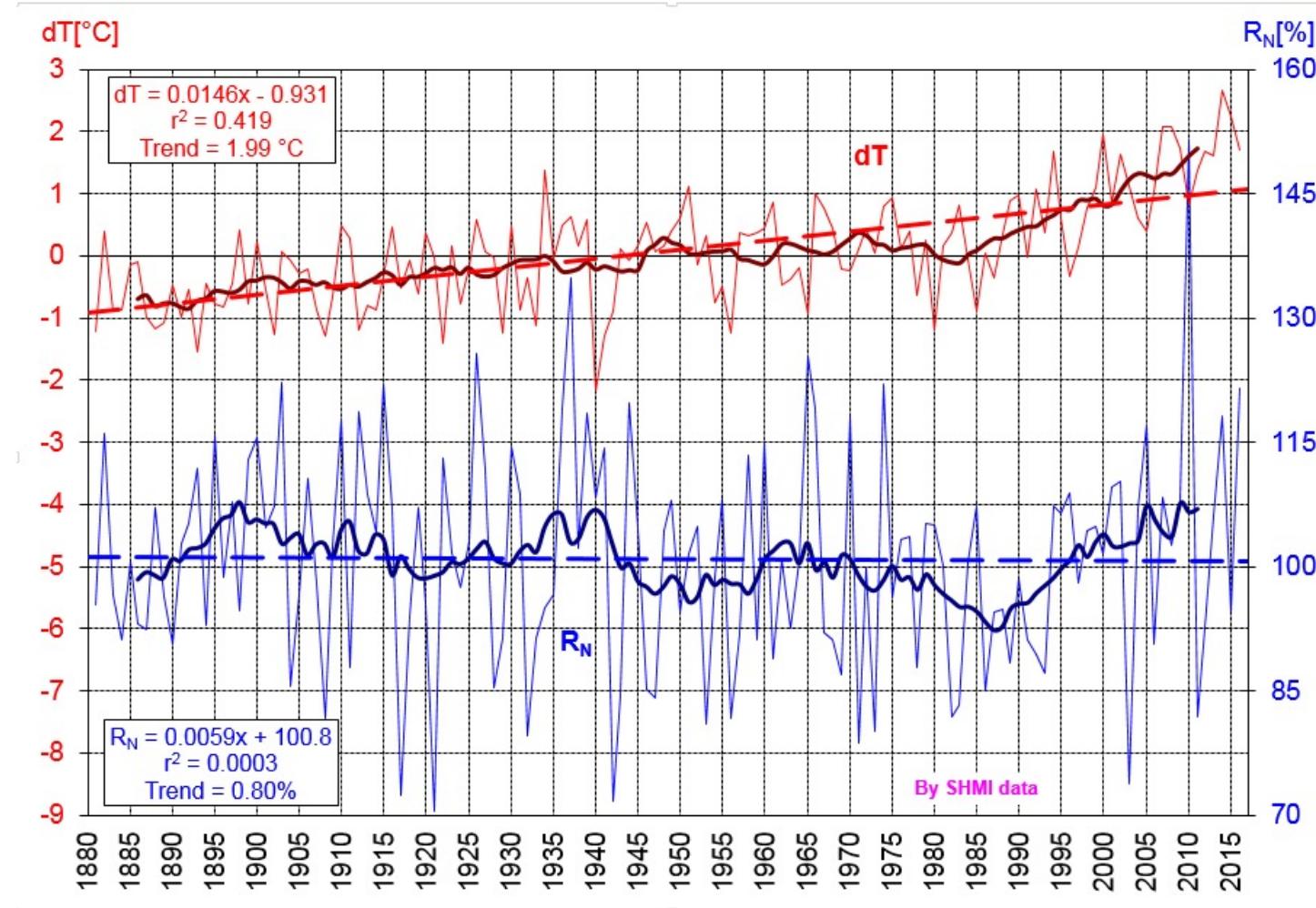
Impact of Climate changes - Europe

- Warming is quite uniform throughout Europe
- Precipitation increases in the north and decreases in the south of the continent - Slovakia is in transition zone between these conflicting trends



