ATMOSPHERIC FACTORS USED TO CHARACTERIZE SOIL RESOURCES

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Abstract. *The paper presents the influence atmospheric factors present in the formation, evolution and use of soil resources. Of the atmospheric factors majorly involved in soil resource formation in the Arad county, and more, the greatest importance carry light, average annual temperature, atmospheric as well as at the soil level and average atmospheric annual precipitations. These factors direct or limited conditioning of soils and, implicitly, of the production obtained due to these atmospheric factors leads to a heightened importance and a special role in plant growth and development, thus directly influencing the harvests. The studies were carried out over a period of three years (2015-2017). The studied area was the Arad County. Within that region, the studied areas were chosen taking into account soil type, altitude, land slope, exposition and underground water level. Annual averages were calculated for temperatures, precipitations and light intensity, as annual averages, as well as monthly averages from the vegetation period, respectively the months April-October. The calculation results highlighted the fact a major importance in the manifestation of each climatic characteristic have geographic position, land slope and also soil texture. Studies carried out by other researchers showed that time and space variations require in depth research regarding the microclimate, characteristics specific for billowy territories. On the other hand, it is necessary to establish specific measurements of each climatic characteristic so that it can be further elaborated into mathematic expressions and regression curves. In order to render the hygric resource as precise as possible, during the years, a series of mathematic models were tried out, only partially corresponding with the requirements. For starters, we tried a generalizing synthetic indices, more relevant for the photosynthesis offered to plants, resulting from multiplying average annual temperatures (or other indicators regarding the thermal resource) with average annual precipitations (hygrothermal indices) (D. TEACI – 1976).*

Key words: *soil, temperatures, precipitations, light intensity, slope, texture*

INTRODUCTION

From a geographic point of view, the studied area is situated in not very different bioclimatic conditions, however, due to the variation in hydrologic and lithologic conditions, the soil formation process is different in each place, determining a technical-edaphic factor variability which helps forming an environment where plants grow and produce yields.

From a geomorphologic point of view, the studied territory pertains to the broad physical-geographical unit called “The Banato-Crişana Plain“ (GR. POSEA, 1997) where the following subunits occur: The High Vinga Plain; The Low Aranca Plain and the Mureşului Everglade.

The Vinga Plain is situated North between the course of the Mureş river and the Bega river to the south, in the Piedmont Vinga Plain, the oldest and highest Mureş plain, formed by an intense secondary network of flowing waters and valleys. The relief altitude oscillates between 120-110 m, and presents a general plain aspect, slightly inclined from south to north and from east to west, a fact reflected by the valley discharge direction. The plateaus are covered with a series of microdepressions resulting from clay and carbonated loess compacting.

The high plain is fragmented by parallel erosion valleys, of various sizes, which flow towards the Mureş river. The longer and deeper the valleys, the larger the slopes bordering them.

The Aranca Plain, is situated between the Mureş and Galatca rivers, the mentioned plain being represented by its most eastern and relatively recent portion, protected by the construction of the Felnac dam from the Mureş river floodings. It occurs as a low alluvial plain with altitudes ranging from 99-103 m, with a faded land morphology, sometimes with small depressions and grinds whose level difference form the general land level does not usually exceed 0.5-1.0 m. All in all, it is a wide low area, with many courses and dried out branches, whose main characteristic is constituted by excessive clay content of the superficial layer and the expended character of the argillaceous materials.

The Mureşului Everglade, is situated at the limit between the Mureşului Everglade and the high plain. The everglade presents a general plane aspect with very few unevenness determined by the alternation between dried out and grinded valleys).

The supply system is pluvio-nival, a fact which determines the occurrence of great spring floods producing floodings.

Underground waters are stored in pebble and sand layers and present small seasonal fluctuations. In the everglade and the low plain, the underground water can be found at a 1-3 m depth.

MATERIALS AND METHODS

The climatic conditions were characterised based on climatic data registered at the Meteorological Station Arad.

In order to render the influence of the hygric resource as accurate as possible, during the years, a series of mathematical models have been tried out, which only partially corresponded with the requirements.

