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Drought in the Czech Republic in 2015

A preliminary summary

October 2015, Prague

DISCLAIMER

All data used in this preliminary report are operational and might be a subject of change during quality control. Therefore, it cannot be used for design or evaluation studies. The verified data will be published in the final report on the 2015 drought which should be published in early 2016.

Drought 2015 in the Czech Republic: A preliminary summary

A significant drought developed in the territory of the Czech Republic in 2015.

A long-term water regime in the Czech Republic is characterized by a significant peak of surface- and groundwater in the spring period (March to April) in response to the snow melting. However, only a limited snow cover developed during the winter of 2014–2015. It developed mainly in mountainous areas. On the other hand, lower and middle elevations remained without snow during the whole winter. The lack of permanent snow cover and its melting negatively affected the recharge of soil and groundwater storage. In addition, the previous winter (2013–2014) has been the one with the least snow water storage since the start of its evaluation in 1970.

A below-normal precipitation total occurred in the majority of months of 2015. A precipitation deficit, defined as a negative balance of accumulated precipitation since the beginning of calendar year with respect to normal values, started to develop in February and significantly deepened in spring and summer months. Since June, the amount of "missing precipitation" has corresponded to approximately 25 % of normal. The maximum absolute value of the precipitation deficit reached 150 mm in the middle of August (the mean annual precipitation for the territory of the Czech Republic is 674 mm).

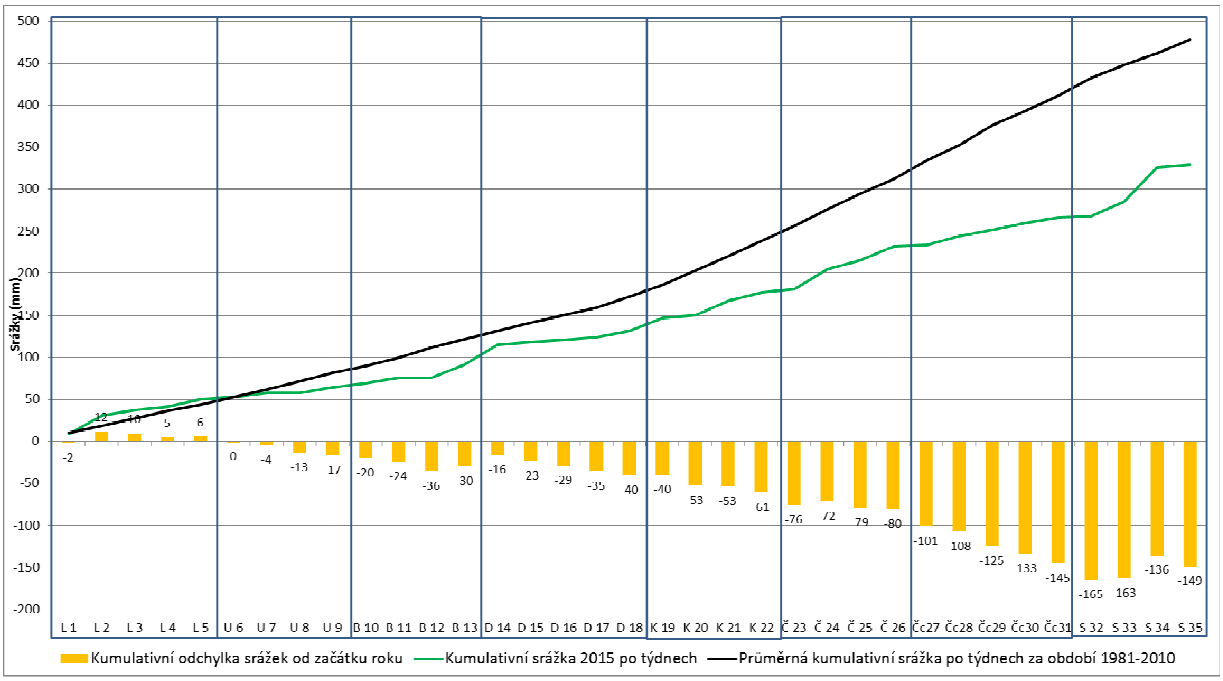

Fig. 1 Accumulated weekly precipitation from January to August 2015 (green line) in comparison to long-term mean (black line) and precipitation deficit (yellow columns).

Pressure lows absence due to the occurrence of a stable high pressure field over Eurasia resulted in below-normal precipitation in winter and spring 2015.

Large pressure highs developed repeatedly also in summer. As a response, the transfer of moist air from the Atlantic Ocean and the Mediterranean Sea decreased. Frontal systems that reached Central Europe were mostly too dry to produce significant precipitation. In addition, the generation of moist convection was limited due to the relatively stable atmospheric condition and dry soil and landscape. Low relative humidity, limited cloud cover and heat waves caused increased evaporation.

