MICROCLIMATIC SPECIFICS OF MOHELNO SERPENTINE STEPPE – PRIMARY RESULT

Hana Středová[1,3], Jaroslav Knotek[1], Tomáš Středa[2,3], Miroslav Vysoudil[4]
[1]Department of Applied and Landscape Ecology, Faculty of Agronomy, Mendel University in Brno, Zemědělská 1, 613 00 Brno, Czech Republic
[2]Department of Crop Science, Breeding and Plant Medicine, Faculty of Agronomy, Mendel University in Brno, Zemědělská 1, 613 00 Brno, Czech Republic
[3]Czech Hydrometeorological Institute, branch Brno, Kroftova 2578/43, 616 67 Brno, Czech Republic
[4]Department of Geography, Faculty of Science, Palacký University Olomouc, 17. listopadu 12, 771 46 Olomouc, Czech Republic

Abstract
Obtained measurement results (the years 2014 to 2016 so far) enable formulate more precise conclusions about topoclimate and microclimate of Mohelno Serpentine Steppe (MSS) protected area and its specifics. The measurement brings data that may play a crucial role in the subsequent evaluation of implemented management interventions. Woody central parts of MSS, affected by vegetation, shows ground air temperature during the hottest days even about 8.5°C lower than typical steppe areas. Marginal, continuously forested parts of MSS, are cooler even about 15°C. Also extremity of the environment, strongly affecting the species composition and plants habitus, is significantly lower in the parts of continuous or at least sparse woody vegetation (up to 15.6°C). Differences in relative humidity during the episodes of high air temperature in the central steppe part are not so noticeable. The role would probably play rather longer effect of smaller differences. Only one exception comprises an environment where the relative humidity is strongly affected by the largest thermal amplitude and a larger active surface area (dried plants) – what represent suitable conditions for increased night dew condensation. Higher air humidity of continuously forested parts of the steppe is predictable and is given, among other things, by the plant transpiration.

Key words: land-use, management plan, air temperature, air humidity, surface temperature

Introduction

The paper is focused on evaluation of topoclimatic conditions of Mohelno Serpentine Steppe (MSS). The natural uniqueness of the steppe is given by unusual climate conditions based on a combination of specific geological substrates – serpentine (a rock of volcanic origin not only attracts and accumulates heat but also releases magnesium, iron and other heavy metals into the soil, causing unique phytocoenoses and zoocoenoses), the orientation of the majority of the steppe to the south and the terrain morphology. These factors greatly contribute to the creation of topoclimate (Středová et al., 2011). The emergence of topoclimate is most affected by extremely rugged relief which leads to a different climate in lowlands than on slopes or in valleys. The size and shape of the relief consequently influences the horizontal and vertical extent of the climate. Topoclimate is also a mode of meteorological phenomena that are on one hand formed by the influence of morphology, prevailing structure and composition of biotic and abiotic components of the active surface and on the other hand under the influence of

microclimates located in its range. Due to the mentioned phenomena the steppe temperature reaches up to 10°C higher than the surrounding areas. To preserve the high natural value of the steppe, regular care and management is necessary. The trees and shrubs that grow over the areas with the valuable vegetation are removed because this is the only way of preserving their natural habitat which requires free sunlit space for their survival (Knotek and Štefka, 2015; Středová et al., 2015).

Materials and methods

Long-term climatic conditions of wider area:

Climatic characteristics were evaluated as climate diagram of Walter and Lieth (Fig. 2) based on climatological data from Dukovany station from 1961–2014. Dukovany is a professional climatological station operated by trained staff of the Czech Hydrometeorological Institute (CHMI) and their methodical guidance. It is situated at 400 MASL about 4 km far from the MSS.

Topoclimate monitoring:

To evaluate the topoclimate conditions (Rožnovský et al., 2010) the meteorological stations are placed in the area of interest to identify spatial difference of whole locality. Thus purpose-built stations (main climatological station marked I, seven ground air temperature and humidity HOBO sensors in the radiation shield marked II–VIII, rock surface temperature sensor OS210 marked Surface temperature and two ground air temperature sensors DS18B20 marked Tair Inf 1 and Tair Inf 2) were established in MSS in 2014. They were located on rocky slopes, steppe area of the valley and wooded hillsides (see Fig. 1). Measurements (in 10-minute step) were carried out from July 2014 up today. The evaluation deals with the data from August 2014 to November 2015. The distribution of the individual stations is shown in detailed description of measurement sites bring Středová et al. (2015).