For starters, we tried a synthetic generalizing indices, relevant especially for the photosynthesis possibility offered to plants, resulting from multiplying average annual temperatures (or other indicators regarding the thermal resource) with average annual precipitations (hygrothermal indices) (D. TEACI – 1976), according to the formula:

$$I = t^{O}C \,.\, Pmm \;/\; 100 \,.\, K_1 \,.\, K_2$$

where:

I – hygrothermal indices;

$t^{O}C$ – annual average temperatures;

Pmm – annual average precipitations;

K_1 – correction coefficient for areas with various frequencies for drought months;

K_2 – correction coefficient for areas with negative average temperatures.

Another quantification for the two hygric and thermal resources is proposed by *O. Berbecel* (1979), who establishes a hygrothermal indices for 4 characteristic periods, more difficult to use in general studies, but very useful for details, based on the fomula:

$$K = 0.6 \cdot H + Q / 0.1 \cdot t^{O},$$

where:

H – precipitation total fallen during the interval November-March;

Q – precipitations fallen during the vegetation season the analysis refers to;

t^{O} – temperature sum >$0^{O}C$ calculated at 4 reference dates (31 May – K_1; 30 June – K_2; 31 July – K_3; 31 October – K_4).

The current methodology for qualitative land assessment, uses the thermal resource as multiannual resource, which it corrects depending on land declivity and soil permeability; this method employing scales equal or smaller than 1:10 000 seems to be considered correct for now.

Soil temperature was determined with the help of the soil thermometer. It was taken during the three years for the intervals April-October, being determined in four different spots, respectively the localities: Arad, Lipova, Săvârșin and Șiștarovăț.

RESULTS AND DISCUSSIONS

The average annual temperature registered at the Meteorological Station Arad during the studied period, was of 10.3◦C. The air temperature during the 12 months of the year observed a non-uniform distribution, as shown in table 1.

Table 1

Air temperature during the period 2015-2017

Months	Years	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	**Annual average**
Temperature ◦C	2015	-1.1	-0.3	5.8	11.8	16.1	19.3	21.4	20.8	18.0	11.5	5.7	1.4	10.8
	2016	-1.4	-0.6	4.3	10.9	15.7	19.1	21.2	20.7	18.2	11.3	5.2	1.6	10.51
	2017	0.2	-0.1	5.3	9.4	15.8	18.7	20.6	19.5	18.4	11.2	5.1	1.8	10.49

The data presented in table 1 shows the fact that, during the vegetation period, the average monthly temperature registered close values, the smallest one, respectively 9.4◦C being registered in April 2017 and the highest (11.8◦C) in April 2015. Higher values were registered during summer months, especially July and August. Crop seeding during the first era can begin at the middle of March and maize can be seeded starting with the middle of April, while for the most temperature sensitive plants, it took place towards the end of April.

Vegetables, however, except for early cabbage, could be planted starting with the third decade of April during 2015 and 2016 and starting with May in 2017.

For June, the highest value (19.3◦C) was registered in 2015 and the lowest (19.1◦C) in 2016, he various temperature differences between the years being insignificant.

In July, temperature values were close, with insignificant differences, that is under one degree from one year to the other, while August brought differences of over 1degree Celsius, namely the temperature was of 20.8◦C in 2015; 20.7◦C in 2016 and respectively 19.5◦C in 2017, a year in which temperature differences observed oscillations between months, but the average temperature of 2017 observed a difference as compared to 2016, of 0.02◦C.

During the vegetation period, 01.04 –30.10, average temperatures ranging from 16.98◦C in 2015 to 16.72◦C in 2016 and 16.22◦C in 2017 were registered. As an average, the warmest year is considered 2015 and 2017 the coldest. Absolute maximum temperature is of 40.4◦C and it was observed on 16.08.2015, while the absolute minimum of - 26.1◦C was observed on 23.01.2016.

The above presented data show that, for the main plant groups (autumn and spring cereals, hoeing cereals, vegetables, root vegetables etc.), the temperature degree sum is insured during the vegetation period.

The first rime was signalled in September and appear isolated with an average frequency of 0.1 days. Late spring time appears in April, but it was signalled in May as well, with an average of 6.3 days. The annual average for rime days is of 19.8 days.

The average duration of the frostless day interval is of 186 days, with 90.2 frost days.

