PRACTICAL MODEL OF CLIMATE VARIABILITY AND VEGETATION DISTRIBUTION IN THE OLTENIA PLAIN

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Abstract. The paper is focused on the following research objectives: (1) characterization of the elements of physical-geographic similarity of the Oltenia Plain, (2) recording the evolution over time of temperature and precipitation parameters from the five meteorological stations located in the surveyed area (3) analysis of the index of desertification (De Martonne), and (4) investigating the distribution of vegetation (CLC), which may bring changes in the analysis of interval 1990-2018. The extreme meteorological phenomenon –desertification - for the Oltenia Plain was analysed in terms of time and space, through the calculation and statistical interpretation of the Martonne Index. In Oltenia Plain, there is an obvious altitudinal zoning of vegetation as result of the fact that the altitude increases from the south (about 18-50 m in the Danube Meadow) to the north (about 200 m in the Getic Piedmont), which means a decrease in temperatures in highlands, and, to a certain extent, an increase in the amounts of average annual precipitation in the meadow areas. The purpose of this research was the analysis of the vegetation's territorial distribution, taking into account the values, the "De Martonne" desertification? Index, the information presented in books and scientific articles, but also the Corine Land Cover statistical database (CLC 1990/2012- 2018).

Keywords: desertification, vegetation, extreme meteorological phenomena, drought, Oltenia Plain.

Rezumat. Model practic al variabilității climatice și al distribuției vegetației din Câmpia Olteniei. Lucrarea se bazează pe următoarele obiective de cercetare: (1) caracterizarea elementelor de similitudine fizico-geografică a Câmpiei Olteniei, (2) surprinderea evoluției în timp a parametrilor de temperatură și precipitații de la cele cinci stații meteorologice din arealul analizat (3) analiza indicelui de aridizare (De Martonne), și (4) investigarea distribuției a vegetației (CLC), care poate să aducă modificări în intervalul de analiză 1990-2018. Fenomenul meteorologic extrem – aridizarea a fost analizat în timp și spațiu pentru Câmpia Olteniei, prin calcularea și interpretarea statistică a Indicelui de Martonne. În cadrul Câmpiei Olteniei, se înregistrează o zonare altitudinală evidentă a vegetației ca urmare a faptului că altitudinea crește de la sud (circa 18-50 m în Lunca Dunării) la nord (aproximativ 200 m în Piemontul Getic), ceea ce înseamnă scăderea temperaturilor în zonele înalte, și, într-o anumită măsură, creșterea cantităților de precipitații medii anuale în zonele de luncă. Scopul cercetării a fost reprezentat de analiza repartiției teritoriale a vegetației, ținând cont de valorile, indicelui de ariditate "De Martonne", de informațiile redate în cărți și articole științifice, dar și de Baza de date statistică Corine Land Cover (CLC 1990/2012-2018).

Cuvinte cheie: aridizare, vegetație, fenomene meteorologice extreme, secetă, Câmpia Olteniei.

INTRODUCTION

The Oltenia Plain is presented in specialized literature as one of the most important agricultural regions in Romania and one of the most sensitive in terms of the instability of extreme meteoritical/weather phenomena, among them drought (DUMITRAȘCU et al., 2018), hail and even storms associated with electrical discharges (frequent in the warm season, associated with very pronounced atmospheric instability).

The most recent extreme meteorological phenomenon in the Oltenia Region was recorded in the Dolj County, more precisely a tornado, which occurred on August 21, 2022; this rare phenomenon, but increasingly common in the South-West area of Romania, is due to climate change. Humidity, atmospheric instability and strong wind contributed to the formation of this extreme meteorological/weather phenomenon. At the same time, we consider the following basic elements regarding the susceptibility of Oltenia Region to extreme events, related to climate change: the sandy soils and sand dunes in the Dăbuleni area – natural elements, and the high unemployment, poverty and lower standard of living – socio-economic elements.

Climate variability can influence droughts through changes in atmospheric water holding capacity, circulation patterns and moisture supply (UKKOLA et al., 2020). Currently, the Southwest Oltenia Region is experiencing extended desertification due to climate variability in recent years. The two parameters that have negative effects as far as desertification is concerned are: the decrease in rainfall and the increase in temperatures; these statistical parameters lead to a reduction of vegetation, grain cultivation, animal husbandry and fruit and vegetable production.

In Southwest Romania, the desertification process is very intense, especially in the area called "Sahara of Oltenia"; the largest affected area is located in the Dolj County, being delimited by Calafat, Poiana Mare, Sadova, Bechet, Dăbuleni and the Danbe, with an area of 104,600 ha. This entire surface is currently covered by sand, is arid and shows desertification tendencies (VOROVENCII, 2017). Desertification is a natural phenomenon that contributes to highlighting the fragility of the territorial system in the Oltenia Plain. Agricultural production systems are the most affected by climate change (PEPTENATU et al., 2013), as desertification generates a significant reduction in the agricultural production of cereals (wheat, corn, barley, oats, etc.), which are highly dependent on favorable climatic conditions.

Given its devastating and widespread effects on the environment, economy and society, the notion of 'drought' has gained global visibility/attention/importance in recent decades. Drought can occur in all climate regions, including wetlands (KUNDA et al., 2021). Even so, the severity of this phenomenon and its frequency of occurrence may not be similar in all regions. Drought represents one of the most vulnerable natural hazards with negative consequences on the natural, economic and social environment of a geographic area (AHMADALIPOUR et al., 2019; BUSHRA et al., 2019; MOKARRAM et al., 2021).

The economic damage caused by drought and its negative effects on human society are greater than those of other extreme meteorological/weather phenomena (PANDEY et al., 2010). Therefore, it is very important to make maps of natural hazards, such as drought maps, to identify possible areas of higher risk for a future better management (BATHRELLOS et al., 2017). Droughts have a direct impact on drinking water supplies and water-dependent economic sectors such as agro-industry, crop irrigation, hydroelectricity production and other related activities (PEÑA-GUERRERO et al., 2020). We consider it very important to point out the triggering factors of the climatological risk phenomenon known as "drought":

- natural factors (they define the particularities of the Oltenia Plain: relief, edaphic factor and type of vegetation);
- anthropogenic factors (population and land use);
- time factors (the amount of precipitation, relative humidity, air temperature, soil temperature and wind speed – these elements are influenced by the circulation of air masses).

