Rožnovský, J., Litschmann, T., (eds): Mendel a bioklimatologie. Brno, 3. – 5. 9. 2014,
ISBN 978-80-210-6983-1

Drought monitor for the Czech Republic - www.intersucho.cz

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Abstract

Because drought and its impacts are among the worst hydrometeorological extremes (including also Central European conditions), the aim of this paper is to describe the core and use of the *Integrated drought monitoring system* for the Czech Republic. Land-use, information about soil, vegetation characteristics and meteorological data are used as inputs to validated water balance SoilClim model, which is applied for estimates of actual and reference evapotranspiration and water saturation of the soil profile in % or soil moisture content in mm. Moreover the prognosis of expected soil moisture (based on probabilistic analysis) is calculated for next 1, 2, 4 and 8 weeks. Main results are weekly updated in form of drought occurrence maps, which are published in spatial resolution 500 m for whole territory of the Czech Republic and for all its 76 districts separately. Final maps with detail comments are available at drought topic dedicated web page (www.intersucho.cz).

Key words: soil moisture, land use, evapotranspiration, drought assessment

Introduction

Drought is natural phenomena, which belongs to hydrometeteorological extremes with strong impacts on life, economy and generally on most of human activities. It must be emphasized that drought is a common feature of any climate (Smith et al., 1996). Central Europe is not at the moment frequently thought of as being a particularly drought-prone region not even in the European context, where much more emphasis concentrates on the Mediterranean area. As the vegetation in general as well as agriculture systems in Central Europe profited from the advantage of evenly distributed precipitation (e.g. Tolazs et al., 2007), the region is susceptible to even short-term droughts (e.g. Brázdil et al., 2008; Hlavinka et al., 2009). The Central Europe including the Czech Republic, however, experienced substantial (in terms of extend and impact) drought events of various intensity in the past several years including those in the years 2000, 2003 and 2011-2012 or 2013-2014. According to Wilhite (2005) we can distinguish meteorological, agricultural, hydrological and socio-economic drought. These four drought types can be monitored, checked or described on various ways. There are drought systems (monitors or portals) which are more or less successful and used. The most well-known drought systems seems to be drought monitor provided by The National Drought Mitigation Center (http://drought.unl.edu/) in Nebraska, USA or The European Drought Centre (http://www.geo.uio.no/edc/) which is a virtual centre of European drought research and drought management organizations. This contribution offers look inside to Czech national drought monitor (such called: Integrated drought monitoring systems) which has been built for agriculture purposes and his stakeholder group consist of farmers, rural experts and decion-makers primary in agricultural sector. The trigger for development of drought monitor were recent scientific work concerning changing soil moisture and expected higher amount of drought spells occurrence in the Central Europe due to expected patterns of climate change (Trnka et al., 2013; Hlavinka et al., 2009; Žalud et al., 2009; Trnka et al., 2009a; Trnka et al., 2009b; Brázdil et al., 2008).

Materials and methods

Drought is assessed using water balance model SoilClim. Its structure and validation was published by Hlavinka et al., (2011) and Trnka et al., (2013). This model is based on the work of Allen et al. (1998 and 2005), but includes many modifications and adaptations to follow the conditions of the Czech Republic. The current version of the model can estimate the value of a reference and actual evapotranspiration, and soil moisture content in two layers of the root profile (0-40 cm and 40-100 cm) for the 11 vegetation types. For this purpose also dynamic growth and phenological model or algorithm for snow cover accumulation and melting (Trnka et al., 2010) are included within SoilClim. Integrated Drought Monitoring System uses several databases which are interpolated to 500m grid. For each grid description and actual stage of vegetation cover, land use, land steepness and exposition, interception, underground water level (not for all grids are data available) and basic soil physical properties are taken into account. Actual meteorological data in daily time step (i.e. minimum and maximum air temperature, global solar radiation, precipitation, air humidity and wind speed) are taken from Czech Hydrometeorological Institute. The model provides for each grid information about the actual and reference evapotranspiration, the water content in the soil in both layers, expressed either as proportion of water soil profile saturation in % (in maps 0-1) or as soil moisture content in mm. The final product is a map of the intensity of dryness. This is for each grid determined by comparing the current value of soil moisture content at a given day with the values of soil moisture distribution achieved during the 1961-2010 time period ± 10 days from the date considered. The value expresses the probability of repetition of soil moisture in the given day and is used to assign the appropriate intensity of droughts (<S0, S0, S1, S2, S3, S4, S5) according to this simple 7 step color scale. Every color (= drought level) responds to certain year drought probability. For instance S1 (= drought level 1) responds to occurrence of 3-year drought. Moreover the probabilistic analysis (based on 50 years of meteorological measurements) is used to forecast the probable soil moisture development from the actual state for next 1, 2, 4 and 8 weeks. Drought parameters and forecast

