SOILS FOR FUTURE UNDER GLOBAL CHALLENGES
SERBIAN SOCIETY OF SOIL SCIENCE
University of Belgrade, Faculty of Agriculture
Sokobanja, 21-24 September 2021
III International and XV National Congress
https://congress.sdpz.rs/

PREDICTION OF SOIL TEMPERATURE BY AIR TEMPERATURE: A CASE STUDY FOR RIMSKI ŠANČEVI

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Introduction

Soil temperature is a very important parameter that affects agronomic, climatological and hydrological processes. The microbiological and biological processes that affect the physiological growth and development of plants, pest growth, as well as the speed and amount of evaporation, the speed of snow melting, etc. depend on soil temperature. Knowing the soil temperature, in the depth in which the root system extends, would help in making decisions on the time of sowing, i.e. planting, in the fight against pests, etc. However, soil temperature data are often inaccessible to farmers, primarily due to the high cost of thermometers, as well as the complicated installation procedure, which requires training and technical expertise.

The aim of the research

The aim of this research is to show how the soil temperature can be estimated based on the measured air temperature data, which are more accessible

Materials and methods

The research included the measurements of air temperature and soil temperature at the Rimski Šančevi meteorological station in the period 1993-2019. The soil on which the measurements were made is carbonate chernozem on a loess terrace (0-60 cm loam; 60-100 cm clay loam). A regression and correlation analysis of the measured mean daily air temperatures and mean daily soil temperatures in the period 1993-2013 was performed at the depths of 5, 10, 20, 30, 50 and 100 cm. After that, the estimated values of soil temperature (at all mentioned depths) for the period 2014-2019 were verified

Results

Regression and correlation analysis of measured mean daily air temperatures and mean daily soil temperatures

The results showed that up to a depth of 50 cm, soil temperature shows a very high correlation with air temperature, with the dependence decreasing slightly with depth. The values of the coefficient of determination R^2 at the depths of 5, 10, 20, 30 and 50 cm, respectively, are: 0.94, 0.93, 0.90 and 0.86 ($p<0.0001$). At 100 cm of soil depth, the dependence of soil temperature on air temperature is lower, but in the range of high dependence ($R^2 = 0.67$) ($p<0.0001$).

Soil depth	Regression equations	Coefficient of determination
5 cm	y = 1.07x + 0.7261	R^2 = 0.9379
10 cm	y = 1.0274x + 1.1948	R^2 = 0.9294
20 cm	y = 0.9526x + 1.9018	R^2 = 0.9019
30 cm	y = 0.8716x + 2.8156	R^2 = 0.8635
50 cm	y = 0.7652x + 4.1804	R^2 = 0.8102
100 cm	y = 0.5542x + 6.6002	R^2 = 0.6665