DATA & METHODS

1. Field of study. The Oltenia Plain represents the western extremity of the Romanian Plain (which is the largest relief unit, in terms of surface area), which is delimited by the Danube River to the west and south, the Olt River to the east (ROȘU, 1980) and the Getic Plateau to the north, covering approximately 8350 km^2 (ie 17% of the Romanian Plain surface) (BĂLTEANU et al., 2013). The relief is fragmented by wide valleys that create flood plains, terraces and piedmont plains, overlapping over four counties: Mehedinți, Dolj, Olt and Teleorman (MITITELU-IONUȘ et al., 2019).

In terms of formation, according to some researchers (COTEȚ, 1957; POSEA et al., 1987), the Oltenia Plain lays on 5 terraces above the level of the Danube, (the highest terrace having a height varying between 95 and 110 m), to which the plains of old Piedmont type should be added (Sălcuței Plain, Leu-Rotunda Plain, with altitudes of 100-180 m).

Within the Oltenia Plain, the following land forms are identified: Blahniței Plain, Băilești Plain and Romanați Plain (Fig. 1). Hypsometry is between 18-50 m in Salciei Meadow, Bistrețului Meadow, Potelului Meadow and Suhaei Meadow, up to 151-203 m in the Getic Piedmont area.

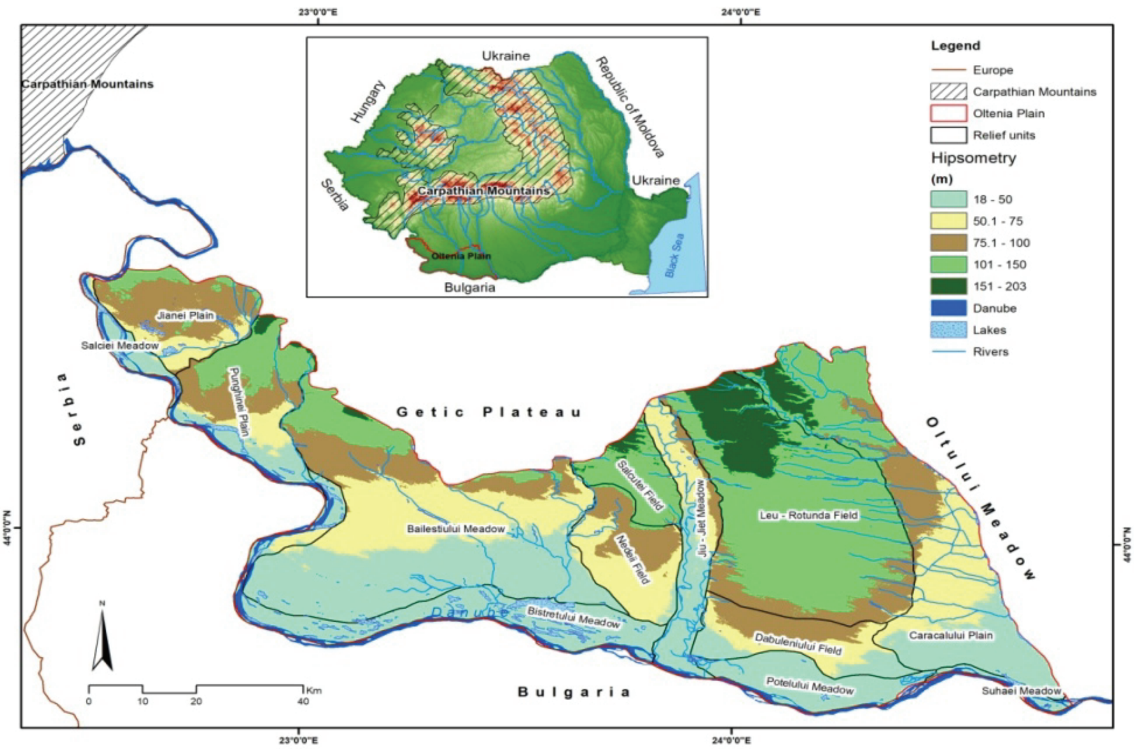

Figure 1. Geographical location at national level/hypsometry of the Oltenia Plain
Source: authors' processing of ArcGIS 10.1 data http://www.geo-spatial.org/.

Oltenia Plain had developed over geological eras, witnessing two major phases (CEAUȘESCU & LAZĂR, 2013, p. 11):

1. The Pre-Quaternary phase, which lasted from the formation of Getic Plateau until the end of the Pliocene period, and corresponds to the process of marine and lacustrine subsidence;

2. The Quaternary phase, the most important in the formation of the plain land, which took place from the end of Levantine period to the present, during which the entire Getic Plateau becomes dry land.

The presence of sand dunes, oriented West-North-West and East-South-East, mitigates to some extent the gradual descent of the relief towards the Danube, especially towards the Danube meadows, so that these sand dunes determine the landscape of a vast plain. From a geological point of view, the Oltenia Plain consists of Quaternary deposits, with aeolian, deluvial-rainfall and fluvial deposits predominating on its surface.

Dunes are land forms with the appearance of mounds or small hills, which have emerged due to accumulation provoked by winds. According to the structural character and fineness of the particles that make them up, aeolian deposits are of two types: sandy and dusty (COTEȚ, 1957). Both of these eolian formations are found in the Oltenia Plain: dune sands and loess. (COTEȚ, 1957).

The Oltenia Plain dunes are closely and directly related to the Danube and its tributaries' activity, and indirectly, by nature of the deposits, to the Carpathians and the plateaus crossed by it and its tributary valleys (COTEȚ, 1957).

The Blahniței Plain has the appearance of an extended plateau, with lower altitudes in the west of the Blahniței Valley, where it corresponds to the 40-50 m terrace and higher in the east, as a result of the presence of the 60-70 m and 90-100 m terraces. Almost the entire plain it is covered with sands, gravels and loessoid deposits resulting from aeolian and fluvial deposits (Fig. 2), between which a series of lakes are interspersed. The Băilești Plain, located between the Blahnita River in the west and the Jiu River in the east, crossed by the Desnătui River from north to south, is a terraced plain, made up of gravel and sand for the most part, with the exception of the Salcuței Plain located to its northeast, in which marls and clays predominate (Fig. 2). The Romanați Plain, located between the Olt River to the east and the Jiu River to the west, has the highest altitudes within the Oltenia Plain, being covered by sandy dunes found to the east of Jiu and presenting a north-south slope.

