

Drought periods in 2014

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Abstract

The first half of year 2014 was characterized by the occurrence of extreme weather. Episode without precipitation were alternated with thunderstorms, temperature were mostly above normal and was occurred first heat wave. The year began with a very mild winter, when amount of snow was only 27 % of long term average and in agricultural region South Moravia only about 10 %. The winter temperature was more than 2°C higher than normal. March and April were characterized by low sum of precipitation mainly again in South Moravia, both months were about 70% of long term average. March and April temperature were significantly above normal (March about more than about 4°C and April more than 2°C). In contrast May was cold and rainy. In the middle of the month there were persistent rainfall, which caused an increase of river levels and flooding several areas. June was again very dry. These weather conditions led to the strong dry episodes during first half of the year.

Key words: Drought, Czech Republic, year 2014, precipitation, temperature

Introduction

Drought is an essential part of climatic conditions and significantly influences many human activities. Drought in the Czech Republic occurs irregularly in a form of drought periods lasting from several days up to months, characterized by below-average precipitation. These drought periods are usually also

accompanied by above-average temperatures. Although there is no unanimous definition of a drought, most authors divide it into four types – meteorological, agricultural, hydrological and socioeconomical drought (Heim 2002). Despite the fact that these are different types of drought, they come in a particular time order or they can appear later simultaneously. Meteorological drought could be defined as a period with negative deviation of precipitation from the normal value, subsequently causing agricultural, hydrological and socioeconomical drought (Brázdil et al 2007).

The weather conditions in 2014 began with a very mild winter with abnormally little snow cover and overall higher air temperatures. This trend continued with a very warm March and April and also the rainfall amount was very small and longer periods with no precipitation occurred. In contrast, the following month, May, was rather cold and after a period of heavier precipitation, higher water levels were observed at many rivers causing flooding. The next month was again dry. A lot of precipitation events in May were associated with thunderstorms, so they had a substantial spatial variability. Tropical days and first heat waves of the year 2014 were observed relatively early.

Materials and methods

Weather conditions in 2014 were first analyzed especially from the perspective of standard meteorological parameters such as air temperature (T), precipitation (SRA), amount of new snow (SNO) and snow cover depth (SCE). The data for 2014 come from the CHMI database. As a reference period, the so-called technical series were used – in case of air temperature from climatological stations (268), for precipitation from rain gauging stations (787). These series underwent quality control, homogenization and all the missing values from 1961-2013 were added (Štěpánek et al., 2011a, 2011b, 2013). No technical series exist for the snow parameters, so as a reference, stations measuring in the period from 1961 to 2000 were used. The rain-gauging station network is quite extensive so the number of such stations is sufficient. The meteorological data were visualized on a map using orographic interpolation with a resolution of 500 m.

A more detailed analysis of air temperature and precipitation during the first half of 2014 was performed for four selected stations (Kroměříž, Kuchařovice, Hradec Králové and Doksany). In case of temperature, daily deviations from a long-term average value from 1961-2000 were used and the total sum of precipitation since the beginning of the year was also compared with the long-term average.

The outputs from drought monitoring (www.intersucho.cz) operated within the Intersucho project were used for illustration of the progression of agricultural drought in the Czech Republic in the first half of 2014.

Because of the close relationship between an agricultural drought and soil water content, information regarding the daily, root-zone soil moisture content (up to 1.3 m or to the maximum rooting depth) is used to estimate the intensity of agricultural drought. The soil moisture content in two soil layers was calculated for all growing seasons between 1961 and 2012 in a 500 m grid using the SoilClim model (Hlavinka et al., 2011). This model is based on the Penman-Monteith method to estimate reference evapotranspiration and also takes into account other factors affecting soil moisture such as the soil water holding capacity, phenology development, root growth or snow cover accumulation/melting (Trnka et al., 2010, 2014). The SoilClim model also accounts for the interception by vegetation as well as for the soil water percolation to the deeper soil layer and its performance was evaluated by an array of observed data from Hlavinka et al. (2011).