Training Workshop, Bratislava, 10 – 11 November 2021

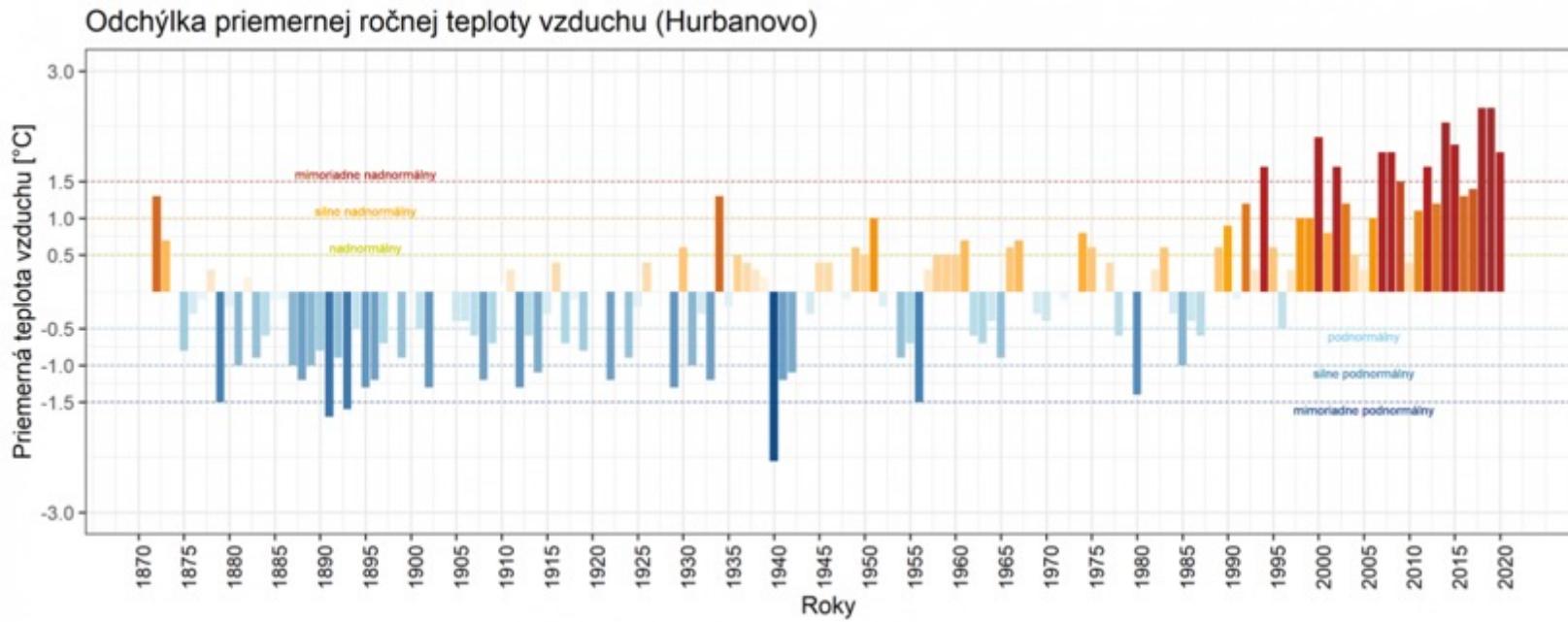
Impact of Climate changes - Slovakia



Trend of mean annual air temperature (dT) and areal mean precipitation (R_N) in Slovakia for the period 1881-2016

Training Workshop, Bratislava, 10 – 11 November 2021

Impact of Climate changes - Slovakia



Variations of mean annual air temperature at Hurbanovo station for the period 1872 -2020.

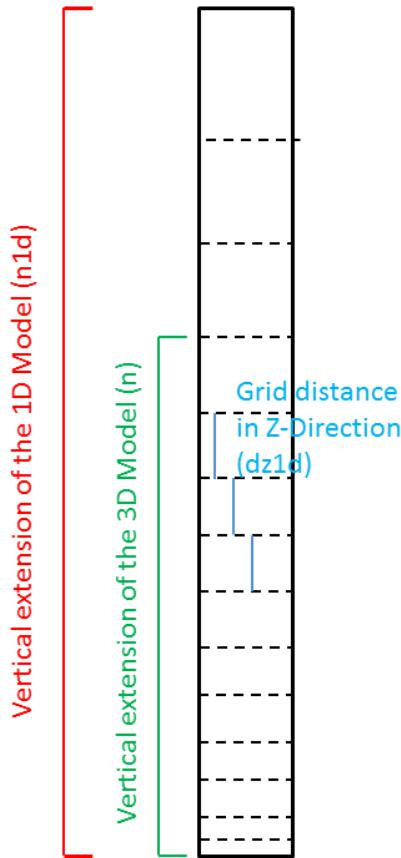
Training Workshop, Bratislava, 10 – 11 November 2021

Impact of Climate changes - Slovakia

Urban heat island research on SHMI

MUKLIMO 3 model

- Developed by German Meteorological Service (DWD)
- Nonhydrostatic microclimatic model
- Simulation of air temperature, relative humidity and wind direction and velocity
- Forecast for 24 hours
- Resolution 100x100 meters grid; vertical resolution 10 to 100 meters (higher resolution near surface)
- Digital elevation model and landcover inputs