In conclusion, from the information listed above, a uniform distribution of rock types can be observed in this territory.

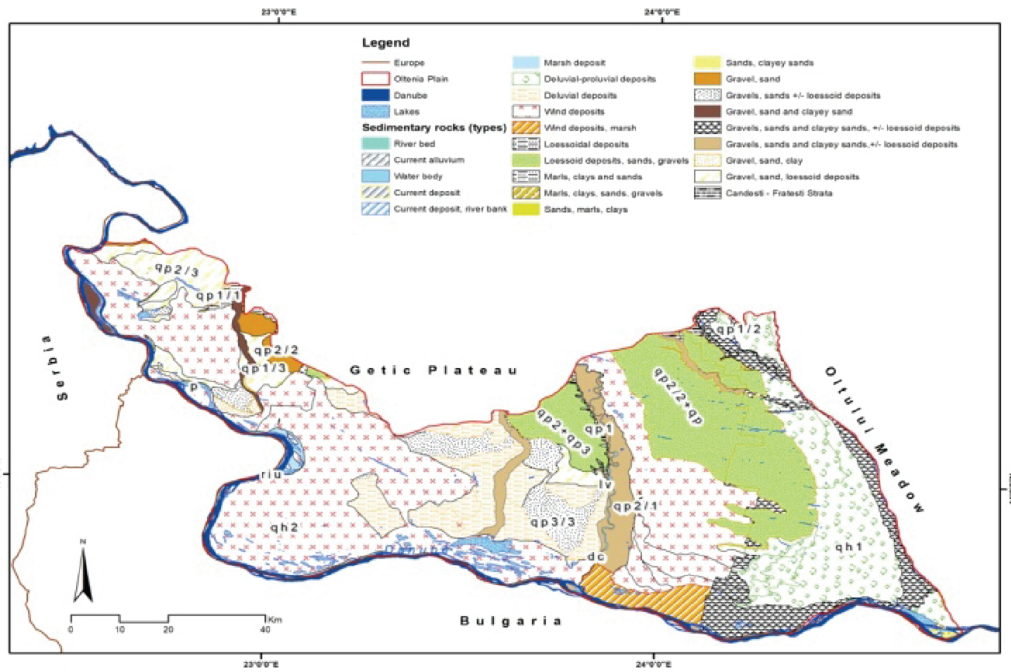

Figure 2. Distribution of sedimentary rocks in the territory – Oltenia Plain
Source: authors' processing of ArcGIS 10.1 data http://www.geo-spatial.org/.

Along with the previously analysed geological substratum, the texture of the edaphic factor plays an important role in the occurrence of dryness and drought phenomena in the Oltenia Plain. Therefore, according to the Geography of Romania, (2005), ""almost 1/3 of the Oltenia Plain surface is covered by an uneven blanket of sands and dunes, which follow the Danube Meadow, most of its terraces and those of the Jiu River, a good part Leu-Rotunda Plain and only partly the terraces found on the lower course of Olt River. Thus, along the Danube, the sandy relief extends with interruptions over a distance of over 200 km, between the Ostrovul Corbului/Raven Isle, in the west, and close to Olt River, in the east"" (Fig. 3).

The types of soil existing in the geographical space of the Oltenia Plain were formed under the conditions of a smooth, plain relief; these having a high degree of fertility for various agricultural crops. The types of edaphic factor are grouped into the following classes: Molisoils, Clayey soils, Cambisoils, hydromorphic soils, halomorphic soils and undeveloped soils (CEAUȘESCU & LAZĂR, 2013).

Most of the Oltenia Plain is covered with chernozem, formed on loess and loessoid deposits (Fig. 3). These soils have a very high nutritional potential. Their fertility is given by nitrogen, phosphorus and potassium salts, i.e. those substances in the soil that "quickly reach an advanced degree of exhaustion through leaching and lifting along with the crops" (IONESCU ȘIȘEȘTI, 1966, p. 188).

Also, on the upper terraces of the Danube River from the northern part of Oltenia Plain, at the point of contact with the Getic Plateau, clayey soils develop, with reddish-brown and reddish-brown Luvic soil types. These types of soils are characteristic of deciduous forests, being considered soils that make the transition between podzol and chernozem.

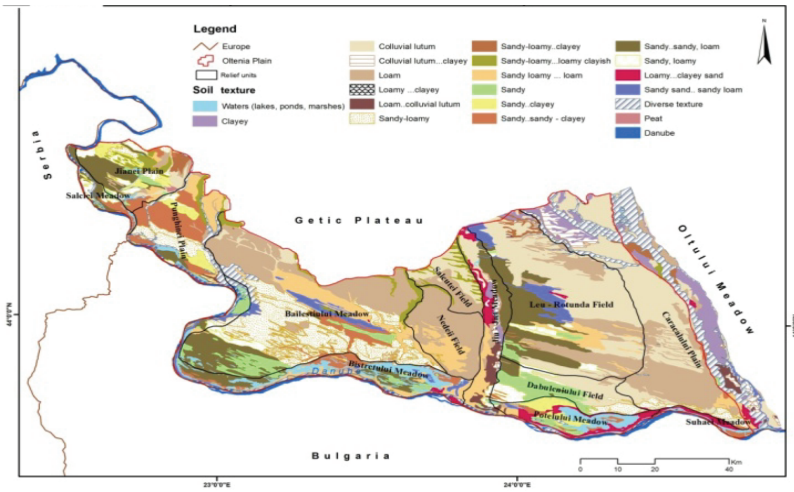

Figure 3. Structure of the edaphic factor in Oltenia Plain
Source: authors' processing of ArcGIS 10.1 data http://www.geo-spatial.org/.

The hydrographic network is composed of rivers (Olt and Jiu), having their source in the Carpathian Mountains and the Getic Plateau (Desnățui, Blahnita, Teslui), and the southern limit is the Danube River and its meadows (Fig. 4).

The length of the hydrological network studied within the Oltenia Plain totals 508 km distributed over the following rivers (Fig. 4): Topolnița, Blahnita, Drincea, Balasan, Desnătui, Baboia, Jivan (Perișor), Jiu, Jieț, Gioroc, Olteț, Gemărtălui, Teslui and Gologan (Caracal) (ROGOZ, 1979).