Results

The year 2014 began with a very mild winter characterized by above-average temperatures and below-average precipitation. The western part of the republic was colder, with temperatures 2 to 3 °C above the long-term average from 1961-2000. Moravia and northern part of Bohemia was more than 3 °C above average and the eastern end of the republic even 3.5 °C above the long-term average from 1961-2000. The spatial distribution of precipitation was opposite. In western and southern Bohemia the precipitation amount was 50 % of the long-term average, in some places even less than 30 % (Fig. 1a). Moravia was

also below-average in terms of precipitation, but not so significantly. Here, the precipitation amount was usually between 50 to 70 % of the long-term average. Little precipitation and high air temperatures of course also had an effect on the amount of snow. The average spatial amount of new snow for the entire Czech Republic was just 27 % in comparison to the long-term average from 1961-2000 (Fig. 1b). The least amount of new snow was observed in southern Moravia (around 12 %). In western Bohemia the percentage was higher, but usually not more than 50 %. For example, in southern Moravia, the maximum depth of snow cover did not exceed 3 cm. The spatial average for the Czech Republic was 8.6 cm, which is 30 % of the long-term average.

March 2014 was again quite warm in the region of the Czech Republic. The average air temperature for the Czech Republic was 3.7 °C higher than the long-term average. The regions with highest deviation included eastern Bohemia and central Moravia (more than 4 °C), the least difference was observed in western and southern Bohemia (around 2.5 °C). The spatial distribution of precipitation in March 2014 was very variable. In southern Bohemia, the observed precipitation was just 37 % of the long-term average, in the region of Pohořelicko, Znojensko, Břeclavsko and Hodonínsko even below 30 %. On the other hand, precipitation in central and eastern Bohemia corresponded to or was slightly above the long-term average.

In April 2014 the high temperatures continued. This time, the deviation from the long-term average was smaller in Moravia, especially in its southern and eastern part (1.5 to 2.5 °C). In contrast, the largest difference was measured in western and northern Bohemia (more than 3.2 °C). The average deviation for the Czech Republic as a whole was 2.6 °C. The precipitation showed a very big spatial variability due to rather changeable weather. In the southern part of the republic (Znojensko, Jindřichohradecko, Domažlicko, Třebíčsko) there were places with less than 50 %, while in Vsetínsko, Rokycansko and other local places, the precipitation amount was more than 130 % of the long-term average.