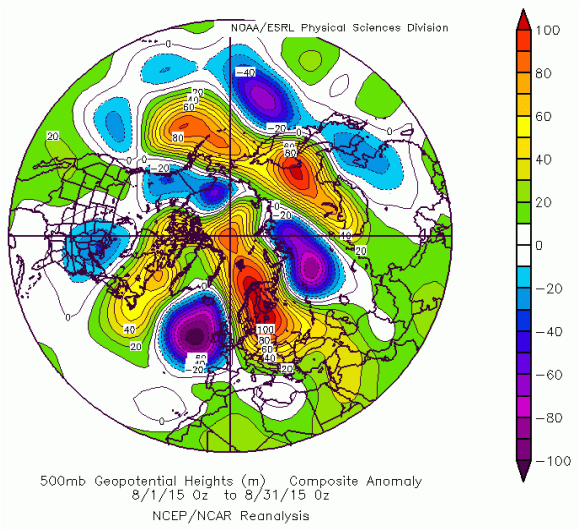

Fig. 2 Geopotential height 500 hPa anomaly for northern hemisphere in August 2015 (source: NOAA/ESRL).

August 16th could be identified as the peak of the summer 2015 drought. Subsequently, a significant precipitation event occurred which enhanced the soil saturation conditions as well as the stream flows. However the precipitation was not sufficient to end the drought completely.

Rainfall total reached 353 mm in the Czech Republic from January 1st to August 31st 2015. This makes it the second lowest rainfall total since 1961 (the lowest precipitation of 335 mm occurred in 2003).

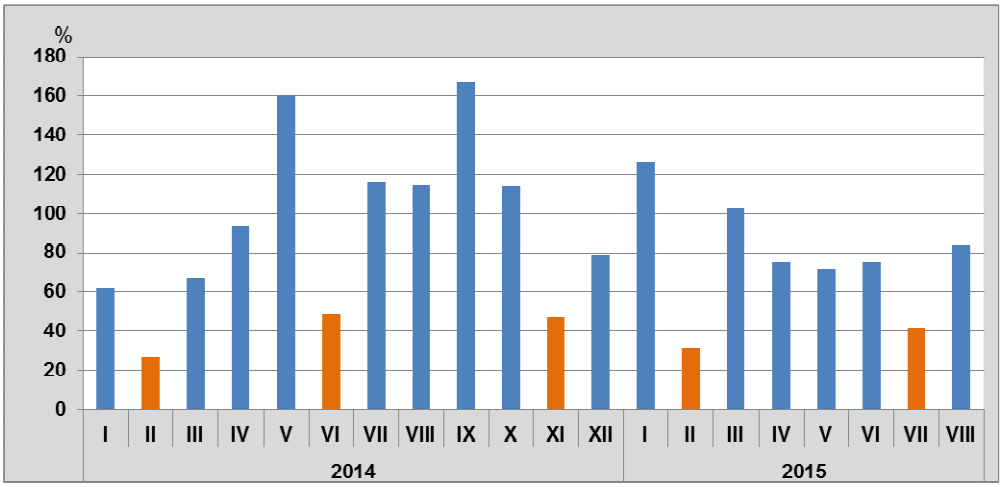

Fig. 3 Monthly precipitation totals in % of long-term mean (1981–2010) in 2014 and 2015.

The potential evapotranspiration balance was negative with values bellow -100 mm for the majority of the area of the Czech Republic with the exception of mountain ranges in the border areas of the Czech Republic. The soil water content exhibited a continuous decrease from March to mid-August when it fell under 10 % of available water holding capacity in large areas of Moravia, East, South, and West Bohemia. It is likely that the wilting point was reached in some localities. The soil water content thus equaled only about 25 % of long-term mean.

A significant precipitation event occurred in mid-August. Some localities recorded more than 100 mm in three days. One-day and two-day precipitation reached up to 50-year return periods at few stations; however, the runoff response was relatively low with evaluated runoff coefficient of only 0.03 to 0.05 %. This illustrates extreme initial conditions and soil water deficit.