An extremely interesting aspect of the hydrographic network is the change of direction of the main rivers, when passing from the Getic Plateau to the plain. For instance, Desnătui River deviates to the southeast, a phenomenon interpreted by Vâlsan (1918), as a result of capturing phenomena. On the other hand, COTEȚ (1957) explains it as the effect of the influence of neotectonics' movements imprinted by the crystalline marginal fault/fracture and, at the same time, by the presence of the Lom Plateau.

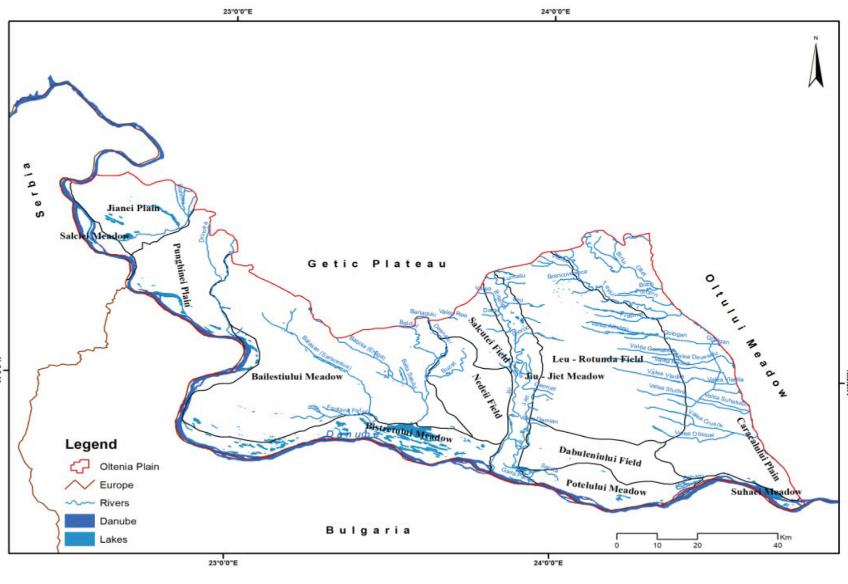

Figure 4. Hydrographic network tributary to Oltenia Plain
Source: authors' processing of ArcGIS 10.1 data http://www.geo-spatial.org/.

Especially in rainy years (1970, 1972, 1975), when the amount of water falling over short periods of time is very high, some deviations occur in the rivers' flow regime. In such situations, river flows greatly exceed (by 25-50 times) the multiannual average (CEAUȘESCU & LAZĂR, 2013). On the Jiu River, at the Podari Hydrological Station, in 1972, the highest flow was recorded, namely 2,000 mc/s, followed by 1,690 mc/s, at the Zăval Station (Fig. 5). The lowest flow was recorded, also in the same year, at the Afumați Hydrological Station, on the Baboia River.

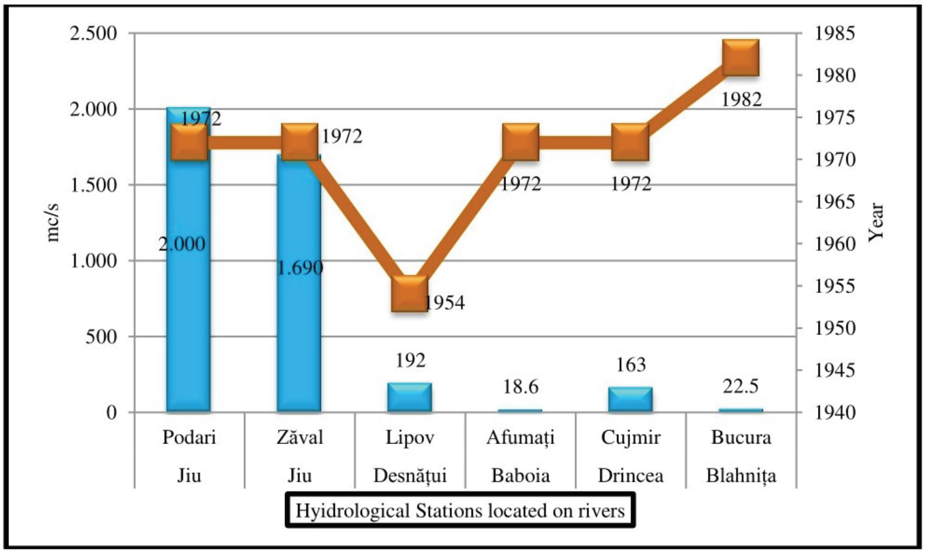

Figure 5. Maximum flows recorded on the rivers of Oltenia Plain between the Danube and Jiu
Source: data processing after PLENICEANU, 1999.

2. Gathering of statistical data. In order to elaborate the graphs and the temperature and precipitation maps, the values of meteorological elements were extracted from the points where the stations are located in the Oltenia Plain. Thus, the resulting data for Calafat, Băilești, Bechet, Craiova, Caracal stations were analysed (Table 1), and all the values covering the Oltenia Plain area were used to create the maps (Fig. 6). The used meteorological elements are: atmospheric precipitation and air temperature.

Table 1. Meteorological/weather stations in the Oltenia Plain.

No.	Meteorological/ weather stations	Latitude	Longitude	Altitude (m)
1.	Calafat	43°59`	22°57`	61
2.	Bechet	43°47`	23°57`	36
3.	Băilești	44°01`	23°20`	57
4.	Caracal	44°06`	24°22`	106
5.	Craiova	44°19`	23°52`	192

(Source: data processing after VLĂDUȚ, 2010, 2016, 2017)

This study used CORINE Land Cover (CLC) databases, for the period 1990/2012-2018, to delineate forest areas for which statistical data were extracted and analyzed. Other geospatial data used included the limits in vector format of different spatial units (example: relief units that are subdivisions of the Oltenia Plain), which were used to analyze the possible relationships between the conditions of the natural landscape and the climatic conditions of the studied area.