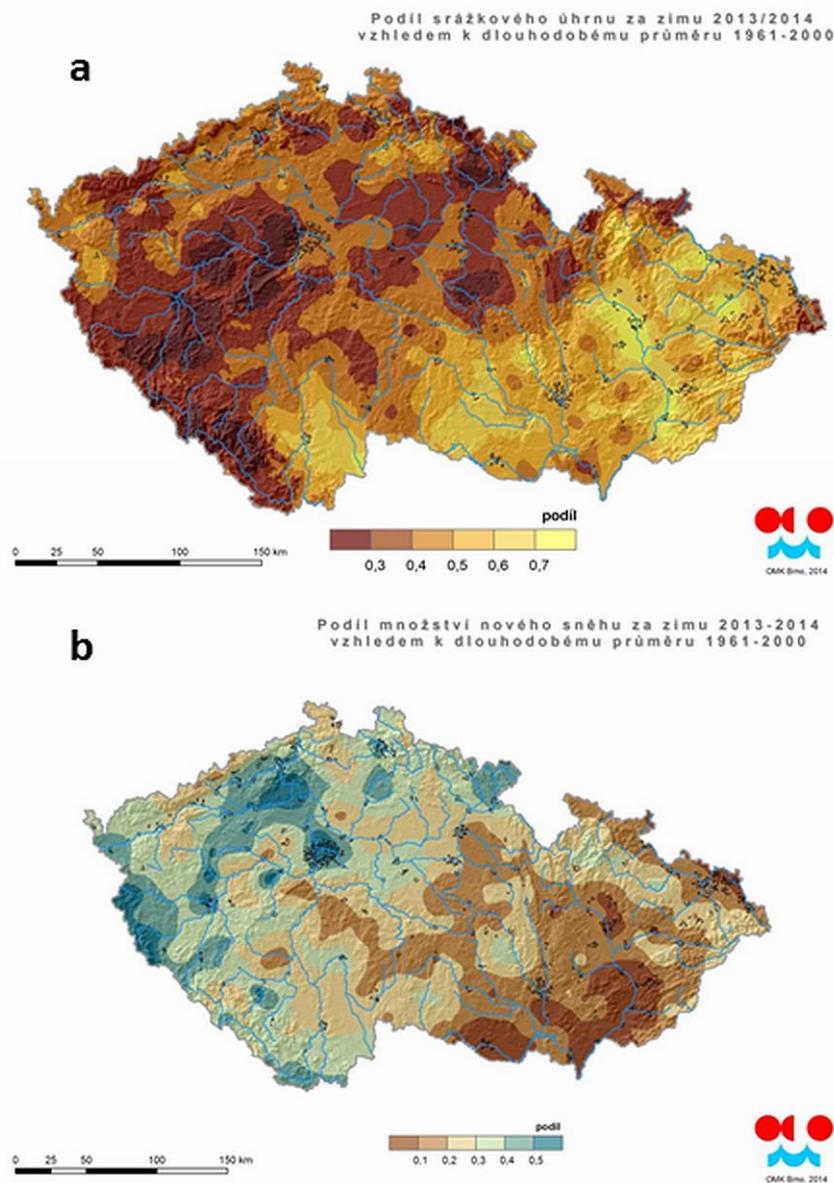


Figure. 1. The ratio of precipitation (a) and amount of new snow during the winter 2013/2014 with respect to the long-term average

The following month, May, was in fact the exact opposite of the previous spring months. In terms of temperatures it was normal for most parts of the republic, with average deviation from the long-term average for the whole Czech Republic of $-0.2\text{ }^{\circ}\text{C}$. Bohemia was slightly colder, with deviations smaller than $-0.4\text{ }^{\circ}\text{C}$. The amount of rainfall in May 2014 was relatively high, especially in the western part of the republic. On average, there was 57 % higher precipitation

than the long-term average, but for example in Jeseníky, central Bohemia or western Bohemia, the amount of precipitation was even more than double the average. On the other hand in Moravia there were locations, where the precipitation amount corresponded to the average, or was even slightly below it. With exception of 21st and 22nd, precipitation was observed in the Czech Republic on each day of May and quite common were intense thunderstorms. The situation culminated at the end of the month from 27th to 29th May, when flash floods rose rivers leading to locally even third flood degree. Highest precipitation (Fig. 2) for this period was observed in the region of Jeseníky (maximal daily precipitation of 86 mm), Mladoboleslavsko (64 mm), Klatovsko (40 mm) and Novohradsko (31 mm). The most significant change in discharge was in the affected basins, i.e. in Černý potok basin in Jesenicko in Velká Kraš (location of monitoring), where the third flood degree was exceeded for a short period of time. The third flood degree on 28th May was also reached in Klabava in Hrádek and Nová Huť and for the Úslava River in Koterov, for a period of 17 hours (28th May 2014 from 3 AM to 8 PM). The maximum flow rate was 39.4 m³/s and water level 183 cm. State of emergency in Nová Huť lasted for 21 hours (28th May 2014 from 10 AM to 5 AM on 29th May 2014), with maximum flow rate of 101 m³/s and water level 236 cm. In Červený potok basin in Jesenicko, third flood degree was shortly reached in Velký Kraš profile (Internet Source 1).

Overall the spring could be characterized as above-average in terms of temperature, with average deviation for the entire Czech Republic being 2.1 °C. The highest deviation was observed in central and eastern Bohemia, i.e. in the so-called Polabské lowlands (Fig. 3a). Surprisingly the smallest difference compared to the long-term average was in Břeclavsko and Hodonínsko (+ 1.7 °C). Due to heavy rains in May, this month the territory of the Czech Republic as a whole was on average normal or above-average (116 %). This number, however, does not reflect the spatial differences. The highest precipitation was measured in an area stretching from southern to northern Bohemia and Jeseníky. On the contrary, in terms of precipitation average or below-average

was most of Moravia (Fig. 3b). The precipitation in the agricultural county Břeclavsko was 83 % of the long-term average.