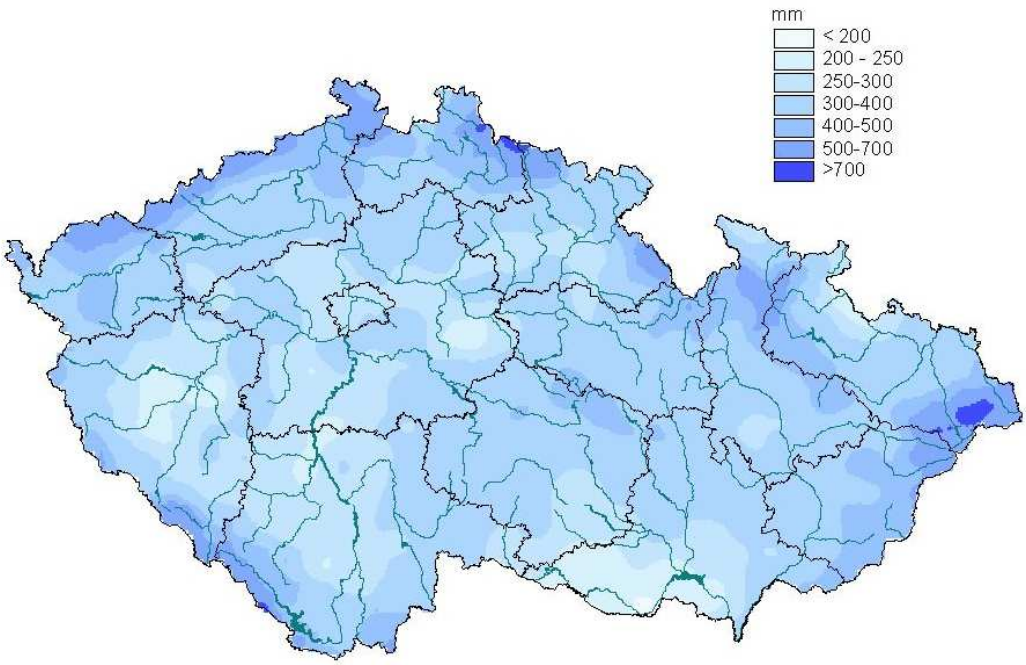

Fig. 4 Precipitation from January to August 2015.

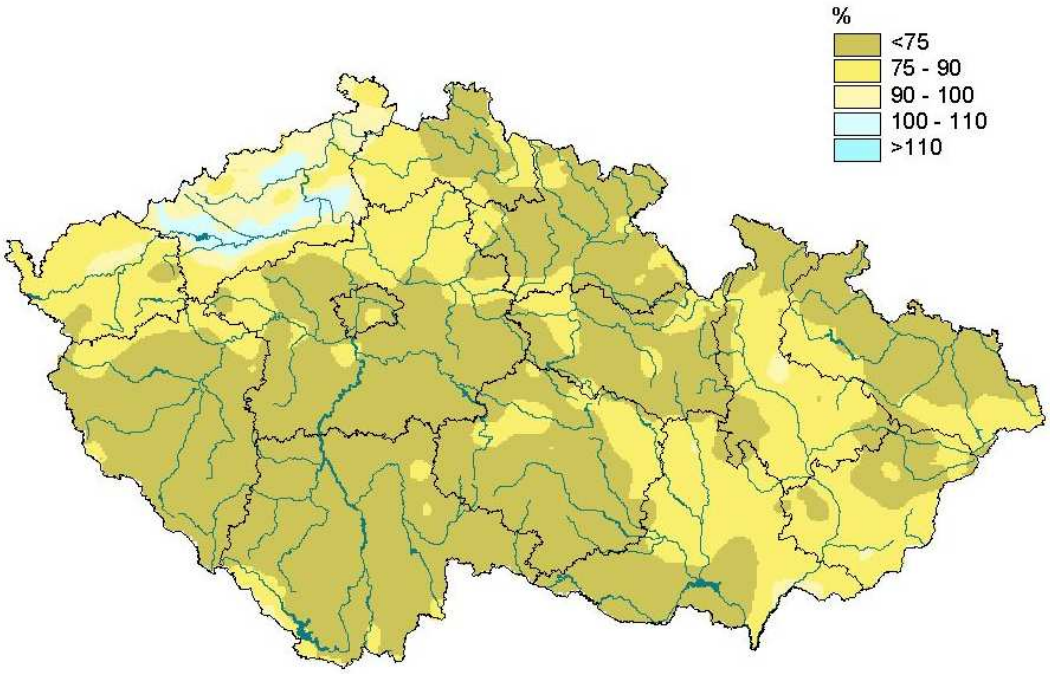

Fig. 5 Precipitation in % of long-term mean (1981–2010) from January to August 2015.