The "De Martonne" index (DE MARTONNE, 1926) is one of the frequently used indices in Romania (DE MARTONNE, 1920 cited by CROITORU et al., 2013; BARBU & POPA, 2001; GACEU, 2002; DUMITRAȘCU, 2006; PĂLTINEANU, 2007; SANDU et al., 2010; VLĂDUȚ, 2010; VLĂDUȚ et al., 2017), for the characterization of climatic restrictions in a certain region, representing the ratio between annual amounts of precipitations and the sum of the average annual temperature and the coefficient 10:

$$Ia = \frac{P}{T + 10} \quad (1)$$

P – represents the average annual amount of precipitations;
T – represents the average annual temperature;
10 – coefficient that is added to obtain positive values

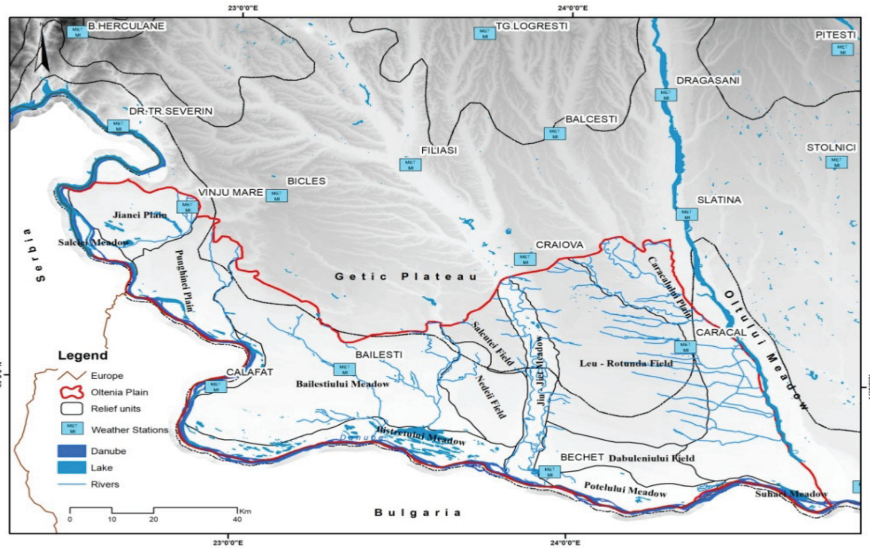

Figure 6. Location of meteorogical/weather stations in Oltenia Plain
Source: authors' processing of ArcGIS 10.1 data http://www.geo-spatial.org/.

RESULTS & DISCUSSIONS

1. Analysis of average annual temperature (°C) and multiannual average amount of precipitation (mm/an). According to the Climatological Atlas of R.S. Romania (1966), it turns out that the analysed area has a continental lowland climate. The region, being open to the east, remains exposed to invasions of very cold continental air in winter and of very warm air in summer, hence increasing the amplitude of temperature variations throughout the year. (ROGOZ, 1979).

Air temperature is the main weather element that expresses from a physical point of view the speed with which the air particles perform boolean (disordered) movements caused by the thermal state of air volume (***. CLIMA ROMÂNIEI, 2008).

Air temperature is measured 2 m above the ground, with the help of several types of instruments (ordinary thermometers, minimum thermometers, maximum thermometers and the thermograph), installed in the shelters on the weather station platforms (CIULACHE & IONAC, 2003). In meteorology, air temperature is monitored, and in agrometeorology, soil temperature.

From a climatic point of view, according to the WorldClim - Global Climate Data (***. https://www.worldclim.org/) high average annual temperatures are seen in the Oltenia Plain (1961-2000) (11-12 °C) and two areas can be observed: the northern area where temperatures range from 10 to 11°C and the southern area that mainly occupies the Danube Meadow, where the multiannual average temperatures range from 11 to 12°C (Fig. 7), being the area with the highest temperatures in the Romanian Plain, even in the country.

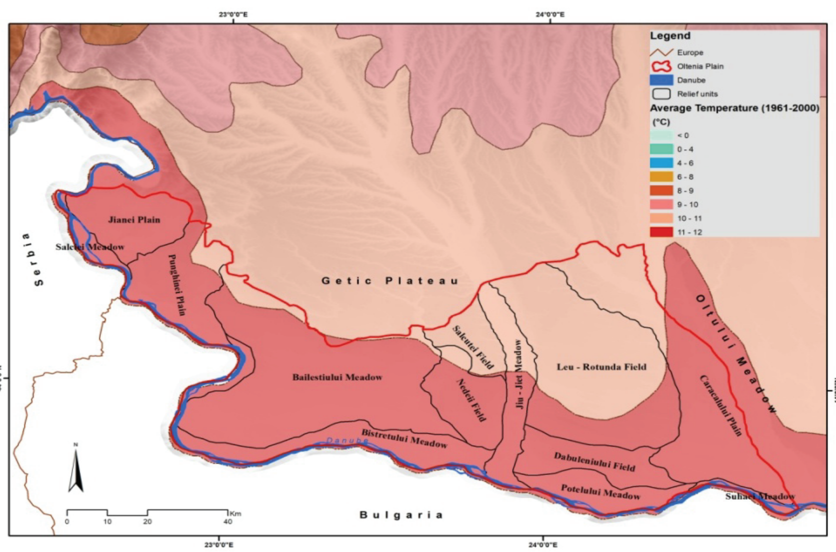

Figure 7. Multiannual average temperature 1961-2000
Source: authors' processing of ArcGIS 10.1 data https://www.worldclim.org/.

Atmospheric precipitations include all the products of condensation and crystallization of water vapor in the atmosphere, also called hydrometeors, which usually fall from the clouds and reach the earth's surface in liquid form (rain and downpour, drizzle), solid form (snow, hail) or in both forms at the same time (sleet and sleet showers) (***. CLIMA ROMÂNIEI, 2008). The main characteristic of atmospheric precipitation regime and its space-temporal distribution is its variability and discontinuity in time and space (***. CLIMA ROMÂNIEI, 2008).

The average multiannual precipitations (1961-2000), according to (***. https://www.worldclim.org/) WorldClim - Global Climate Data information, range from 550 to 600 mm/year and exceed 600 mm/year to the west of the Oltenia Plain (Jianei Plain) (Fig. 8), causing a frequent occurrence of dryness and drought phenomena.

Meteorological drought represents the decrease of subnormal precipitation, for months to years (CARRÃO et al., 2014), and relative humidity, along with the increase of evapotranspiration under conditions of high temperatures, as well as higher duration of sunshine and wind frequency and speed. Thus, meteorological drought is triggered by persistent anomalies in a high-pressure system at global-scale atmospheric circulation patterns (GIANINI et al., 2003; SCHUBERT et al., 2004; SEAGER & HOERLING, 2014; CHATTERJEE et al., 2022). Unlike drought, the dryness phenomenon has a lower degree of intensity, being a precursor of the first one.