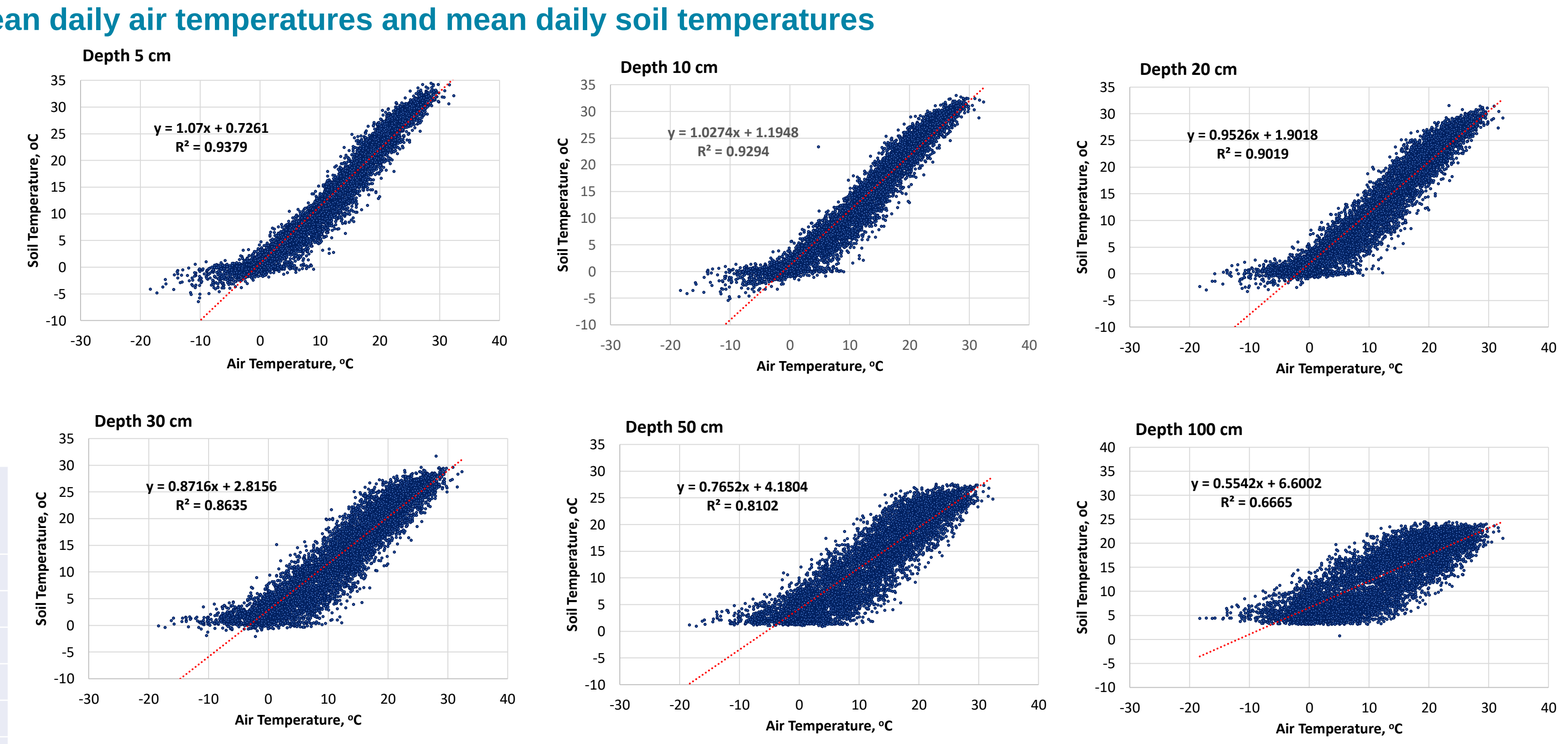

Figure 1. Regression and correlation analysis of measured mean daily air temperatures and mean daily soil temperatures in the period 1993-2013, performed at the depths of 5, 10, 20, 30, 50 and 100 cm

Verification of estimated values of soil temperature for the period 2014-2019

Testing of regression equations in all six years (2014-2019) showed a very good agreement between the estimated and measured values of soil temperature at all depths, but the agreement decreased slightly with the increase in depth. The average correlation coefficient (Pearson distribution) for the six tested years, at the depths of 5, 10, 20, 30 and 50 cm, shows a very high correlation (0.969, 0.966, 0.954, 0.926 and 0.904, respectively), and at a depth of 100 cm shows a high correlation (0.820).

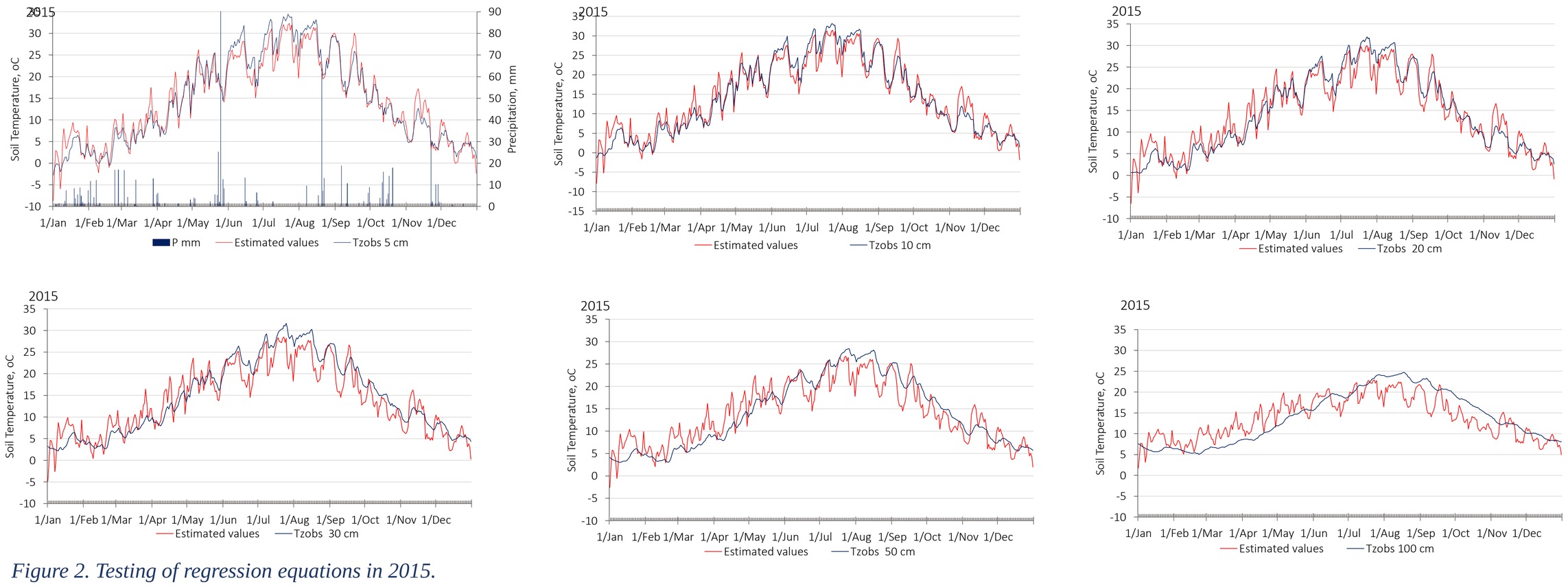

Figure 2. Testing of regression equations in 2015.

Acknowledgement

This paper is an outcome of research within the contract on realizing and financing scientific research work in 2021 between the University of Belgrade, Faculty of Agriculture and the Ministry of Education, Science and Technology Development of the Republic of Serbia, Contract Reference No.: 451-03-9/2021-14/ 200116 .