are computed weekly on Sundays (for whole territory of the Czech Republic and for each of its 76 districts) and final maps with relevant comments (www.intersucho.cz) are upgraded on Mondays.

Results

Results of Integrated drought monitoring system are maps showing actual drought over the Czech Republic territory in 500 m grids for rooting zone layers 0-100 cm (Fig. 1-3). In addition two districts (Fig. 4 – Znojmo, and Fig.5 – Přerov), has been selected as outputs for drought monitoring on local level. All examples are for real date 29th June 2014 (maps were published one date later).

Conclusion

According to Czech farmers experience (especially in middle and south Moravian region) drought becomes one of the most adverse factor influencing soil structure, erosion and finally crop yield. Development of drought detection tools is crucial condition for mitigation and adaptation processes. Recently developed and weekly updated drought monitor should help for decision processes concerning long term impacts but also actual situations. That is why we work on improving of our *Integrated drought monitoring system*. Drought monitor will be improved by integration of another two methodologies in the near future. First approach is based on satellite observations (as independent source of information), when seasonal greenness deviations will be compared with drought monitor outputs. Second new approach will be connected with soil moisture measurements network (observed data).

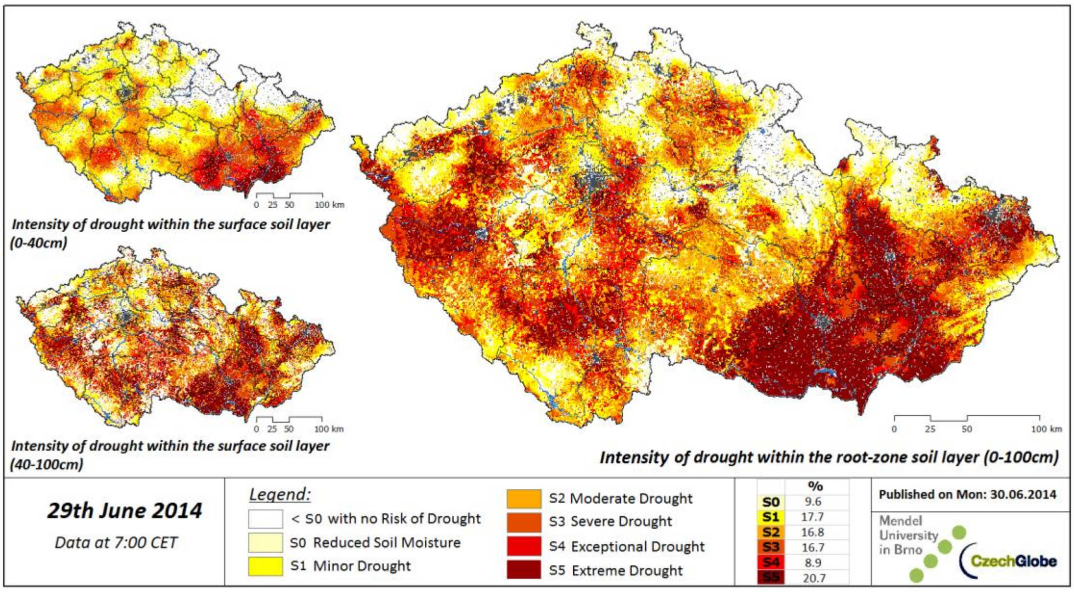

Fig 1: Intensity of drought within the surface layer for whole area of the Czech Republic