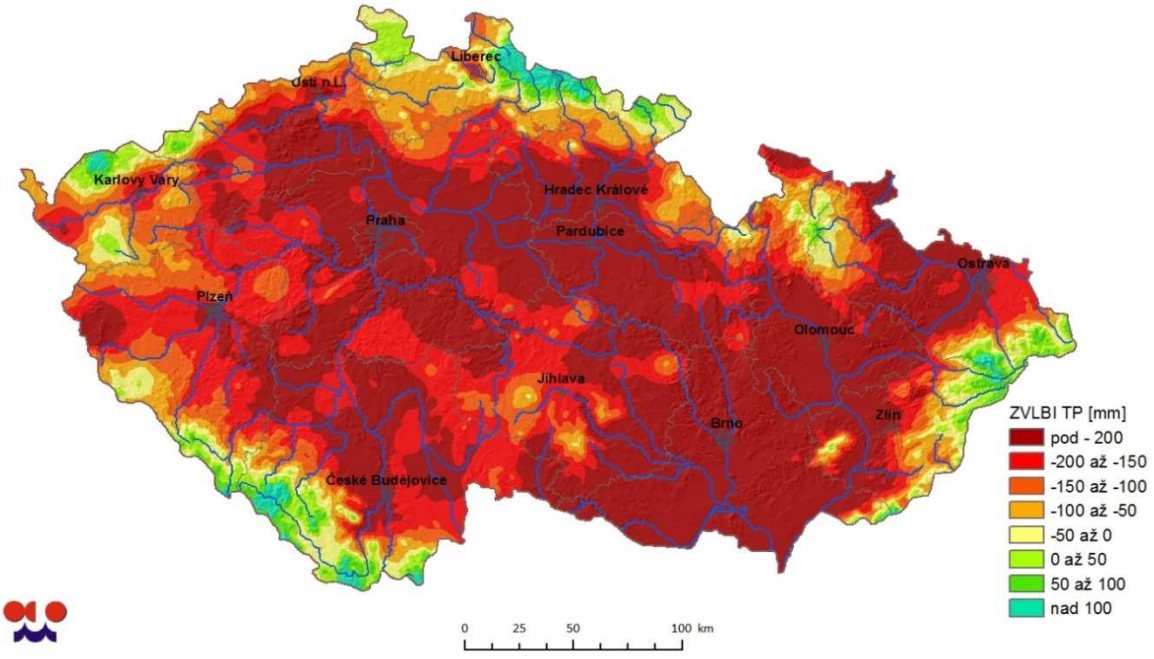

Fig. 6 Evapotranspiration balance (precipitation – evapotranspiration) from March 1st to August 16th.

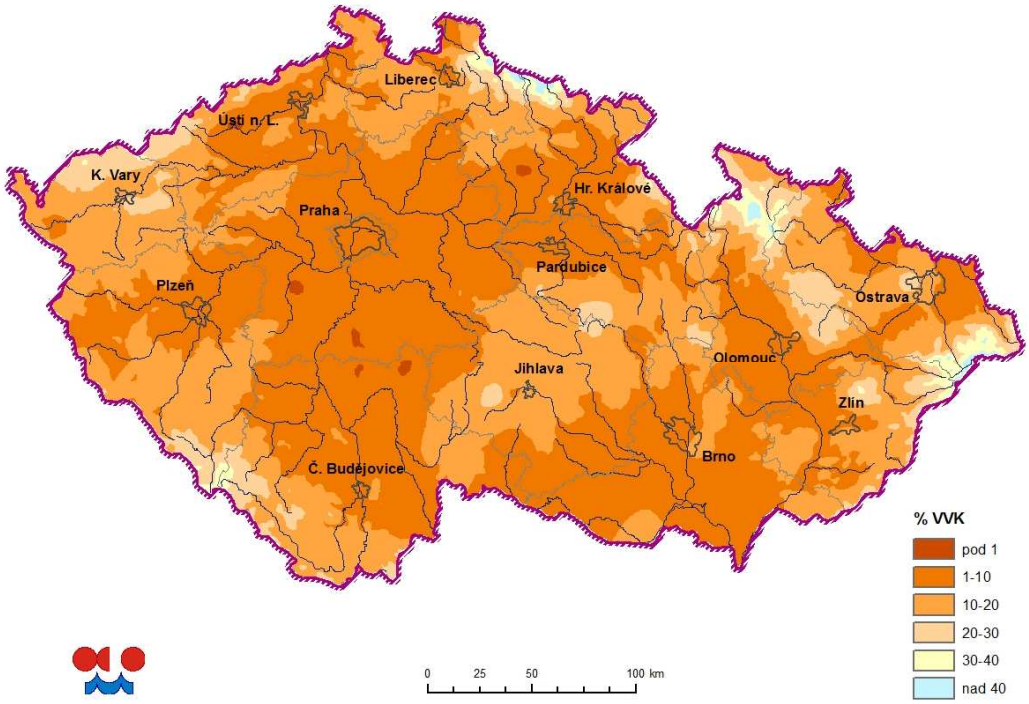

Fig. 7 Modeled soil water content (0–40 cm) in % of available water holding capacity as of August 12th.

Water stress resulted in an increased number of wild fires as well as in an observed shift of phenology phases in the late summer.

Low-flow conditions were recorded at most water-gauges on streams with natural flow regime across the Czech Republic, but especially at low and middle altitudes where the snow cover had not developed in winter. A value of so-called Q_{355} is generally understood as a low-flow threshold in the Czech Republic. Q_{355} represents a flow which is on average equaled or exceeded during 355 days in a year.

Tab. 1 A list of dried-up streams.

Stream	Profile	Catchment area [km^2]	Date	Discharge Q [m^3.s^{-1}]
Rokytenka	Žamberk	59.7	13. 8.	0
Žejbro	Vrbatův Kostelec	49.1	14. 8.	0
Klejnárka	Chedrbí	63.7	11. 8.	0
Brzina	Hrachov	133.3	10. 8.	0
Úterský p.	Trpísty	297.2	14. 8.	0
Lomnický p.	Pila	60.2	13. 8.	0
Vrbovec	Bystrc	15.1	31. 7.	0.0001