According to Hellman's criterion (DONCIU, 1928; BOGDAN & NICULESCU, 1999; MARINICĂ, 2006; SOROCOVSCHI, 2009), a period of dryness is characterized by a decrease in the amount of precipitation below the daily average for 5 consecutive days, while the drought phenomenon is seen where, for a period of either 14 consecutive days (cold season) or 10 consecutive days (warm season), there was no precipitation at all or it was quantitatively insignificant. The phenomena of dryness and drought can be evaluated based on their duration, intensity and spatial extent. Depending on the duration, droughts have been classified into episodic and permanent (CIULACHE & IONAC, 1995).

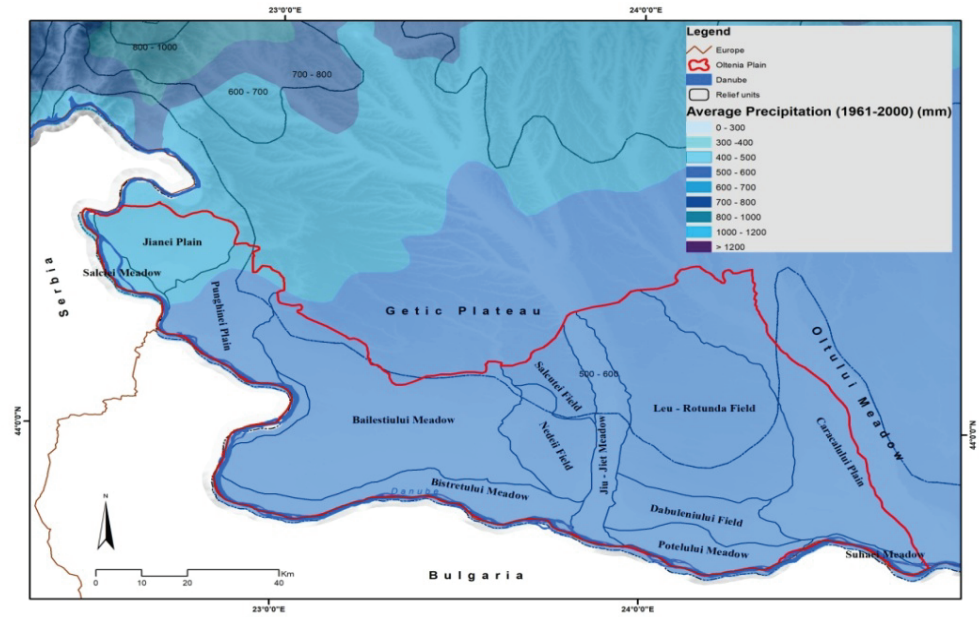

Figure 8. Multiannual average rainfall 1961-2000
Source: authors' processing of ArcGIS 10.1 data https://www.worldclim.org/.

"De Martonne" – values lower than 5 correspond to arid climate, between 5 and 20 - semi-arid, 20-30 - semi-humid, 30-50 - humid, and values greater than 50 correspond to very humid climate (PĂLTINEANU, 2007; DUMITRESCU, 2012).

This aridity index, introduced by De Martonne, is one of the indices used for determining irrigation demand (WORLD METEOROLOGICAL ORGANIZATION, 1975, NASTOS et al., 2013, apud SHAHABFAR & EITZINGER, 2013).

In the Oltenia Plain, during the period 1901-1990, this index recorded values between 24 and 26, which means that semi-arid years prevailed during the analyzed period (Table 3).

Table 3. „De Martonne" Aridity Index (1901-1990).

No.	Weather Stations	Average annual amount of precipitation	Average annual temperature	Aridity Index
1.	Calafat	558.7 l/m^2	11.5°C	25.90
2.	Bechet	529.6 l/m^2	11.2°C	24.98
3.	Băilești	567.6 l/m^2	11.1°C	26.90
4.	Caracal	541.7 l/m^2	10.9°C	25.91
5.	Craiova	531.7 l/m^2	10.9°C	25.44

Source: authors' processing

The purpose of this index is to identify the months in which irrigation is necessary and which, in turn, depend on the amount of precipitations and the surrounding environment's temperature. Therefore, irrigation becomes necessary when the values of this index are lower than 20 (SHAHABFAR & EITZINGER, 2013). Following the calculation of the Aridity Index (Table 2), irrigation is not necessary in the Oltenia Plain, since no values lower than 20 were recorded during the analysed period.

2. Analysis of vegetation CORINE Land Cover 1990-2018. The problem of the dynamics and evolution of the use and cover of land categories is fundamental in order to accurately predict future changes and to facilitate the development and proposal of sustainable management practices designed to preserve essential landscape functions (LIN et al., 2007).

On the other hand, the investigation and interpretation of past, present and future land use categories is substantially important for the rigorous and detailed study of two essential research questions, namely: (1) knowing the exact space in which land use/cover changes occur in the Oltenia Plain and (2) analysis, in terms of time and space, of the new land categories.

Changes and modifications in the evolution of land use and agricultural landscapes are the result of socio-political and economic transformations (OVREIU et al., 2021).

The land use maps for the Oltenia Plain (Figs. 9, 10 and 11) were made in the ArcMap software. The database for Corine Land Cover product was downloaded for free from https://land.copernicus.eu/pan-european/corine-land-cover, choosing the product for years 1990, 2012 and 2018 (the last year for which this product was created). The map contains all the specific elements, and these were technically processed in the program as follows: View - Layout View - Insert: Title, Legend, Scale Bar, Text, etc. The resulting map was exported: File – Export Map, and the saving destination and the format (jpg) were chosen.

The analysis of land use in the Oltenia Plain in terms of space and time, using the data provided by Corine Land Cover (Figs. 9, 10 and 11), shows significant changes in the categories of land used for the periods 1990-2012, 1990- 2018, but also 2012-2018. Forests, pastures and water resources (rivers, lakes) represent the three fundamental elements that play a key role in maintaining optimal ecological conditions for the Oltenia Plain terrestrial and aquatic ecosystems.

In all three periods of analysis (1990-2012) it is noted that arable land prevails in a very large proportion, compared to the other categories of land used in the Oltenia Plain. Arable land is the most important category of land use, because it maintains soil moisture for agricultural crops during the drought period (July, August, September), while cereal crops represent a barrier against the consolidation of sand dunes (Southern Oltenia – Sand Dune Museum from Dăbuleni).