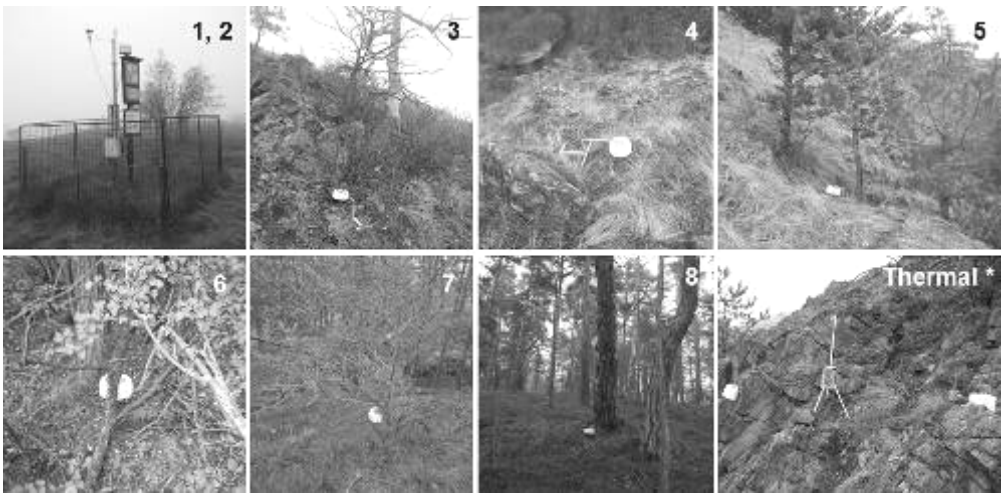

Fig. 1: Position of individual measurement sites on Mohelno Serpentine Steppe

Note: 1: main climatological station
2–8: HOBO sensors
THERMAL*: sensor of rock surface temperature + additional ground air temperature measurement (Tair Inf 1, Tair Inf 2); steep rocky slope with southern to southeastern exposition, almost bare surface

Sensor No	GPS
I, II	49.109022°; 16.187336°
III	49.107956°; 16.182994°
IV	49.108208°; 16.183553°
V	49.108372°; 16.184303°
VI	49.103028°, 16.193144°
VII	49.103269°; 16.191328°
VIII	49.103444°; 16.190967°
THERMAL (surface temp. and Tair Inf 1, Tair Inf 2)	49.107910°; 16.183433°

Results

Basic macroclimate characteristics:

Mean (1961–2014) annual / monthly values of air temperature and precipitation total of climatological station CHMI Dukovany are given by Fig. 2. The average air temperature is 8.6°C. Average total precipitation amounted to 491.5 mm.

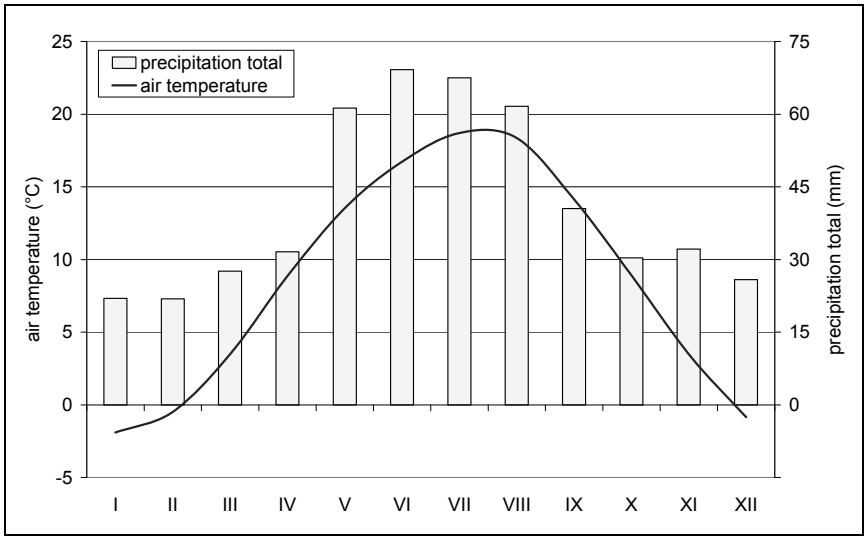

Fig. 2: Climate diagram of Walter and Lieth; Dukovany climatological station, 1961–2014

Topoclimatic evaluation:

The air temperature and relative air humidity across the steppe differ from site to site (Fig. 3).