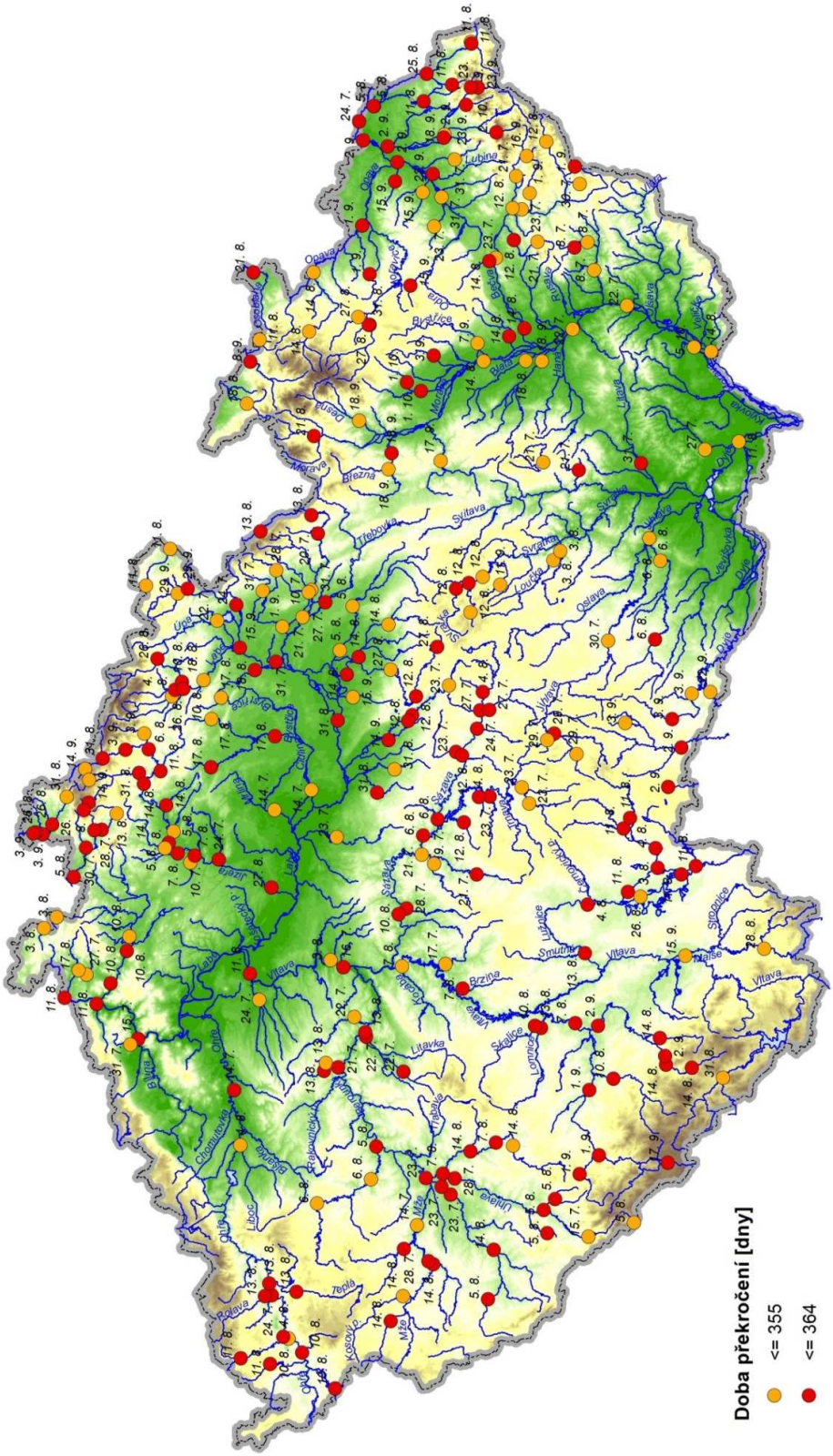

Fig. 8 Overview of water-gauges where discharge measurement recorded low flows (Q_{355} or smaller).