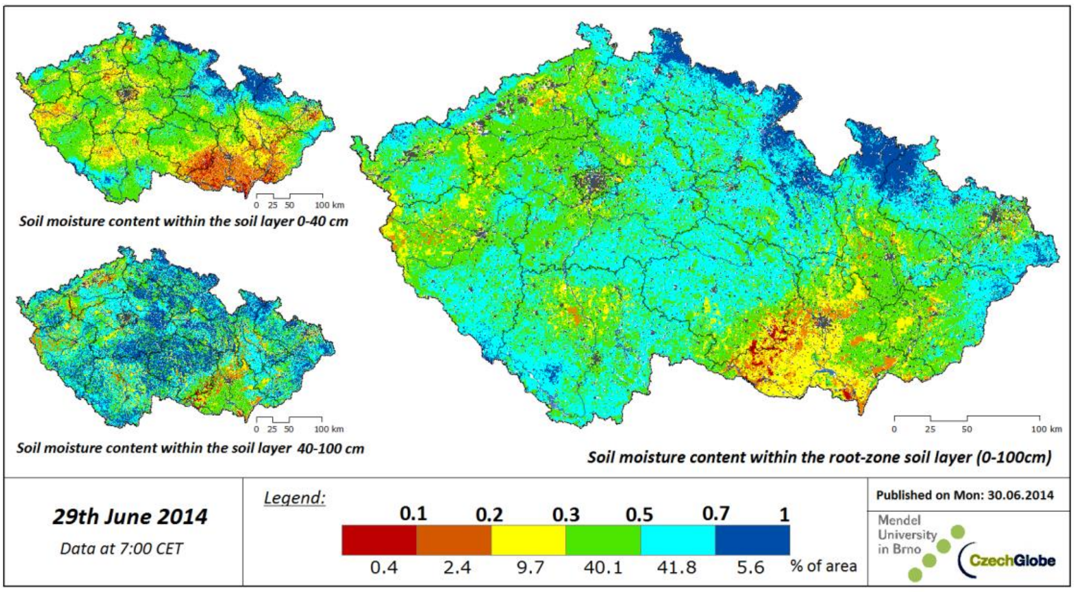

Fig 2: Soil moisture content (x 100 = % of saturation) within the surface layer for whole area of the Czech Republic

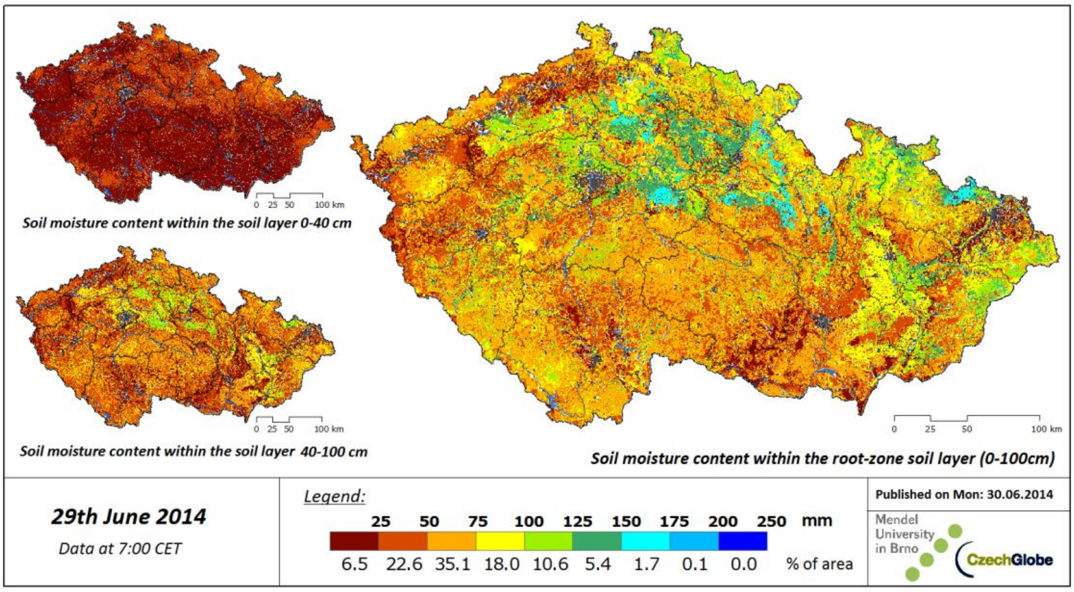

Fig 3: Soil moisture content in soil profile (mm) within the surface layer for whole area of the Czech Republic