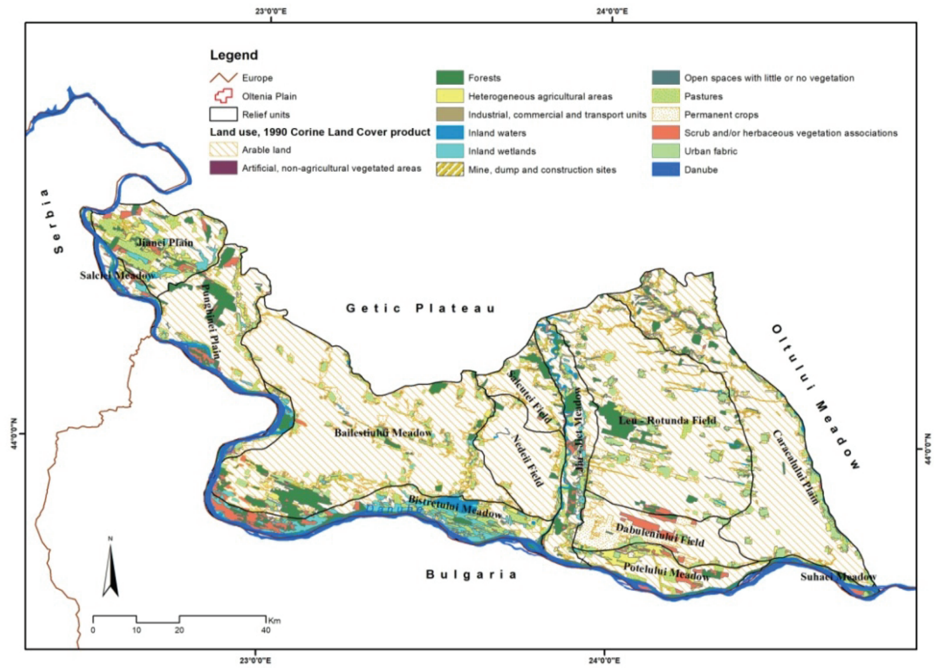

Figure 9. Corine Land Cover 1990

Source: authors' processing data https://land.copernicus.eu/pan-european/corine-land-cover.

At first glance, from the perspective of practical field analysis, forest and pasture areas have not undergone drastic changes in geographic space, but, after a careful and thorough analysis of the Corine Land Cover database during the aforementioned 28 years, the differences between the surfaces of forest and pastures become worrisome for the population, but at the same time for the ecosystems, which maintain optimal ecological conditions for the development of vegetation in time and space.

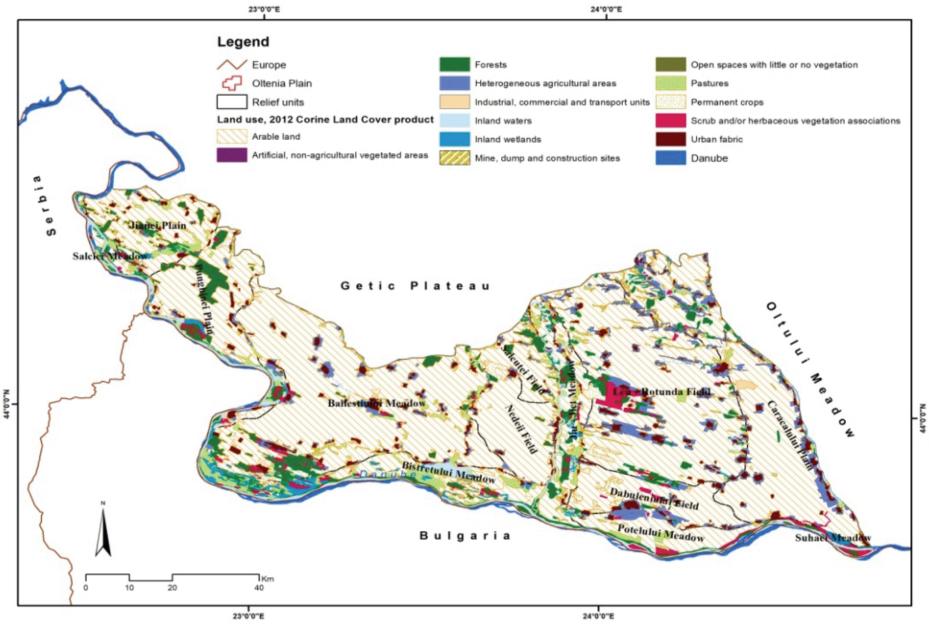

Figure 10. Corine Land Cover 2012
Source: authors' processing data https://land.copernicus.eu/pan-european/corine-land-cover.

The main cause of forest decline (Fig. 11), compared to 1990 (Fig. 9) and 2012 (Fig. 10), is represented by the massive deforestation of vegetation carpet. Thus, according to the Corine Land Cover database, significant forest areas were cleared in the area of contact between the Dăbuleni Plain and the Leu-Rotunda Plain, the Potei Meadow, but also in the most vulnerable areas, namely in the southern part of Băilești Plain and the Ciuperceni – Desa area.

The Oltenia Plain is considered the most vulnerable in Romania, due to the expansion of sand dune areas. We propose to the local communities, but also to the governmental institutions active in the domain under study, to plant the trees so to restore the vegetal carpet. In conclusion of the previously mentioned, deforestation represents an increasingly obvious phenomenon in recent years; at the same time, massive deforestation causes significant problems in the destabilization of sand dunes. Over time, these sand dunes in the Oltenia Plain will increase considerably in size, due to the reduction of the forest ecosystem.