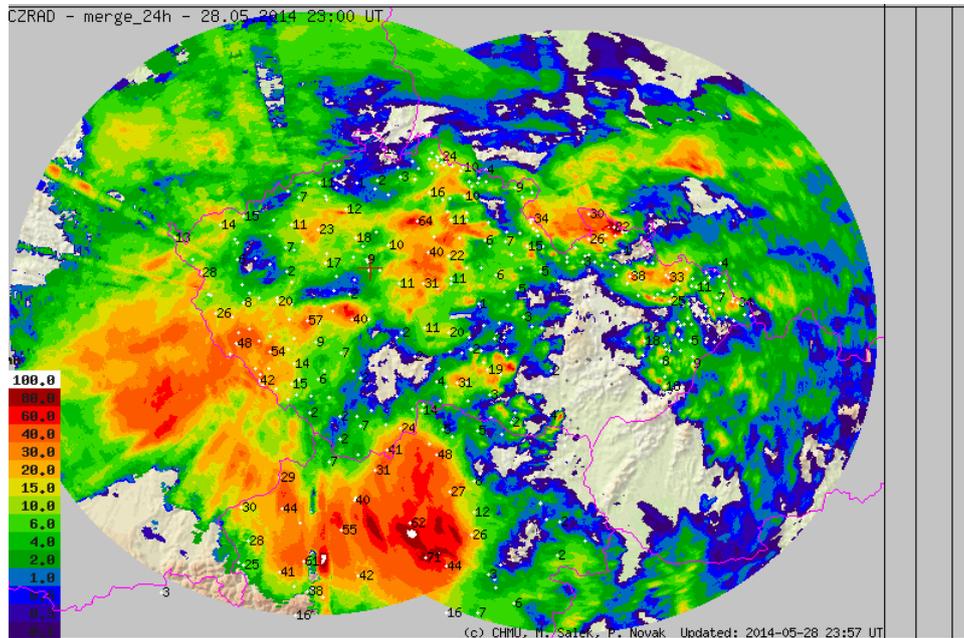


Figure 2. Radar 24h precipitation estimate for 28th May 2014 (www.chmu.cz)

June 2014 was again above-average in terms of temperature and below-average in terms of precipitation. The average air temperature deviation was 0.7 °C. The southern part of the republic was warmer, especially the regions of southern Moravia and southern Bohemia (+ 1.1 °C). On the contrary, average or below-average air-temperature was observed in northern Moravia. Less precipitation was in the western part of the republic. The amount of precipitation in comparison to the long-term average was smallest in southern and central Bohemia (35 %), the average for the whole Czech Republic was 44 %. Smaller deviation from the average was in northern Moravia (60 to 75 % of the long-term average).