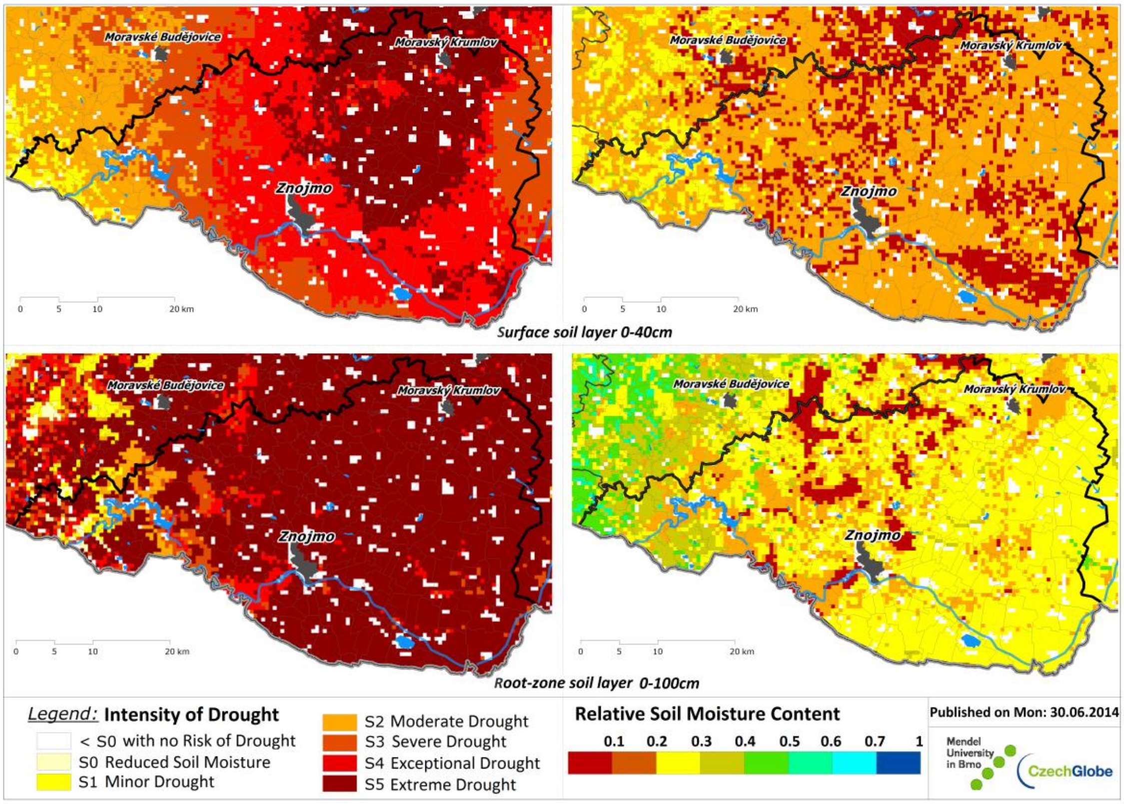

Fig 4: Intensity of drought (left) and soil moisture content (right) for Znojmo district (one square = 500 m x 500 m)