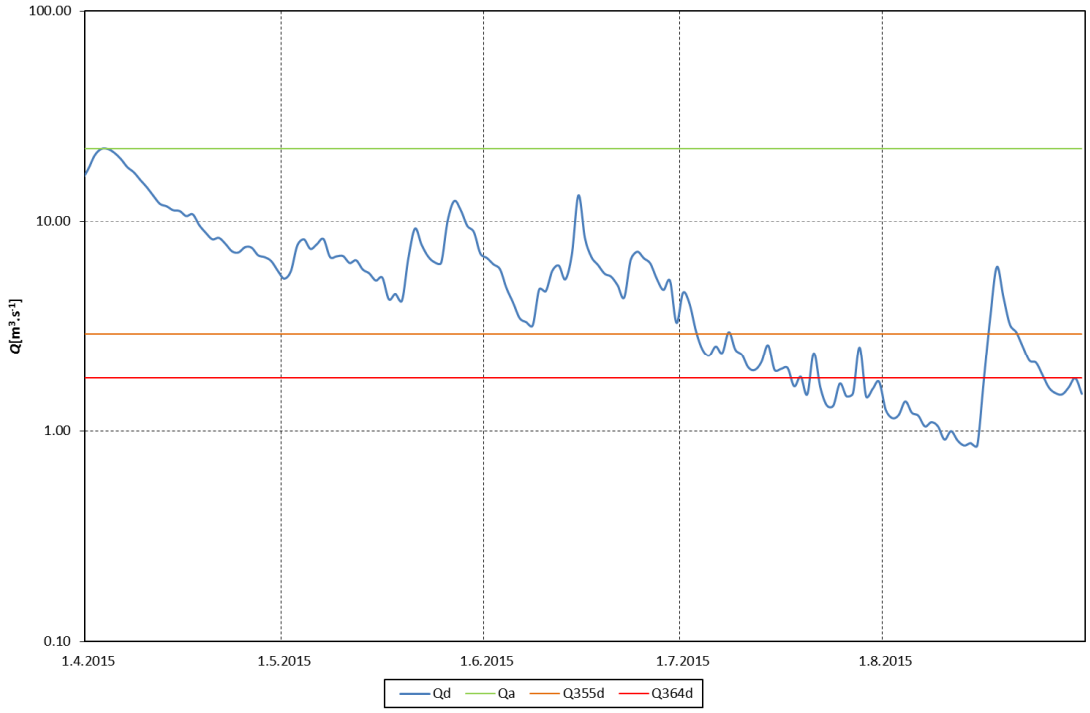

Fig. 9 Daily discharges of the Lužnice River in Bechyně.

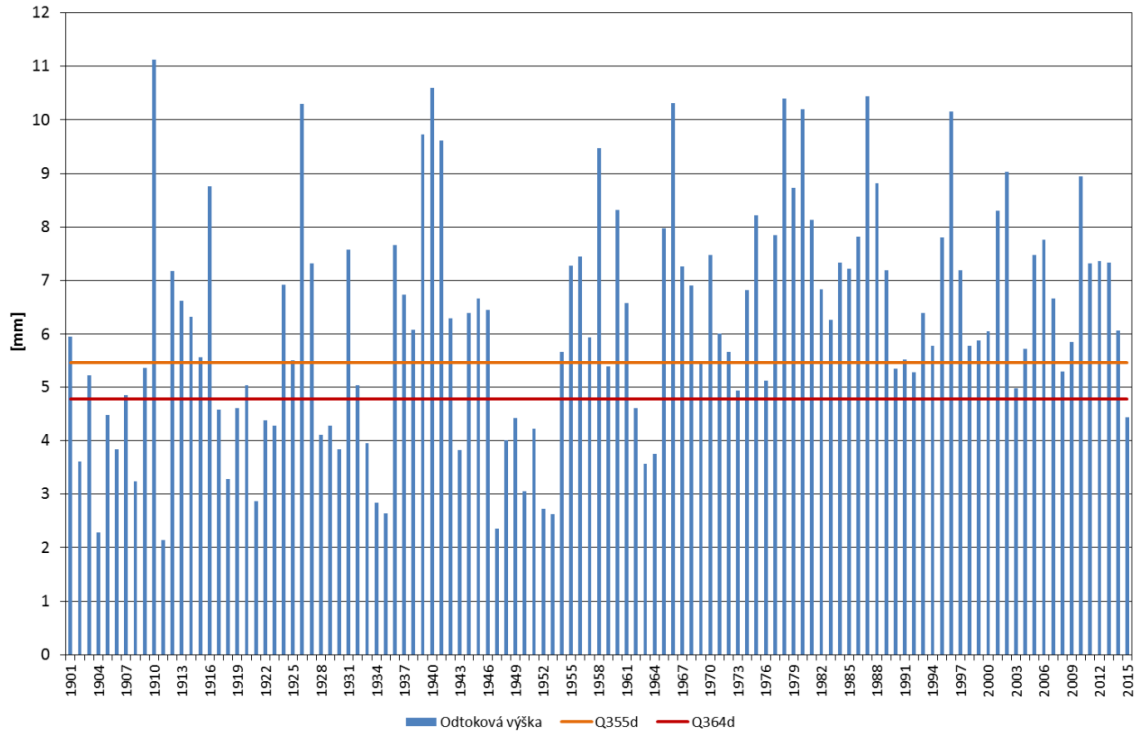

Fig. 10 Annual minimum 30-day runoff depth of the Elbe River in Děčín.

The low flows of 2015 represent absolute minima recorded on many smaller streams and rivers. Some streams dried completely, including some with a relatively large catchment area (e.g. Úterský Stream with an area of 297.2 km^2). The Elbe River in Děčín experienced the lowest daily flow (preliminarily 77 m^3.s^{-1}) since the construction of large reservoirs in the Vltava River basin in the 1960s. The effect of the Vltava River basin reservoirs on the increase in low flows in 2015 will be estimated in a final report, but it can be preliminarily estimated somewhere in a range between 15 and 25 m^3.s^{-1}.

