CONSIDERATIONS ON THE DROUGHT PHENOMENON IN THE WESTERN PLAIN

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RESEARCH ARTICLE (REVIEW ARTICLE)

Abstract

The analysis of rainfall and temperature data reveals the occurrence and intensity of drought and aridity phenomena in the Western Plain. In order to study these phenomena data recorded at the Oradea weather station between 1970 and 2020 were used. The interpretation of climographs and aridity and drought indicators provides insight into the evolution, extent and effects of aridity and drought in the context of climate change. Dryness and drought events in the area included in the study represent on average 5 months per year. The monthly analysis of the number of dry days shows a summer-autumn drought and a spring drought, with the summer one being much more intense.

Keywords: aridity, climate change, drought, frequency.
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INTRODUCTION

In Romania, drought phenomena, unusually strong in some periods, were reported and described a long time ago.

In the last decade, as a result of profound transformations (deforestation, destruction of protective forest covers etc.), along with an unbalanced climate background, which have occurred in most of the land (agricultural and forestial), drying processes have spread.

Drought is a natural phenomenon that occurs when precipitation is significantly lower than normal, leading to disturbances in the water balance that adversely affect the productive systems of land resources.

Drought and desertification are major current problems of mankind and therefore the UN General Assembly decided that 17 June each year shall be designated as World Desertification and Drought Day, thus demonstrating our agreement with the importance attributed to these phenomena by the highest international forum in view of the worrying topicality and perspective of changes on a planetary scale. (Hera and Canarache, 2004).

Romania's territory subject to desertification covers Dobrogea and part of south-eastern Romania. An important part of Moldova, the Romanian Plain and a portion of the Western Plain reaching as far as the sandy area of Valea lui Mihai is considered a "zone vulnerable to desertification" (Canarache A., 2001). This is a radical change in perception, since areas where not many years ago (20-30 years) scientific research only addressed the issue of excess humidity (the west of the country, but not only) are now considered to be areas vulnerable to desertification.

MATERIAL AND METHOD

Drought and aridity in the Western Plain were studied based on air temperature and atmospheric precipitation data. The meteorological data used were recorded at the Oradea weather station between 1970 and 2020 (51 years).

RESULTS AND DISCUSSIONS

Air temperature regime

The multiannual average of this climatic parameter in Oradea is 10.8°C.

The annual average air temperature shows the lowest values in the first part of the period included in the study - 1970-1993.

Starting from 1994 a significant increase in temperature values is recorded.

It can be concluded that *the first 2 and a half decades were cooler, while the last 2 and a half decades were warmer*.

The warmest years were **2014** and **2019** (12.8°C) (Figure 1).

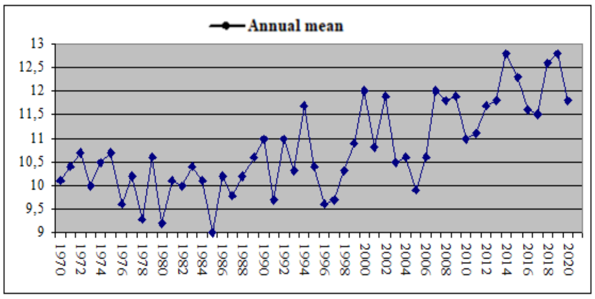

Figure 1. **Evolution of annual average temperature in Oradea, 1970-2020**

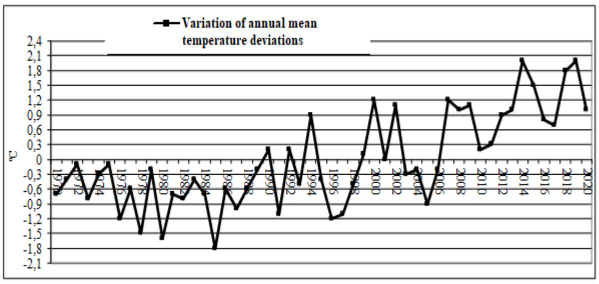

Figure 2. **Variation of annual average temperature deviations against the multiannual average in Oradea, 1970 – 2020**

The coldest year was **1985** (9.0°C) (Figure 1, 2).

The linear trend of the annual average air temperature values is an ***increasing*** one.

Atmospheric precipitation regime

In order to highlight non-periodic variations in annual precipitation, we calculated the deviations of annual precipitation from the multiannual average expressed as a percentage in order to determine the precipitation pattern of the years according to the Hellman criterion.