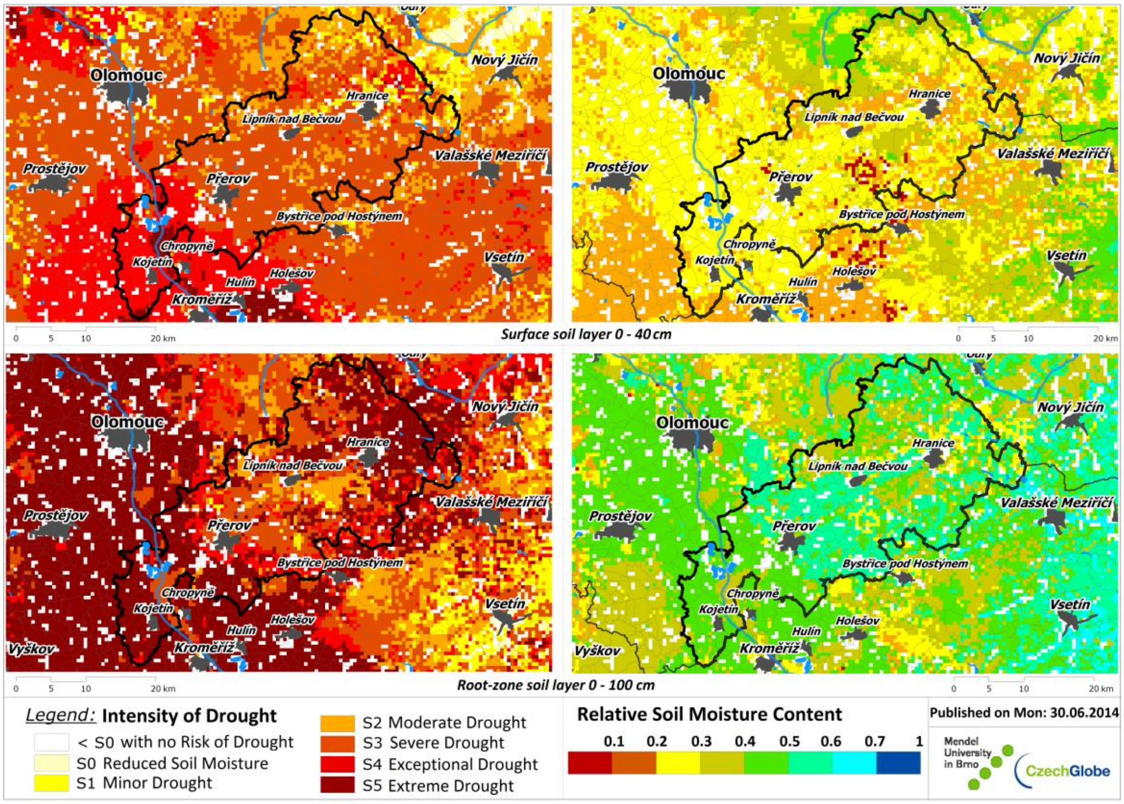

Fig 5: Intensity of drought (left) and soil moisture content (right) for Přerov district (one square = 500 m x 500 m)

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Acknowledgement

This contribution was supported by Czech National Agency for Agricultural Research (NAZV) project reg. No. QJ1310123 “Crop modelling as a tool for increasing the production potential and food security of the Czech Republic under climate change“ and by the Operational Program of Education for Competitiveness of Ministry of Education, Youth and Sports of the Czech Republic, project reg. No. CZ.1.07/2.3.00/20.0248. “Building up a multidisciplinary scientific team focused on drought“.

Summary

Cílem příspěvku bylo objasnit podstatu a využití *Integrovaného systému sledování sucha* (ISSS) pro území České republiky. Vysvětlena byla základní metodika jeho vzniku, ocitovány kalibrace a evaluace systému a naznačeno

jeho praktické využití se zaměřením na zemědělství. Mezi základní atributy ISSS patří jeho podrobné prostorové rozlišení v gridu 500 m, které zahrnuje interpolovaná meteorologická data ze sítě ČHMÚ, detailní půdní údaje vycházející z několika zdrojů (např. VÚMOP - Výzkumný ústav meliorací a ochrany půd, KPP - Komplexního průzkumu půd, ČGS - Česká geologická služba) a land use (CORINE). Jádrem ISSS je validovaný model vodní bilance SoilClim počítající hodnotu aktuální/referenční evapotranspirace a obsah půdní vláhy ve dvou vrstvách kořenového profilu (0 - 0,4 m a 0,4 - 1,0 m) pro jedenáct vegetačních typů. Výstupy jsou buď jako míra nasycení půdního profilu (%) nebo jako obsah půdní vláhy (mm). Finálním produktem (= www.intersucho.cz) je mapa intenzity sucha, která je pro každý grid a pro úroveň ČR a současně úroveň každého ze 76 okresů ČR stanovena porovnáním aktuální hodnoty obsahu půdní vláhy v daný den (vždy neděle) s průměrnými hodnotami půdní vláhy dosaženými v období 1961-2010 v časovém úseku ± 10 dní od posuzovaného dne. Součástí uvedeného webu jsou i mapy pravděpodobnostní prognózy sucha pro 1, 2, 4 a 8 týdnů.

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