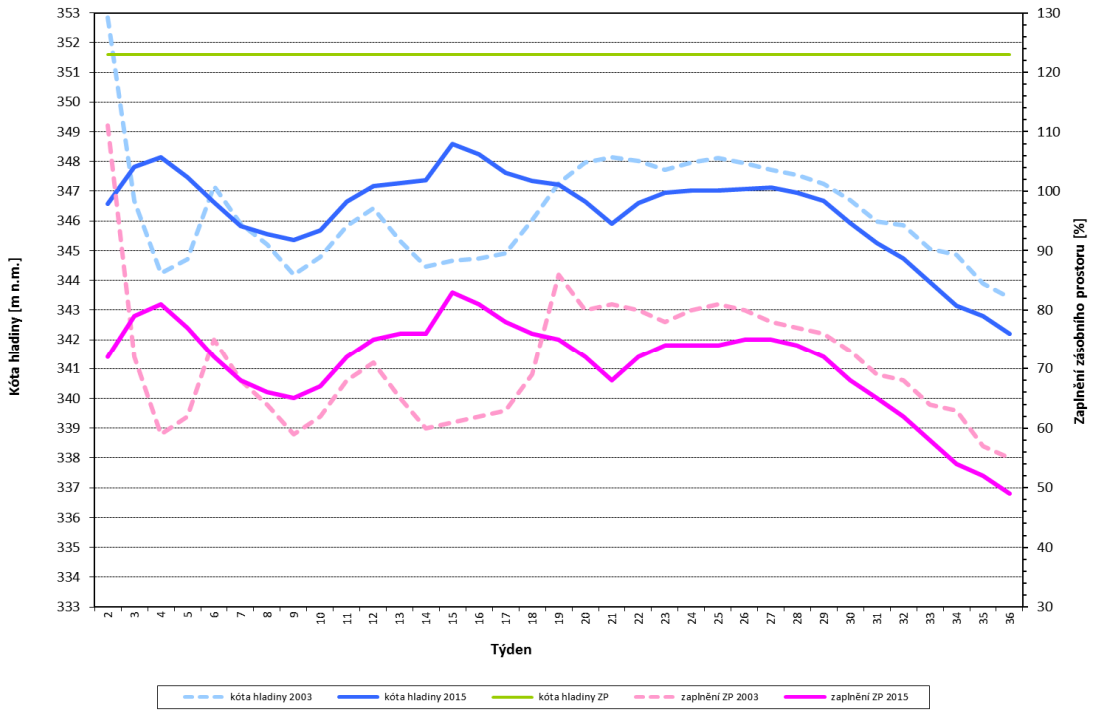

Fig. 11 Course of water level (blue) and relative storage (purple) of the Orlík Reservoir in 2015 (solid lines) in comparison to 2003 (dashed lines).

The operational network of groundwater monitoring is evaluated in a weekly time step. In maximum, 59 % of shallow boreholes reported values that ranked among 15 % of historical lowest values measured in a given calendar month, which is considered to be a drought condition during August 2015. Groundwater drought developed in all the regions of the Czech Republic, but the regions of northeast Bohemia were the most affected.

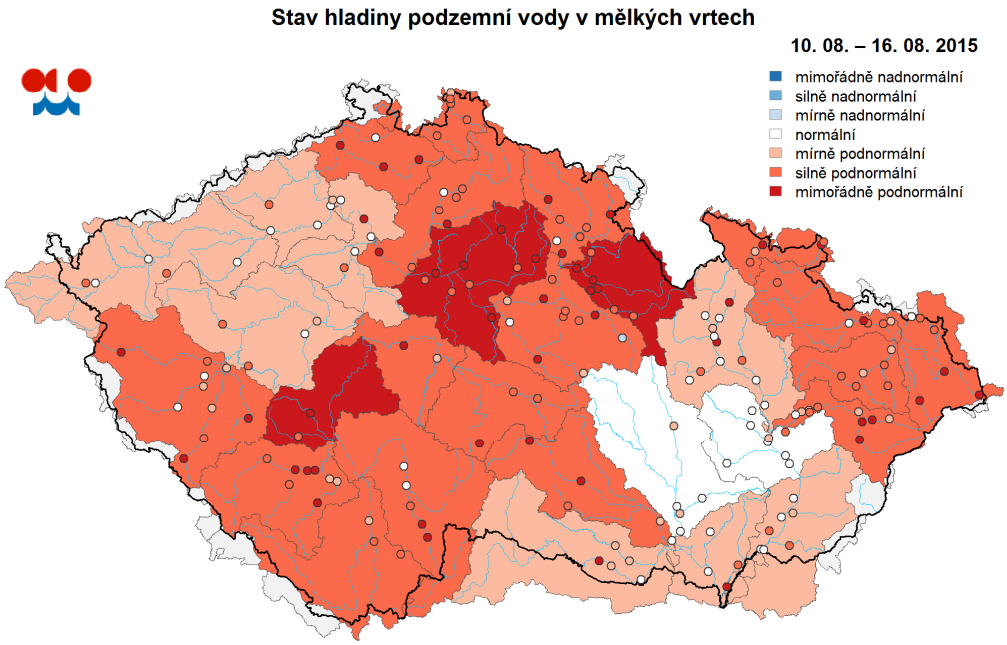

Fig. 12 Evaluation of groundwater level in mid-August, red and orange colors indicate drought conditions.