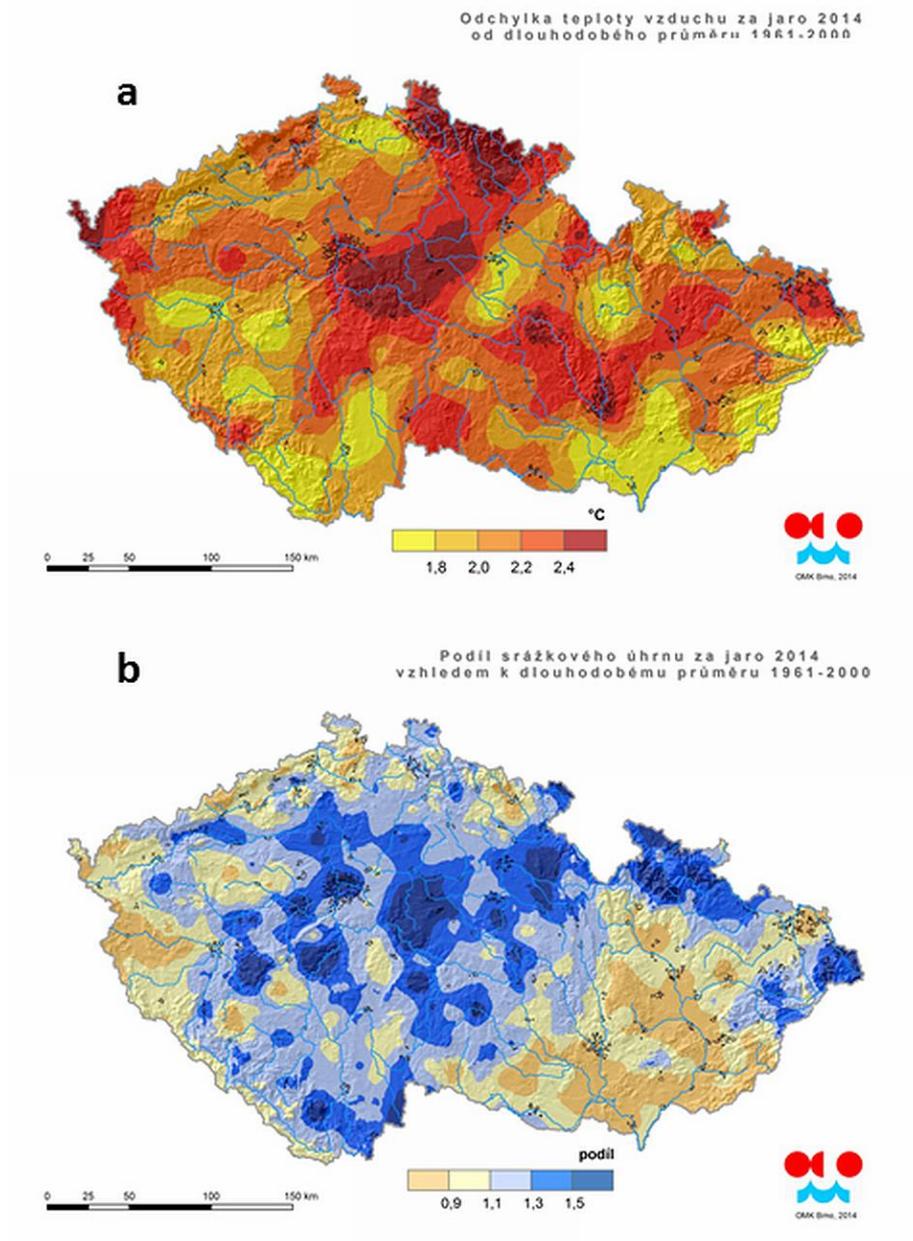


Fig. 3. Deviations in air temperature (a) and precipitation (b) for the spring 2014 from the long-term average of 1961-2000

For the four selected stations, which represent agriculturally important regions, were calculated cumulative values of precipitation for the first half-year of 2014 and these were subsequently compared to the long-term average for 1961-2000 (Fig. 4). The same comparison was also performed for air temperature. As can

be seen on figure 4, the difference in total precipitation from the long-term average keeps getting bigger since the beginning of the year. A change occurs in the middle of May 2014, when due to heavy and frequent thunderstorms there is a rapid shift close to the average. In June, the deficit again becomes larger. In case of the station in Kroměříž, a sudden shift can be seen at the end of June, caused by a local thunderstorm. Such a large deficit and deviation from the average is not observed at stations in Bohemia and the initial precipitation deficit started decreasing earlier. As of the last day in June, the precipitation was smaller compared to the long-term average by 27 % in Kroměříž, 25 % in Kuchařovice, 11 % in Hradec Králové and only 4 % in Doksany. For all the four selected stations one can see a large number of days with above-average temperature. The percentage of such days ranged from 70 % (Doksany) to 75 % (Kroměříž). The first half of 2014 was 2.2 to 2.3 °C warmer in Kroměříž, Hradec Králové and Kuchařovice, a slightly smaller difference (+1.8 °C) was measured in Doksany.

Discussion

The above described weather conditions during the first half of 2014 of course also reflected in the intensity of drought and its spatial distribution. The drought intensities came in various waves depending on the current precipitation at that particular area. As can be seen from figure 5, at the beginning of March drought was observed especially in southern and southwestern Bohemia, which exactly corresponds to the precipitation during the winter of 2013-2014 (fig 1a), when the precipitation percentage was even less than 30 % of the long-term average. By the end of April, more intense drought began to appear in the western part of southern Moravia, where very low precipitation was observed in both March and April. Due to very wet May, however, the risk of soil drought was practically almost completely eliminated and the drought in fact did not occur. However, just 20 dry and warm days in June led to the return of drought situation, this time much more intense compared to the entire preceding period. In particular the region of southern and central Moravia was affected by the highest degree of drought (category S5 – extreme drought). This shows that if there is a longer

period of drought, one wetter month can significantly reduce the risk of drought, but subsequent, even just a short, period without precipitation can very quickly and very intensively lead to drought again.