In the 51 years studied, only three years were considered normal in terms of precipitation, namely 1977, 1985 and 1988.

Excessively dry years had the highest frequency, 47.1%, while excessively rainy years accounted for 35.3%.

Meteorological droughts have been defined by Hellmann as intervals of at least 14 consecutive days without precipitation in the cold season (X-III) and 10 days in the warm season (IV-IX).

Table 1

Precipitation pattern of the years according to the Hellman criterion in Oradea, 1970-2020

Annual average deviation %	**Classification**	**No. of cases**	**Years**
<-20	excessive drought	24	**1971, 1972, 1973, 1975, 1976, 1979, 1983, 1984, 1986, 1989, 1990, 1992, 1993, 1994, 2000, 2002, 2003, 2008, 2011, 2012, 2013, 2015, 2019, 2020**
-20.0…-15.1	very dry	1	**2014**
-15.0…-10.1	dry	0	**-**
-10.0…-5.1	moderate drought	1	**2009**
-5.0…+5.0	normal	3	**1977, 1985, 1988**
5.1…10.0	moderately rainy	0	**-**
10.1…15.0	rainy	1	**1991**
15.1…20.0	very rainy	3	**1982, 1995, 2018**
>20.0	excessively rainy	18	**1970, 1974, 1978, 1980, 1981, 1987, 1996, 1997, 1998, 1999, 2001, 2004, 2005, 2006, 2007, 2010, 2016, 2017**

De Martonne aridity index

An important indicator to characterise aridity is the 'de Martonne' aridity index.

for annual values

$$I_{dM} = \frac{P}{T+10}$$

where: I_{dM} = Martonne' aridity index; P is the annual amount of precipitation, T is the annual average air temperature, 10 is coefficient.

Table 2

Climate types in Romania according to de Martonne aridity index (Donciu, 1986, as cited in Grumeza et al, 1989)

De Martonne aridity index value	Classification
60 - 187	Excessively humid
50 - 60	Very humid
40 - 50	Humid
35 - 40	Moderately humid II
30 - 35	Moderately humid I
24 - 30	Moderately dry

15 - 24	Semi-arid

According to the Martone aridity index classification of climate types in Romania, the climate in Oradea has a moderately dry character, the Martone aridity index value is between 24-30, the index being 28.4.

The annual de Martonne aridity index, calculated using the multiannual average values of temperature (T) and precipitation (P), shows the frequency of dryness and drought phenomena (Figure 3).

We can see that the frequency of years characterized as arid (A) is 9.5%, 57.1% is the frequency of semi-arid (S) years and the frequency of humid ones is 33.3% (Table 3). According to the de Martonne index, the year 2000 was the driest one, the average precipitation was the lowest in this year.

In the period included in the study, the de Martonne aridity index had the highest value in 2010, 41.7. The index was the lowest in 2000, its value for that year is 16.6 (Figure 3).

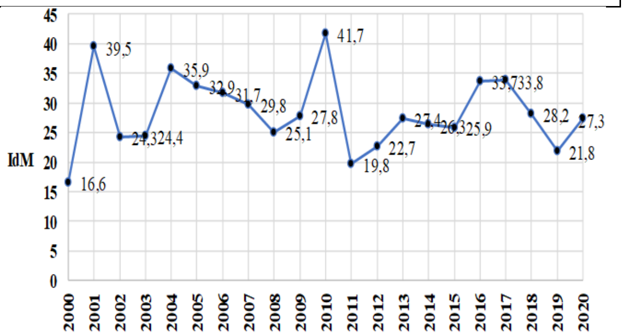

Figure 3. **Annual variation of the de Martonne aridity index in Oradea, 2000 - 2020**

According to the de Martonne aridity index, in Oradea, in the period included in the study, there were 12 semi-arid years (2002, 2003, 2007, 2008, 2009, 2012, 2013, 2014, 2015, 2018, 2019, 2020), in these years the aridity index values were between 20 and 30, 7 humid years (2001, 2004, 2005, 2006, 2010, 2016, 2017), in these years the aridity index was above 30 and 2 arid years (2000, 2011), when the de Martonne aridity index was between 10 and 20 (Table 3).

In the 21 years analysed there were no very dry years, that is, years in which the de Martonne aridity index was lower than 10.