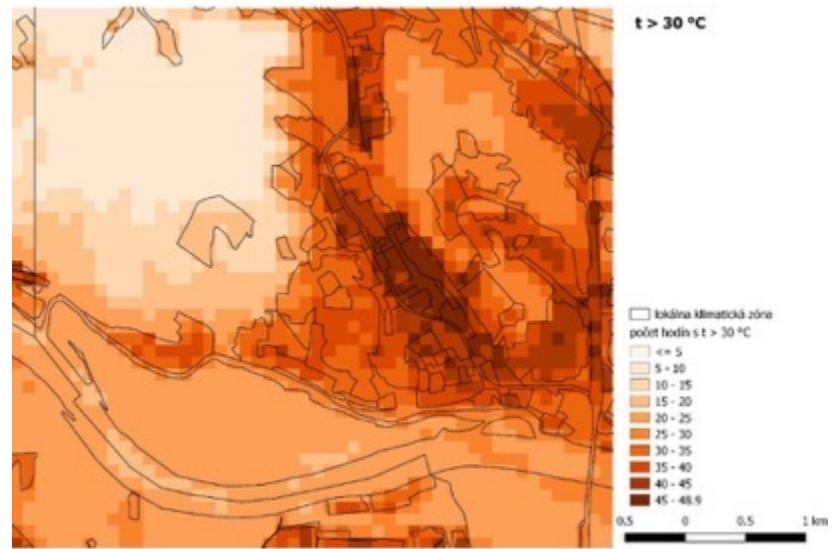
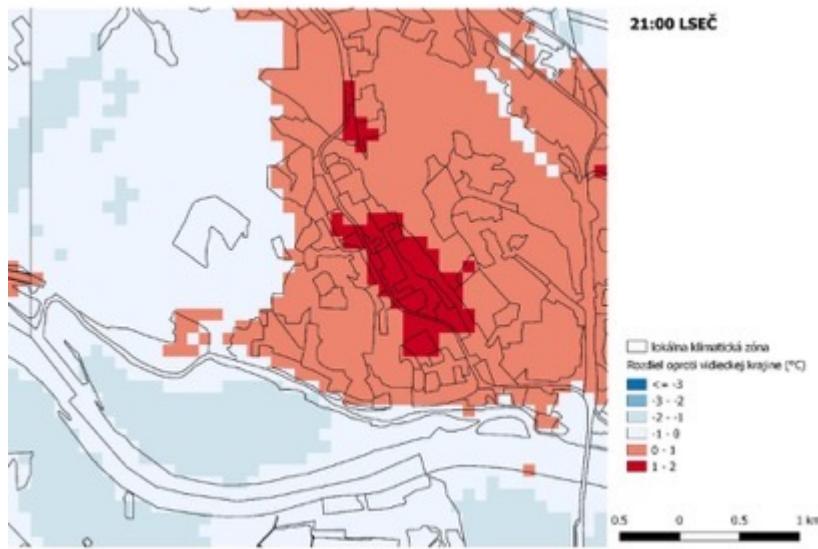
Impact of Climate changes - Slovakia

Urban heat island research on SHMI

Bratislava-Karlova Ves case study

Temperature deviation from
rural area at 9:00 pm

Number of hours with $t > 30^\circ\text{C}$
during heatwave



Training Workshop, Bratislava, 10 – 11 November 2021

Impact of Climate changes – Slovakia

Shift into the Mediterranean climate?