The first frost appears as an average after the 20th of October, while the last frost occurs around the 17th of April. However, there have been exceptions, like the 21st of May

2016. Most frost days have been observed in January and February, respectively 25 of the 90.2 days.

The number of tropical days, that is days with an average temperature of over 30◦C, is of 33.1, with the highest frequency in July.

Regarding the soil thermic regime, we observed that during February- March, it presents a slower evolution, following closely the air temperature of all four locations.

The same evolution can be noticed in autumn, starting with the end of September until the first decade of November, with higher differences, of 1-20◦C between soil level and air temperatures.

Regarding the precipitation regime, the multiannual average registered at the Meteorological Station Arad during 2015-2017 is presented in table 2.

Table 2

Average monthly precipitations during the studied period (in mm)

Months	Years	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	**Annual average**
Precipitations in mm	2015	36.0	28.8	31.9	47.8	60.8	79.7	81.2	51.8	46.4	48.5	50.3	50.1	613.3
	2016	35.1	30.9	31.6	48.1	65.6	81.8	80.3	52.2	44.2	46.6	48.5	45.3	590.2
	2017	35.3	31.4	32.0	49.7	67.5	78.7	80.1	54.2	48.3	47.9	50.3	47.2	622.6

The multiannual precipitation average form the Meteorological Station Arad during the interval 2015–2017 was of 608.7 mm. 2016 was the year with most drought periods, while the rainiest one was 2017. During the mentioned interval, the annual average values present oscillations between years, especially between consecutive months.

During the vegetation period, the most precipitations were observed in July 2015, respectively 81.2 mm and the least, in September 2016, respectively 46.6 mm.

The data registered during the studies carried out during the period 1995-2005 showed that the maximum precipitation capacity of 804.2 mm was registered in 1996.

The monthly precipitation distribution indicates a pluviometric minimum during February with a multiannual average of 30.9 mm, this case registering oscillations between consecutive years, such as the values: 3.4. mm in 2015, and 1.5 in 2017 as compared to the pluviometric maximum of February 2017, 31.4 mm.

In July we registered a multiannual average of 81.2 mm, with the following oscillations: 80.1 mm in 2017 and 80.3 mm in 2016.

As an average, 119.9 days with precipitations of over 0.1 mm were observed, without any month with no precipitations.

With regards to the snow, the average number of snow days were larger water quantities than 0.1 mm fell, is of 18.8 days, the highest number of snow days being registered in January (6 days).

The average date of first snows is the 1st of December, and that of last snow the 12th of March, thus leaving a circa 102 day interval of possible snows.

The average number of days with a snow layer is 31.4. The month presenting most days with a snow layer is January, respectively 12.3 days.

The duration of the snow layer is generally reduced, and the distribution is not uniform due to its thinness.

Due to the interruption of the vegetative cycle, the frequency of rime days during the cold season is less significant, the importance of the phenomenon growing during the spring and autumn seasons. In turn, the white frost, a winter characteristic phenomenon, may bring great damage especially for fruit tree plantations, through its layer pressure and duration. The lowest values are registered in July and August, and the highest during December and January.

Also, in order to more precisely define the intensity of drought or excess humidity periods, we calculated the humidity indices on representative days, respectively 31 May, 30 June, 31 July and 31 October.

Thus, at the end of the spring season, that is when cereal crops, pastures and hay lands experience the period of maximum consumption, humidity expressed through the values of the K1 indices (on 31 May), presents optimal frequencies ranging from 2-3, the humidity being positive for most cases. The proportion of years with optimal humidity frequencies, of 54.1%, generally reflects a good plant supply for this period, with a multiannual average of 2.78.

Years with average values of the K1 indices ranging from 1.5-2, when sensitive diminutions of the autumn crops occur, are observed in a percentage of 6.4%. Droughty years with values of the K1 indices ranging from 8-1.5, are registered in a proportion of 2.2%.

Humidity excess years with values of the K1 indices ranging from 3-4, are registered in proportion of 33.3%.

Years with especially abundant precipitation as compared to the normal season, with K1 indices values of over 4, are registered in a percentage of 6.2%. During these years, moors form on the soil surface, a phenomenon which seriously hinders soil works and crop development.