Table 3

Evaluation of drought using the de Martonne index in Oradea, 2000 - 2020

De Martonne aridity index	**Classification**	**No. of cases**	**Years**
I < 10	very dry	-	**-**
I = 10 - 20	arid	2	**2000, 2011**
I = 20 - 30	semi-arid	12	**2002, 2003, 2007, 2008, 2009, 2012, 2013, 2014, 2015, 2018, 2019, 2020**
I > 30	**humid**	**7**	**2001, 2004, 2005, 2006, 2010, 2016, 2017**

Low values of the de Martonne aridity index show dry conditions, while high values indicate humid conditions.

for monthly values

$$I_{dM} = \frac{12P}{t+10}$$

where: I_{dM} = Martonne' aridity index; P = monthly precipitation, mm; t = mean monthly temperature, ^{0}C; 12; 10 = coefficients.

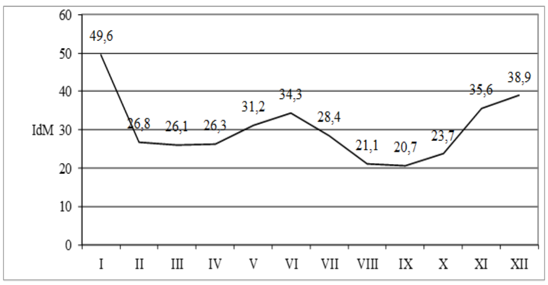

Figure 4. **Monthly variation of the de Martonne aridity index in Oradea, 2000 - 2020**

The highest values of this index occur in the cold period of the year, and the lowest in the warm period. The months with lowest de Martonne aridity index values are September and August, 20.7 and 21.1 respectively (Figure 4).

Walter-Lieth climograph

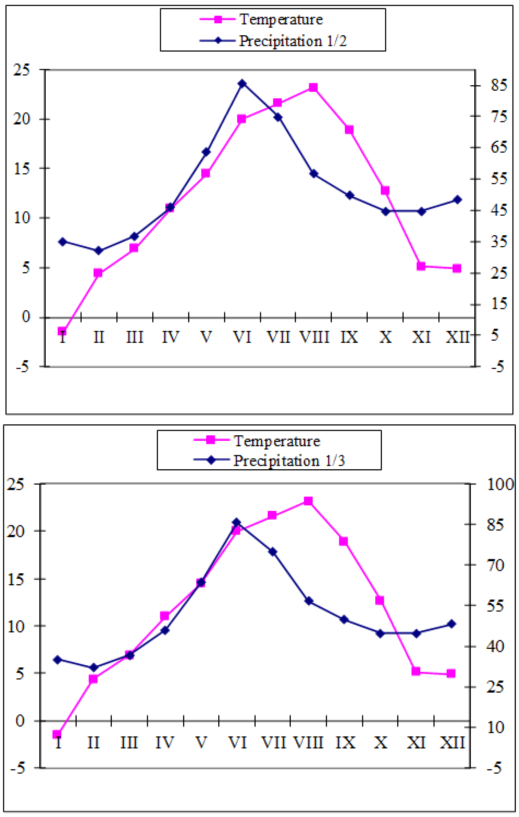

Figure 5. **Walter – Lieth climograph in Oradea**

The periods within a year with dryness and drought phenomena are shown using Walter – Lieth climographs, with the precipitation and temperature on the ordinate and time on the abscissa.

The scales at which the two climate elements are represented should be 1:2 or 1:3.

These ratios show, in a given area, the presence of drought periods, in the case of the 1:3 ratio.

If the temperature curve is below the precipitation curve over the course of a year, the graph indicates an interval of excess humidity. If in the same time interval, the temperature curve is above the precipitation curve, the graph shows a humidity deficit interval; if the two curves intersect more than once in the course of a year, this indicates several intervals of excess and deficit humidity.

The graph shows that during a year, the frequency of droughts and dry spells is higher from July to October (peaking in August) and lower in winter. Dry and drought periods in a year are often consecutive.

CONCLUSIONS

Dryness and drought phenomena represent, on average, about 5 months a year. Looking at the number of dry days in a month, we can see a summer-autumn drought and a spring one, with the one in the some much more severe.

The calculation of the indices revealed that rainfall deficit hazards are more frequent, but also more intense than rainfall surplus hazards.

In the last years, against the background of rising air temperatures, the importance of this hazard is a priority. In this context, recent droughts have become equally intense and damaging. In general, droughts cause greater damage than excess rainfall because they affect much larger areas.

Taking into account that air temperatures will continue to rise in the coming years, it follows that the most important hazards to which society is vulnerable are not only excess rainfall, hailstorms or hail but also droughts.

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