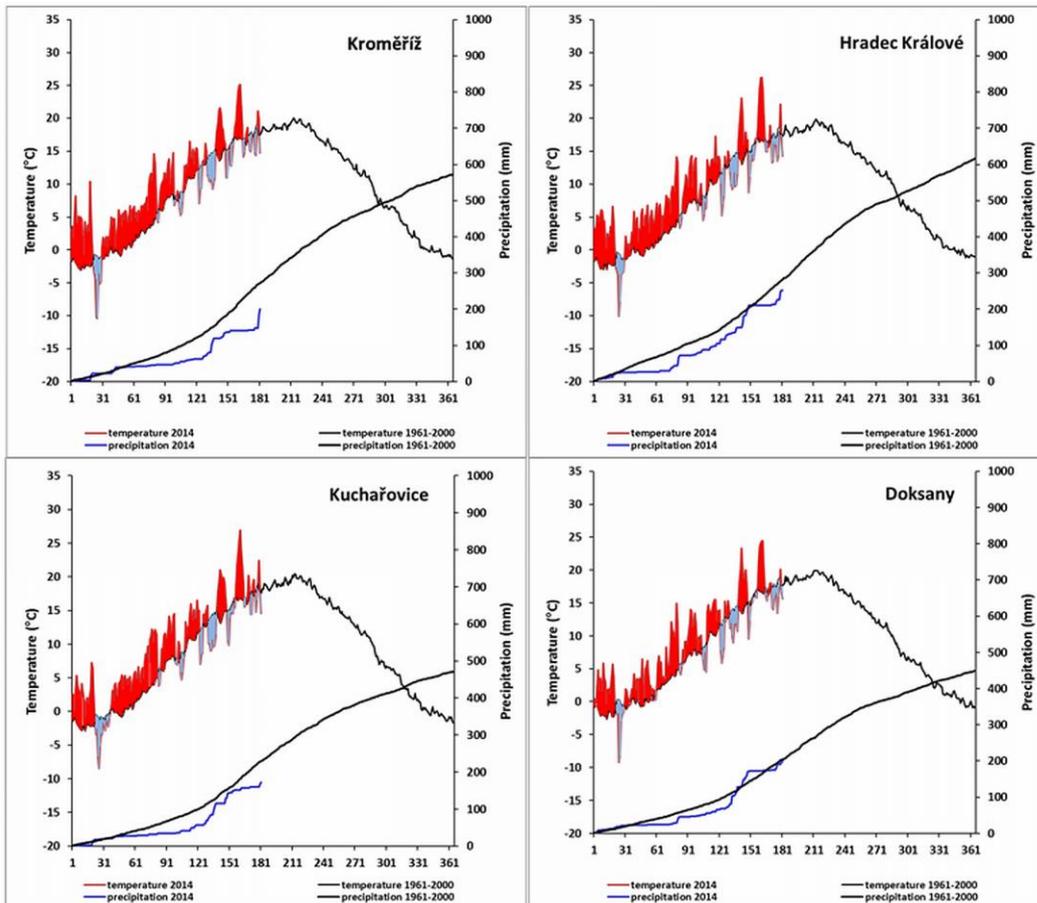


Figure 4. Variations in the daily mean temperatures and precipitation totals for Kroměříž, Hradec Králové, Kuchařovice and Doksany stations from January 2014 to June 2014; blue line – measured cumulative precipitation, black thick line – cumulative precipitation for 1961–2000, red and blue shaded area – measured daily mean temperatures and black thin line – daily mean temperatures for 1961–2000

