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IMPACT OF CLIMATE CHANGE ON AGRO-CLIMATIC INDICATORS IN TRANSYLVANIAN PLAIN BETWEEN 2009-2016

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Abstract

Transylvanian Plain (TP), with an area of 395,616 hectares, is considered as an area with a lowest capacity to adapt to existing climate change. In these conditions, for a better sustainable development of agricultural technologies, the deployment of measures to adapt to these changes and climate monitoring are essential.Purpose of this paper is to analyse and monitor the agro-climatic indicators between 2009-2016 and the data obtained will be the basis for the technological development of the recommendations adapted to the current favourable conditions. For the study we used 10 HOBO microstations located in TP that record the temperature of the soil at 10 cm, 30 cm and 50 cm depth, the soil humidity at 10 cm depth, the air temperature at 1 m and rainfall. In TP between 2009-2016, the multiannual average of temperature at 10 cm depth in soil is 11.50°C, respectively 11.47°C at 50 cm depth in soil and the multiannual average of soil moisture is 0.223 m^3/m^3. The multiannual average of rainfall is 514.29 mm. Results highlight evolution of agro-climatic indicators in TP in the period 2009-2016.

***Key words**: soil temperature, soil humidity, precipitations, Transylvanian Plain.*

INTRODUCTION

Extensive research carried out on climate change, highlighted based on observational data and projections made for long periods of time, show that the changes in the evolution of climate, global, regional and local levels are an undeniable fact, and have a negative impact on maintaining the right balance in the relationship between society and environment (Szajdak et al., 2003; Keskitalo et al., 2015).

Climate is represented by dynamics of all meteorological phenomena from the atmosphere, including the soil hydric and thermal regime, from a specific place or region in the world, during a very long period of time (Dumitrescu et al., 2015).

Between 1880-2012, global average temperatures, show an average increasing of 0.85ºC (0.65-1.6ºC) for several series of independent data, with great inter-annual and decadal variability (Haylock et al., 2008; Lereboullet et al., 2013).

Regarding the climate changes, they are caused by the increase of greenhouses gases, which result from simultaneous actionof certain internal or external factors and external anthropogenic factors changing the atmosphere composition (IPCC, 2014a; Perry, 2015; Marin et al., 2016).

Recent studies estimate that at ground level, extreme temperatures will grow faster than global warming, and the probability of temperatures above 48ºC being met every decade as we approach 2100, is 10%, if the global temperature exceeds the level since 1850.

According to three different observational records of global average annual near-surface (land and ocean) temperature, the last decade (2007–2016) was 0.87 to 0.92°C warmer than the pre-industrial average, which makes it the warmest decade on record (EEA, 2017).

The average annual temperature for the European land area for the last decade (2007-2016) was around 1.6°C above the pre-industrial level, which makes it the warmest decade on record. Moreover, 2016 was the second warmest year (after 2014) in Europe since instrumental records began.

Due to the increase of greenhouse gas concentrations, the global average temperature projected climate forecasts an increase by the middle of the century by 0.4-1.6 (Collins et al., 2013).

In terms of rainfall, at European level, since 1950, the annual amounts of precipitation in northern Europe rose by more than 70 mm perdecade and fell in some parts of the South, while changes made to exploiting fieldsmodify the rainfall (Haylock et al., 2008; IPCC, 2014a).

Changes in large-scale circulation patterns play a key role to observe precipitation changes, but it is not clear if the relatively minor land-use changes at European level since the 1950s have influenced observed precipitation trends.

While agriculture is affected by climate change, in turn, agriculture contributes with 13.5% of the total greenhouse gas emissions (GGE). Of GGE emissions at European level, those from agriculture have a share of 2 to 26% with an average of about 14% of the total (FAO, 2009).

Transylvanian Plain (TP) is considered one of the most affected areas with the lowest capacity to adapt to existing climate change.

In the last two centuries, the anthropogenic impact of TP has increased considerably, being now a hilly area with problems of soil sustainability, limited water, rainfall deficit and very low forest cover of only 6.8% (Rusu et al., 2014).

Due to these conditions, it's essential to monitoring the climate and applying adaptation measures to climate changes for the sustainable development (Rusu et al., 2017). The objectives of this paper are to monitor the agroclimatic indicators (soil temperature and humidity, rainfall and air temperature) and climatic conditions for the period 2009-2016 in TP.