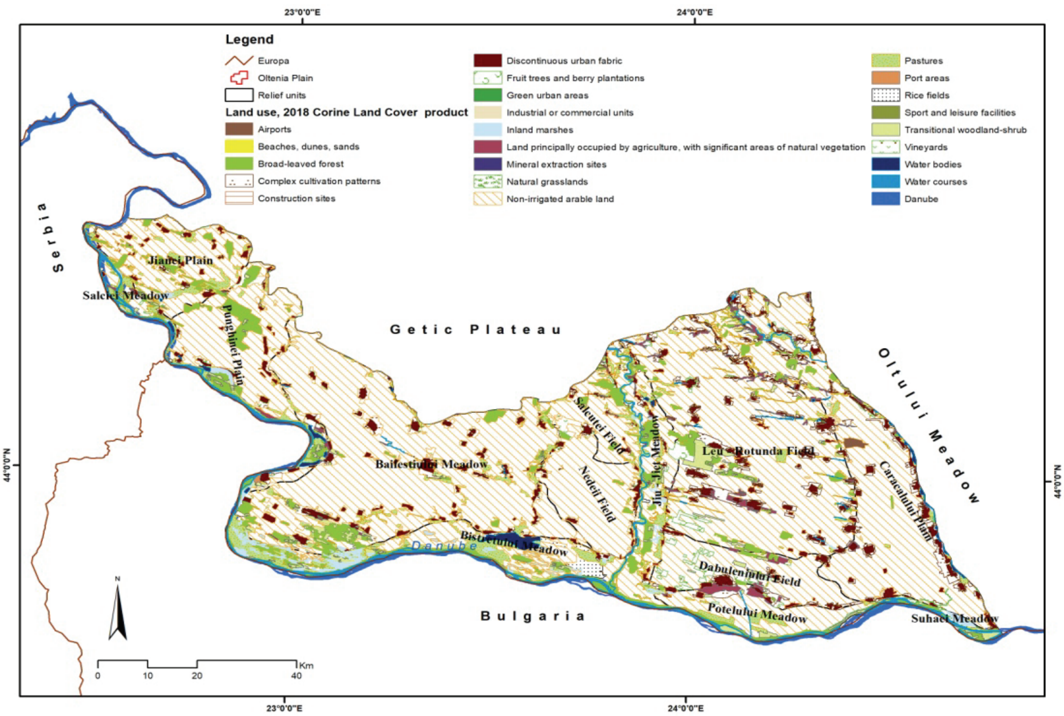

Figure 11. Corine Land Cover 2018
Source: authors' processing data https://land.copernicus.eu/pan-european/corine-land-cover.

CONCLUSIONS

Precipitations represent the most variable climatic parameter in time and space, and their fluctuations affect, first of all, the socio-economic activities, and secondly, the adequate development of the ecosystems in the Oltenia Plain (VLĂDUȚ, 2018).

From our point of view, the "De Martonne" Index is of particular importance in the months when agricultural crops are vulnerable to the phenomenon of drought, when their requirements for the amount of water in the soil are high (May, June, July and August). The best operational example with applicability of this aridity index in Oltenia Plain agriculture is for cereal crops (autumn wheat). Generally, the growing of winter wheat starts in late October and lasts until July (ZIAEI & SEPASKHAH, 2003). With the help of this index, we could roughly monitor the risk of drought, for wheat crops in the Oltenia Plain area.

This paper presents a contribution to the studies that focus on the quantitative analysis (average annual temperature °C, average multiannual precipitation (mm/year)) and the distribution of vegetation in the territory, which was carried out based on the Geographical Information System in the Oltenia Plain.

After these investigations, the authors concluded that the aridity index is most often used in climatological studies, because it expresses the degree of dryness of a geographical space (example: Oltenia Plain). Thus, there is a strong correlation between remote sensing and the De Martonne Index, and the strength of this relationship depends very much on the climatic variables and the evolution of the vegetation in the analyzed study areas.

Also, for a more accurate evaluation of results, the use of more climatological data is required, including the calculation of the Angot and Fournier Rainfall Indices. The Angot index is used in the annual variation of precipitation analysis to highlight rainy intervals ($k>1$) and dry intervals ($k<1$). Thus, depending on the obtained values, the qualifier of rainy month can be assigned for values higher than 1, and that of dry month can be assigned for values lower than 1.

Following the calculation of the Angot Pluviometry Index, it is possible to highlight, based on the obtained values, a predisposition for the triggering of slope and land erosion processes for the study area. The Angot index represents the ratio between the daily average amount of precipitation in a calendar month and the multiannual average amount.

The Fournier index is based on the correlation between the amount of precipitations in the rainiest month of the year and the annual amount of precipitations.

Regarding the effects of climate change on the increase of meteorological drought conditions, we consider it appropriate to introduce, validate and apply drought indices for the construction of monitoring and assessment systems to be used in the plain to oversee the extreme weather phenomenon - drought.

From our point of view, the following methods must be used to mitigate and combat the risks triggered by the drought phenomenon: irrigation for agricultural crops, cultivation of plant species resistant to dryness and drought (sorghum, hazelnut, rapeseed), use of fertilizers and of agrotechnical management systems. The growth of vegetation following the manifestation of an evolution in time and space that is more or less predictable can represent a topic of maximum interest to researchers who study ecology, environmental geography, vegetation development, ecosystem evolution, etc.

The dynamics of vegetation in the Oltenia Plain is thus based on the fundamental idea of the plant species' ability to grow in certain ecological conditions, thus determining the plant groups' composition that will exist in the near future. The ecological conditions assume the influence of both abiotic and biotic factors on the vegetation of the Oltenia Plain (VAN DER MAAREL et al., 2005).

Thus, considering the previously mentioned, the directions of evolution and development of vegetation are influenced by: the characteristics of natural elements that make up the habitat (relief, climate, hydrographic network, edaphic factor, rock types, vegetation layering, etc.), the differentiated capacity of land categories used in terms of time and space, and the ecological potential of terrestrial and aquatic ecosystems.

The study carried out on the last dry interval in Oltenia (MARINICĂ, 1994) led us to some conclusions of a dynamic nature, namely the following (MARINICĂ, 2006):

- most of the rainfall potential of atmospheric fronts was left on the northern slopes of the Carpathian Mountains, while for Oltenia the precipitations were extremely little or completely absent;
- depending on the ratio between the thickness of the cold air mass and the height of the mountain obstacle, the atmospheric fronts encountered major "difficulties", sometimes failing, to cross it, and those that overcame the obstacle manifested themselves only in the field of temperature, pressure and wind; the cloudiness broke up due to depletion of condensation potential on the mountains' northern slopes, adiabatic heating of the air mass down the mountain, and impact with a much warmer air mass extending south of the Carpathians;
- there were also situations when, after crossing the Carpathians, at some distance from the mountain peaks, above the Subcarpathians and the Getic Plateau, these fronts recovered somewhat and gave some precipitation, but insufficient;
- in few situations, when the Icelandic cyclones penetrated the Mediterranean Sea and then moved over Oltenia and southern Romania, in the first stage of the penetration of the warm front, little or no precipitation occurred; only when the cold front penetrated did precipitation fall but, due to the soil being strongly heated from the previous days, the rapid

clearing of sky and wind intensifications provoked by the entry of Azorean Anticyclone ridge, determined the rapid evaporation of water from the soil and, in 24-48 hours, the moisture decreased drastically in the soil.

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