The humidity indices values calculated for 30 June, (K_2, are generally situated under the limits of those registered on 31 May, oscillating between 0.97 (2016) and 4.17 (2017) with an average value of 2.15 registering 48% years with normal precipitations, 41% years with very low precipitations and only 10% years with exceeding precipitations.

During July, simultaneously with the intensive development of the vegetative mass with most crops, thus also of the water consumption, humidity decreases remarkably as compared with the preceding month. On 31 July (K_3), the humidity deficit is even more accentuated, the value of the K_3 indices ranging from 0.97 (2017) to 3.11 (2016), with an average value of 1.74 observing 22% years with normal precipitations, 49% years with very low precipitations and 27% droughty years with only 2% years with exceeding precipitations.

The lowest indices values usually occur at the end of the vegetation season, respectively on 31 October (K_4) when the indices values are located between 0.77 (2016) and 2.26 (2015), with an average of 1.38, which situates the studied perimeter among the areas with a humidity deficit, a fact that justifies irrigation systems from the immediate vicinity (used less and less during the last period).

Data referring to the potential and real evapotranspiration indices after Tornt Weide, highlight the fact that in July, August and September the potential evapotranspiration is higher than the real one.

CONCLUSIONS

The following general conclusions can be drawn from the data presented above:

From a bioclimatic point of view, the studied area does not differ considerably, still, due to the variation in hydrologic and lithologic conditions, the soil formation process is different in each place, and during consecutive years, determining a pedologic and edaphic factor variability which helps forming an environment where plants grow and produce yields.

From a geomorphologic point of view, the studied territory pertains to the broad physical-geographical unit called “The Banato-Crişana Plain“ (Gr. Posea, 1997) where the following subunits occur: The High Vinga Plain; The Low Aranca Plain and the Mureşului Everglade.

With regard to the monthly average temperatures from the vegetation period (April-October), these presented higher values, of 9.4◦C in April 2017 and 11.8◦C in April 2015.

Higher values were registered in summer months especially in July and August.

Crop seeding form the first era can begin at the middle of March and maize can be seeded starting with mid-April, and the most temperature sensitive plants towards the end of April.

However, most vegetables (except for cabbages), could be planted starting with the last decade of April in 2015 and 2016 and starting with May in 2017.

During the vegetation period, 01.04 –30.10, average temperatures ranging from 16.98◦C in 2015 to 16.72◦C in 2016 and 16.22◦C in 2017 were registered. As an average, the warmest year is considered 2015 and 2017 the coldest. Absolute maximum temperature is of 40.4◦C and it was observed on 16.08.2015, while the absolute minimum of - 26.1◦C was observed on 23.01.2016. The degree sum for the main plant groups (autumn, spring and hoeing cereals, vegetables and root vegetables etc.) was insured during the vegetation period.

The number of tropical days, with an average temperature exceeding 30◦C, is of 33.1, with the highest frequency during July.

Regarding the soil thermic regime, during February- March, it shows a slow evolution, closely following the air temperature in all four locations.

The same evolution is observed in autumn, starting with the end of September until the first decade of November, with more pronounced differences, of 1-2◦C between soil and air temperature values.

Unlike the thermic source, the hygric one, once it gets to the land surface, it can accumulate in the soil and be consumed during the vegetation period. However, there is a different way of storing and distributing it between soils, and between plants. That is why it is difficult to study the actual effect of precipitations on the harvests.

Regarding the precipitation regime, the multiannual average during the interval 2015–2017 was of 608.7 mm. 2016 was the year with most drought periods, while the rainiest one was 2017. During the mentioned interval, the annual average values present oscillations between years, especially between consecutive months.

During the vegetation period, the highest precipitations were observed in July 2015, respectively 81.2 mm and the lowest ones, in September 2016, respectively 46.6 mm.

Monthly precipitation distribution indicates a pluviometric minimum in February with a multiannual average of 30.9 mm, with oscillations between consecutive years, registering the following values: 3.4. mm in 2015, and 1.5 in 2017 as compared to the pluviometric maximum in February 2017 of 31.4 mm.

In July we registered a multiannual average of 81.2 mm, with the following oscillations: 80.1 mm in 2017 and 80.3 mm in 2016.

As an average, 119.9 days of higher precipitations than de 0.1 mm were registered, without any month when no precipitations fell.

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