Comparison of 10-minute values of air temperature during the hottest day of monitoring (22. 7. 2015) at individual sites is presented in Fig. 4. The maximum daily ground-level air temperature was reached at the monitoring point sensor II, as well as the minimum values of the night. This site therefore recorded the biggest daily amplitude. This is a site located on a plateau covered with a continuous grass cover. Generally, the vegetation decreases temperature amplitude and through evapotranspiration increases air humidity and cools their surroundings. At this date, however, this grass canopy (fescue) was completely dry and did not transpirate at all, which pretty much describes the steppe habitat conditions.

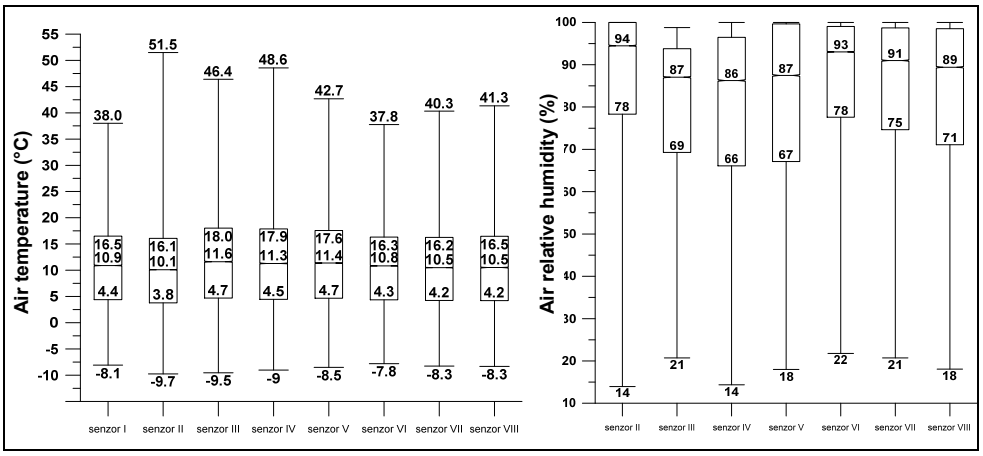

Fig. 3: Boxplot of air temperature (left) and relative air humidity (right) for entire period (August 2014 – November 2015); minimum, maximum, median, I. and III. Quartile

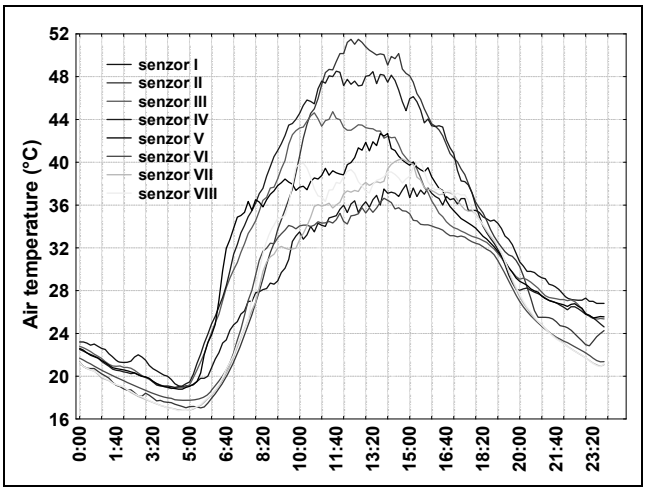

Fig. 4: 24hour course of air temperature during the hottest day of monitoring 22. 7. 2015

The results of parallel monitoring of ground-level air temperature and rock surface temperature bring Fig. 5 – left. The hottest day of this parallel monitoring was 1. 9. 2015 (Fig. 5 – up).