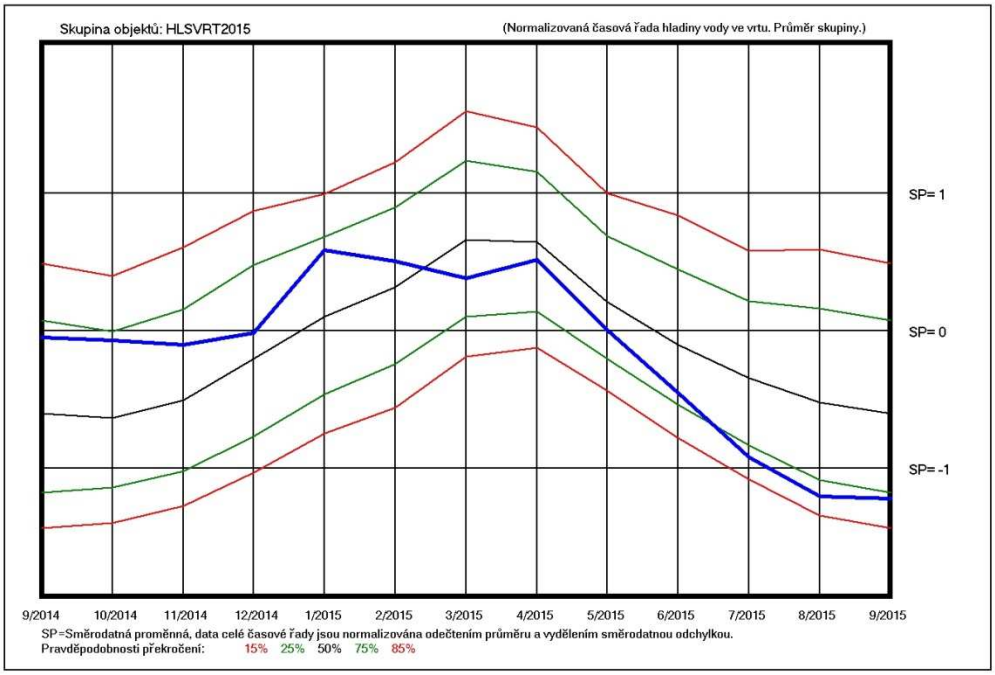

Fig. 13 Course of normalized groundwater level in shallow boreholes compared to long-term values.

A preliminary comparison to historical drought events proves similarities in precipitation between 2015 and 2003 (precipitation total was slightly higher in 2015 than in 2003). Also, the course of evapotranspiration balance and soil water content was very similar in both years.

In the case of surface water, the drought development was negatively affected by the snow-scarce winter of 2014–2015 and the high evaporation during spring and summer. As a result, the minimum discharges of the majority of observed rivers in August 2015 decreased more than in 2003. The low-flow situation is therefore probably more comparable to 1947 or 1904.

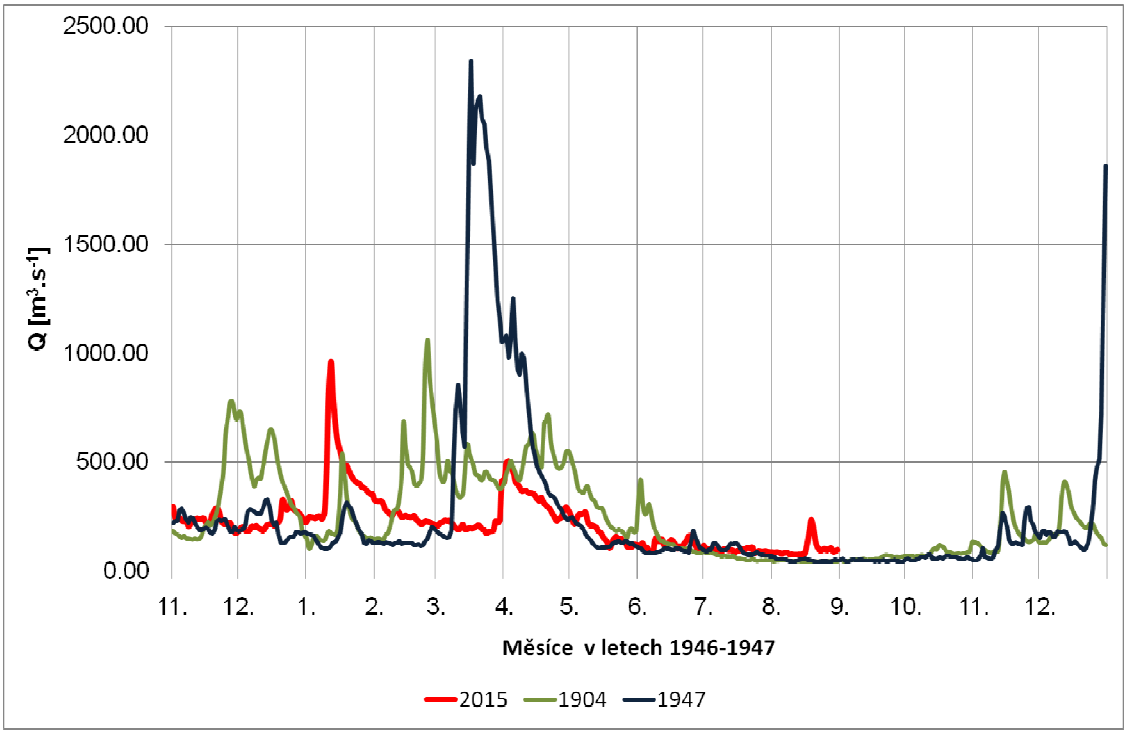

Fig. 14 Comparison of discharge of the Elbe River in Děčín in 2015, 1904 and 1947.