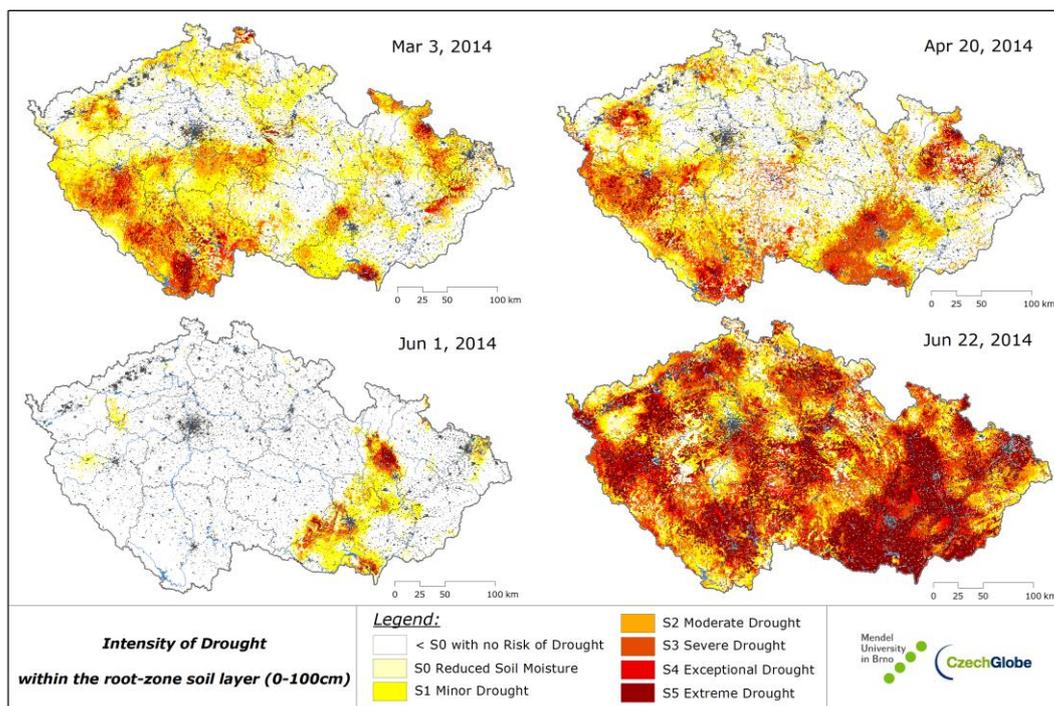


Figure 5. Drought intensity within the rooting zone (0–100 cm) expressed using a six-point scale for selected days from March 2014 to June 2014 for the Czech Republic: S0 – soil moisture level between the 20th and 30th percentile for the given period, S1 – 10th to 20th percentile, S2 – 5th to 10th percentile, S3 – 2nd to 5th percentile, S4 – 1st to 2nd percentile and S5 – less than or equal to the first percentile and for relative soil saturations less than 50% of the maximum water holding capacity for more than one month

There were several drought periods in the last 15 years. Significant were the years 2000, 2003, 2007 and the last episode occurred in 2012. This last one began already in autumn 2011 and lasted for 10 months until the end of May 2012, when the situation got better thanks to rainy summer of 2012. The drought in 2012 was important in terms of its variable spatial distribution – no drought was observed in Bohemia, but in Moravia it was very intense. The drought period began already in autumn 2011, for example in November there was no precipitation at all, or just minimal. The winter was, just like this year, mild, precipitation was, in particular in Moravia, below-average, in Bohemia thanks to wetter January, the precipitation was normal. Spring 2012 was again

very warm and with very little precipitation during all months. The precipitation deficit in spring 2012 was significant over the entire region of the Czech Republic, especially in Moravia. This was reflected in poor grain yields, one of the worst in the last decade, and also in an increased number of wildfires. Despite the fact that the course of weather was different this year, it will be interesting to compare the effects with the year 2012. An interesting point is that drought this year is observed more intensively in Moravia than in Bohemia, though this difference is so far not so pronounced as in 2012.

Conclusion

The article summarizes weather conditions during the first half of 2014, which was characterized by high variability leading to episodes of drought. The year began with a very mild winter with above-average temperatures and significantly below-average amount of rainfall and snow. At many locations, snow was a rather an exception. The spring therefore began with a precipitation deficit, which further increased due to very warm and in terms of precipitation below-average March and April. From April the amount of precipitation increased during frequent thunderstorms and this culminated in May, which was very wet and at some places even third degree floods were observed. Rainy May ended the first episode of drought. However, due to very dry June, a second drought episode began, which within just a few weeks became even more intense than the first one. By the end of June it can be said that drought was more intense in the region of Moravia compared to Bohemia. As this study shows, it can be seen that the weather in the Czech Republic is very variable, with a tendency towards fast development of drought episodes.

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Summary

První půlka roku 2014 byla charakterizována výskytem velké variability počasí. Bezsrážkové epizody byly střídány bouřkami, teploty vzduchu byly většinou

nadprůměrné a vyskytovaly se jak tropické dny, tak i první horké vlny. Rok začal velmi mírnou zimou, kdy množství sněhu odpovídal pouze 27 % dlouhodobého průměru a v zemědělské oblasti jižní Moravy jen 10 %. Teploty vzduchu byly více než o 2°C vyšší než dlouhodobý průměr. Taktéž březen a duben se vyznačoval podobným rysem počasí, kdy byla teplota výrazněji nad svým průměrem a srážky byly podnormální. Zcela opačný byl měsíc květen, který byl značně vlhký a teplotně průměrný. Na některých místech spadlo i více než dvojnásobek obvyklých srážek. To se projevilo koncem měsíce, že na řadě míst stoupla hladina řek až na 3. SPA. Červen byl poté opět teplý a srážkově chudý. To se projevilo i v intenzitě sucha, kdy první epizoda trvala právě do května, kdy díky vydatným srážkám byla ukončena, ale v červnu začala druhá epizoda, ještě více intenzivnější než ta první.

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