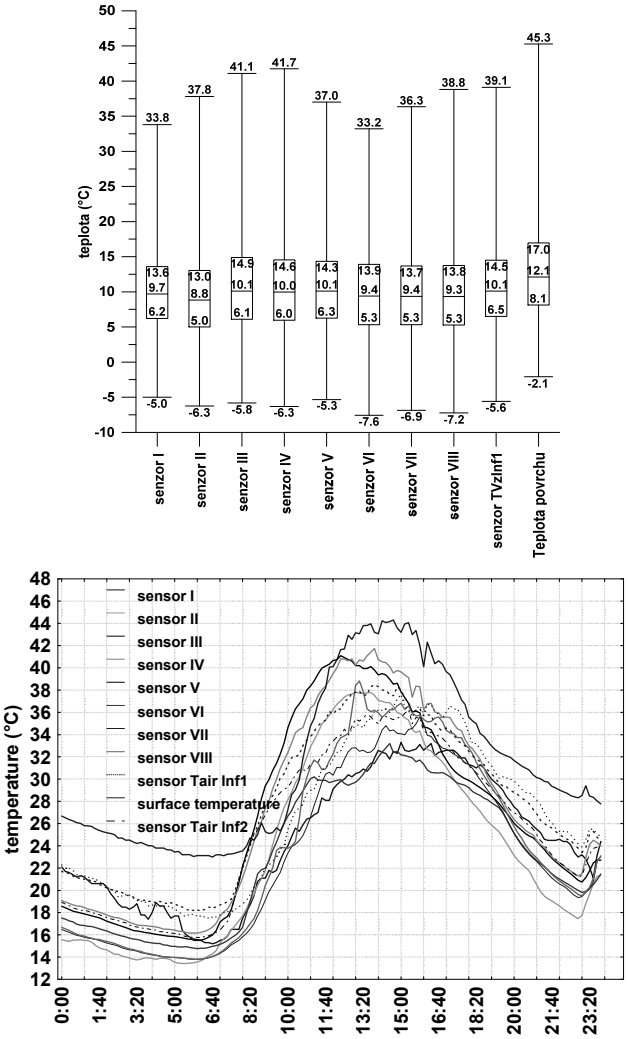

Fig. 5: Boxplot of ground air temperature and rock surface temperature, September to November 2015 (period of parallel monitoring), maximum, minimum, median, I. and III. Quartile (down);

Conclusion

The highest maximum and lowest minimum air temperature was measured at the location on the plateau (2 sensor) which is probably caused by the presence of dry grass canopy (fescue) with limited transpiration. Surface temperature of dark-colored rocks serpentines is given by the heating and their surface, that contains a lot of cracks, reduces thermal conductivity. Direct sunlight therefore heats the surface of these rocks to high temperatures. In winter, the surfaces of these rocks get very quickly cooled and results low temperatures.

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Souhrn
Stromová a keřová vegetace se na mikroklimatických poměrech stepi projevuje nejen přímo prostřednictvím zastínění, ale i prostřednictvím své fyziologické aktivity (transpirace). Pokud se však jedná o netranspirující porosty uschlých travin, uvedené procesy neprobíhají a přítomnost takového vegetačního pokryvu se projevuje naopak zvýšením extremity teploty vzduchu, zejména v přízemní vrstvě a v přilehlé vrstvě půdy. Suché rostliny omezují odvod tepla do povrchových vrstev půdy a způsobují tak zvýšení přízemních teplot vzduchu během tropických dnů. Teplotní režim partií stepi, kde vystupuje na povrch skalní podloží, je dominantně formován tím, že během dne proniká povrchem skalního masivu vedením přijatá tepelná energie v závislosti na jeho tepelné kapacitě a vodivosti (podrobněji v Středová et al., 2014). Tato energie je pak v průběhu noci přiváděna zpět k povrchu a noční teplota skal je tedy zpravidla vyšší než teplota nad povrchem půdy a to zejména v případě, že se jedná o suché písčité půdy. Taková půda se naopak ve svrchních vrstvách během dne ohřívá velmi rychle, s hloubkou však v důsledku špatné tepelné vodivosti vzduchu vyplňujícího jednotlivé póry rychle klesá a v noci v důsledku efektivního vyzařování dochází k markantním teplotním ztrátám. Je zřejmé, že na dřevinnou vegetací ovlivněných centrálních partiích Mohelenské hadcové stepi jsou přízemní teploty vzduchu během nejteplejších dnů i o 8,5 °C nižší, než na typicky stepních plochách. Okrajové, souvisle zalesněné partie Mohelenské hadcové stepi, jsou chladnější i o 15 °C. Také extremita prostředí, výrazně ovlivňující druhovou skladbu a habitus flóry, je výrazně nižší v partiích se souvislou nebo jen rozptýlenou dřevinnou vegetací (až o 15,6 °C).

Contact:
Ing. Hana Středová, Ph.D.
Phone: +420 545 132 408, e-mail: hana.stredova@mendelu.cz