MATERIALS AND METHODS

Transylvanian Plain with an area of 395,616 ha is composed of three counties Cluj (CJ), Bistriţa Năsăud (BN) and Mures (MS), and together with Someş Plateau and Târnave Plateau is forming the Transylvanian Depression. TP is located in the central part of the Transylvanian region, being characterized by absolute altitudes ranging between 250-500 m. From an agricultural point of view, the main crops present here are winter wheat, corn, sunflower, soybean and sugar beet, holding the largest share of the total cultivated areas (INS, 2014).

Although the TP relief is hilly, the dominant vegetation is represented by hayfields and forest steppe, due to the annual precipitation deficit, the wood vegetation occupies a low surface area because of deforestation (Coste, 2015).

For the study, we used data of temperature and humidity electronically recorded by 10 microstations type HOBO-MAN-H21-002, during 2009-2016, located in different areas of TP with different elevations (Table 1), and different types of soil (Rusu et al., 2017).

For recording rainfall, stations were provided with rain gauges RG3-M type. Monitoring climatic elements, stations were located in different areas of TP with different pedoclimatic issues.

Soil temperature data were recorded electronically at 10, 30 and 50 cm depth, air temperature and rainfall to a height of 1 m, and soil moisture at 10 cm depth in soil. Data was downloaded from the Micro Stations to the computer using HOBO Ware Pro Software Version 2.3.0.

Table 1. Station location in Transylvanian Plain

Nr. crt.	Station/County	Soil Type and Subtype*	Latitude	Longitude	Elevation (m)
1.	Căianu (CJ)	Cernoziom calcaric	46º79'	23º52'	469
2.	Mociu (CJ)	Eutricambosoil typic	46º47'	24º04'	435
3.	Ţaga (CJ)	Preluvosoil typic	46º97'	24º01'	469
4.	Braniștea (BN)	Eutricambosoil typic	47º17'	23º47'	266
5.	Dipșa (BN)	Phaeoziom typic	46º96'	24º26'	356
6.	Zoreni (BN)	Preluvosoil typic	46º89'	24º16'	445
7.	Silivașu de Câmpie (BN)	Eutricambosoil mollic	46º78'	24º18'	463
8.	Filpișu Mare (MS)	Districambosoil typic	46º74'	24º35'	375
9.	Band (MS)	Phaeoziom argic	46º58'	24º22'	318
10.	Triteni (CJ)	Phaeoziom vertic	46º59'	24º00'	342

CJ = Cluj County; BN = Bistrita-Nasaud County; MS = Mures County;

RESULTS AND DISCUSSIONS

Thermal regime of the soil, is influenced by a number of factors, primarily on the intensity of the solar regime and its time variation, followed by the physical properties of the soil, orientation and tilt of the slopes.

Analysing the thermal regime of the soil, multiannual average temperature at 10 cm depth in soil recorded in TP during 2009-2016 is 11.50°C, the highest temperature was recorded at Filpisu Mare station (13.25°C), respectly 11.47°C at 50 cm depth in soil with the lowest temperature at Triteni station (10.87°C).

The multiannual average of soil moisture recorded in the same period is 0.223m^3/m^3, the values being ranged between 0.188-0.244 m^3/m^3 (Table 2).

Table 2. Multiannual average (years 2009 - 2016) of temperature and water contentat 10 cm soil depth, for 10 stations in TP

Nr. crt.	Station name	T°C at 10 cm in the soil	T°C at 50 cm in the soil	Soil moisture (m^3/m^3) at 10 cm in soil
1	Țaga (CJ)	10.90	11.13	0.212
2	Braniște (BN)	11.77	11.58	0.220
3	Dipșa (BN)	11.53	11.72	0.241
4	Zoreni (BN)	11.37	11.30	0.238
5	Silivașu de Câmpie (BN)	11.12	11.03	0.235
6	Filpișu Mare (MS)	13.25	12.93	0.210
7	Band (MS)	11.40	11.27	0.188
8	Triteni (CJ)	10.67	10.87	0.244
Average TP		**11.50**	**11.47**	**0.223**

CJ = Cluj County; BN = Bistrita-Nasaud County; MS = Mures County

Temperatures recorded at 50 cm in the soil in TP are ranged between 8-15°C.