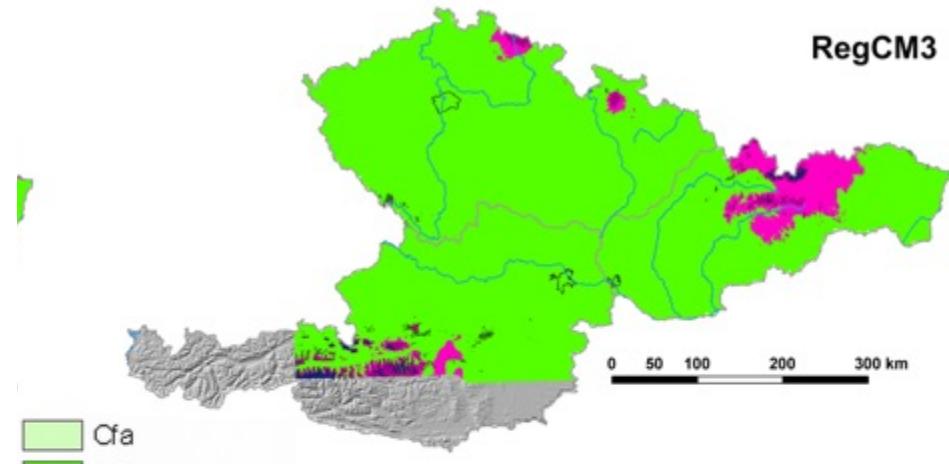
Köppen–Geiger climate classification

Cfa = Humid subtropical climate

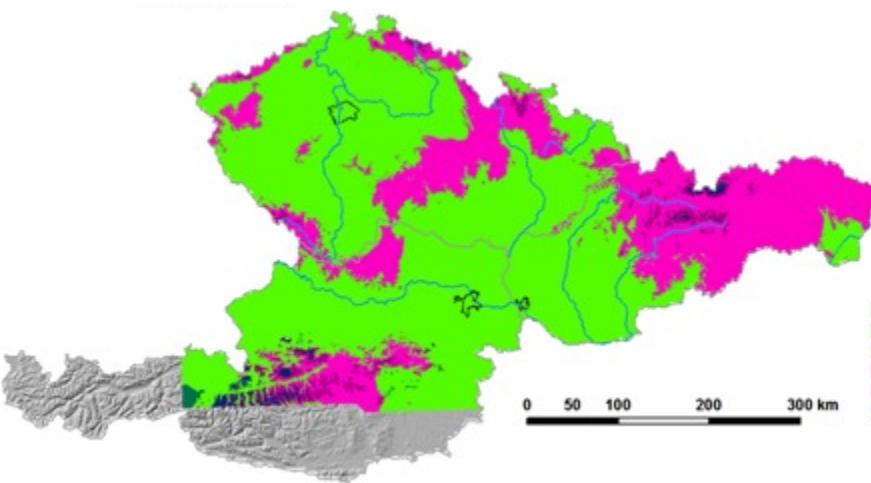
Cfb = Temperate oceanic climate

Dfb = Warm summer humid continental climate

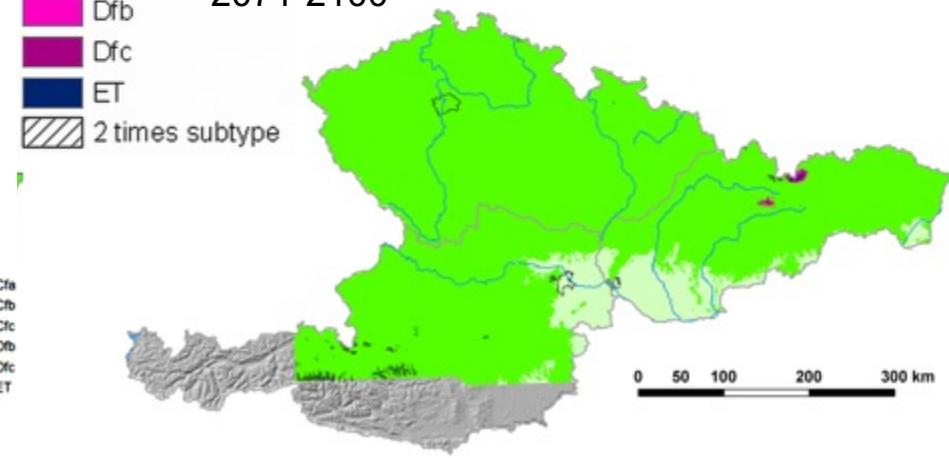
2021-2050



1961-2000



2071-2100



Training Workshop, Bratislava, 10 – 11 November 2021

Projection of climate change until 2100

Temperature

- the equal warming in all areas and altitudes of Slovakia
- annual temperature increase by 3.6°C. (lowest warming in summer).
- the extension of the vegetation period is expected by two months longer.

Precipitation

- future precipitation scenarios are very uncertain (due to Mediterranean, Atlantic and Continental influences)
- the annual precipitation amount is projected to increase by 10%
- more precipitation in the north and mostly in winter
- comparable increase is also projected for the daily maximum precipitation totals.

Snow

- decrease in the number of days with snow cover below 1,000 m a.s.l
- the occurrence of snow in the lowlands will be more sporadic

Projection of climate change until 2100

Storms

- almost no change of number of days with storm compared to the current (15 to 30 days in the summer)
- very strong storms are likely to be up to 50% more
- more frequent occurrence of tornadoes and flash floods

River flows

- increase in winter and spring runoff
- decrease in summer and autumn runoff

Drought

- decrease of snow in the winter and early spring,
- early start of the growing season,
- higher temperatures during the summer,
- insignificant changes in precipitation
- lack of water will be a significant manifestation of climate change in our territory.
- deficit of soil moisture namely in spring, second half of the summer and early autumn

Thank you for your attention

Training Workshop, Bratislava, 10 – 11 November 2021