Regarding the average of the multiannual air temperatures, the lowest value was at Band station with 11.03°C, and the highest one was recorded at Dipsa station with 11.54°C (Figure 1).

In terms of rainfall, multiannual average value recorded between 2009 and 2016 was 514.29 mm, value that falls within the annual average of 500-700 mm/year (Figure 2).

The highest value of annual average rainfall was recorded in 2016, 725 mm and the lowest value was in 2012, 279.40 (Table 3).

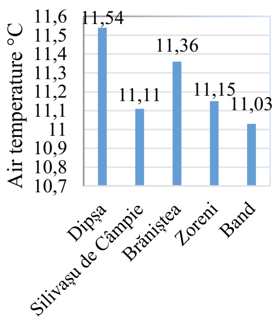

Figure 1. Multiannual averages of temperature (2009-2016), in Transylvanian Plain

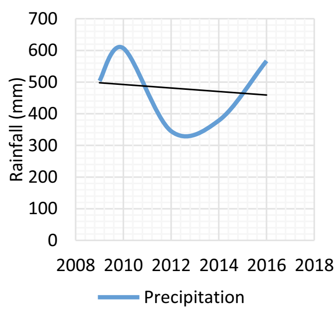

Figure 2. The evolution of the average values of rainfall (mm) in TP, between 2009 - 2016

Table 3. Annual average of rainfall (mm) in TP, between 2009-2016

Station/Year	2009	2010	2011	2012	2013	2014	2015	2016
Brăniștea	653.60	671.40	334.60	279.4	496.00	-	498.40	725.00
Căianu	350.80	662.40	368.60	315.60	343.80	378.60	556.80	514.20
Dipșa	465.40	628.60	396.00	406.00	488.60	-	495.60	-
Silivașu de Câmpie	581.40	561.60	391.80	315.60	522.80	378.60	556.80	-

The soil moisture at 10 cm depth is directly influenced by the rainfall regime.
As can be observed linear decrease tendency is keeping in 2012 when it was recorded the lowest value (0.202 m^3/m^3) compared to 2010 when it was the highest value (0.260 m^3/m^3), (Figure3).
During period 2009-2016, the analysis of annual mean soil moisture values recorded at 10 cm depth in TP indicates a downward trend.
The highest value of multiannual average was recorded at Triteni station (0.244 m^3/m^3), while the lowest value was recorded at Band station (0.188 m^3/m^3).

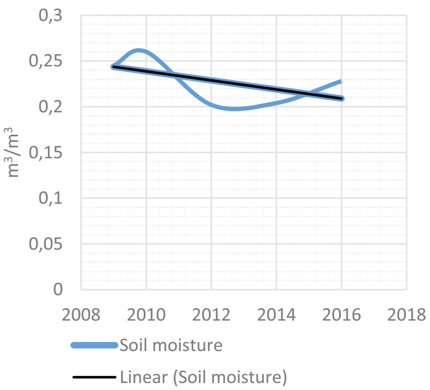

Figure 3. The evolution of the average values of moisture (m^3/m^3) in TP, between 2009 - 2016

CONCLUSIONS

The certainty of climate change has been and is being highlighted by global research, and its effects have a negative impact on all sectors and areas of activity, and can also be observed in the Transylvanian plain.
In Transylvanian Plain, climate changes can be observed both in values of temperature recorded at 10 cm and 50 cm depth, soil moisture and the variation of multiannual averages of air temperature.
The multiannual average of temperature in soil, recorded between 2009-2016 at 10 cm depth is 11.50ºC, respectively 11.47ºC at 50 cm depth. The highest multiannual average of air temperature for the same period was 11.54ºC, recorded at Dipsa station. The multiannual average of soil moisture recorded in the same period is 0.223 m^3/m^3. The multiannual average value of precipitation is 514.29 mm.
In Transylvanian Plain due to the reduced precipitation regime, there is the possibility of increasing the water deficit.
Analyzing the parameters of soil temperature, soil moisture and rainfall, it is recommended to apply measures that help to maintain and increase the water reserves in the soil, thus decreasing the degree of soil erosion.

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