POSIBLE DESERTIFICATION PHENOMENA IN THE OLTENIA TERRACE PLAIN

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RÉSUMÉ: La possible phénomène de désertification dans la Plaine Terrasse de l'Olténie. La Plaine Terrasse de l'Olténie, une partie de la Plaine Roumaine, est situé dans le sud-ouest de cette plaine, au bord du Danube. Pour mettre en évidence l'évolution du système climatique dans les plaines ont été effectuées des comparaisons entre la température moyenne annuelle, et la moitié des saisons extrêmes (hiver et été) et intervalles mensuel 1896-1955, 1961-1990 et 1961-2007. La recherche montre que le chauffage a grandi entre 2001-2007, quand il faisait plus chaud dans le semestre chaud (+ 1.2°C), été (+ 1.3°C), et Juillet (+ 1.6°C); tandis dans le semestre froid, la température grandi avec + 0.9°C, hiver (+ 0.7°C). Plutôt, le mois le plus froid de l'année, Janvier, le chauffage était plus grand avec + 2.0°C et la température moyenne annuelle avec + 0.8°C; les températures pendant les mois d'automne ont montré il ya des écarts négatifs. Par rapport à cette époque, 2007 a été la plus chaude avec des écarts positifs 7.7°C en Janvier, 4.1°C en Juillet, qui a révélé deux grands records climatiques dans l'histoire de la météorologie roumain: l'hiver plus chaud - 2006-2007 et l'été avec les périodes chaudes plus longues et plus intenses. Avec la poursuite de le processus de chauffage et mettant l'accent sur l'impact humain sont à risque de processus de désertification, ce qui nécessite des mesures concrètes et des politiques environnementales appropriées pour le développement durable.

Mots-clés: la Plaine Terrasse de l'Olténie, réchauffement de la planète, le changement climatique, l'aridité et la désertification, Roumanie.

1. Introduction

The Oltenia Terrace Plain, as an integrate part of the Romanian Plain, is situated in the south-western part of this plain near the Danube River which created it. It is characterised by a temperate-continental climate with Sub-Mediterranean influences: the winter presents advections of warm and moist air generated by the Mediterranean cyclones, with relatively frequent precipitations, as rainfalls, freezing phenomena, rime, glaze, ice coating, low intensity and duration snowfalls; the summer presents advections of hot tropical air, that determines high temperatures, hotness, and dryness and drought phenomena (*The Geography of Romania*, I, *Physical Geography*, 1983, p. 279).

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These climatic characteristics are balanced by the mountainous shelter provided by the Carpathian-Balkanic Curvature, by the position in the southern Romania, but also by the particularities of the active surface, which presents terraces in a succession from south to north, with a slight southern exposition, which favours a good insolation; and also by the sand dunes that appear on it, which locally tones these climatic particularities with their physical properties (low specific heat, high heat conductivity and very good permeability).

A brief analysis of the main climatic parameters from the period 1961 – 2007 has shown the following: ***the increase of warm winter's frequency*** (Bogdan, Marinică, Marinică, 2010); ***the increase of maximum temperature's frequency*** ≥44°C, with three events that happened in this plain: 44.0°C at Băileşti, 44.2°C at Bechet and 44.3°C at Calafat (24.VII.2007), with only 0.2°C below the country's absolute thermic record (Bogdan, Marinică, 2011); ***the increase of heat waves frequency*** to 13 consecutive days in June 2007, which caused 33 deaths nationwide (Tudose, Moldovan, 2007, p. 117); ***the increase of tropical days monthly frequency; the appearance of strong pluviometric contrasts, especially after 1980, etc..***

Today, the risk of desertification process appearance is determined by the continuous climate warming process and to human impact.

The researches of Sandu and all (2010, p. 24) about ***decadal evolution of global average temperatures in Romania*** show that in the period 1961-2000 the global average temperatures have risen with 0.4°C in the last decade (1991-2000), and between 2001-2008 (only 8 years) with0.9°C.

2. Data and methods

The observation period was 1961-2007 (47 years)[3], and the analysis period taken into account was the one indicated by the IMO, 1961-1990, but also the extended period: 1961-2000, and the period 2001-2007 from the end of the XXth century and the beginning of the XXIth century; for comparisons it was also used the period: the end of the XIXth century and the beginning of the XXth century (1896-1955 – 55 discontinuous years).

The stations used in the analysis were: Drobeta-Turnu Severin, Calafat, Bechet, Băileşti, Turnu Măgurele for the period 1961-2007; for the period 1896-1955, instead of Băileşti (which was missing at that moment) it was used the station Caracal (even though it is not situated on the terrace), and instead of Bechet (which was also missing), it was used Corabia, because we took into account the fact that, generally, it presents the same settlement conditions.

[3] From lack of data, the observations could not be extended till 2010

3. Results

3.1. Comparisons between the thermic parameters from the Oltenia Terrace Plain in the periods 1896-1955 and 1961-2007

For a better analysis of the thermic parameters evolution trend in the Oltenia Terrace Plain, there were calculated the mean deviations from the period 1961-2007 compared with the period 1896-1955 (Table 1). According to this table, in the period 1961-2007 appears an obvious climate warming process, with most deviation being positive.

Table 1. The temperature difference (ΔT°C) between 1896-1955 and 1961-2007 in the Oltenia Terrace Plain

Period	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1896-1955	-2.1	0.0	5.6	11.2	17.1	20.9	23.1	22.4	18.2	12.0	5.6	+0.5
1961-2007	-1.1	+1.0	5.9	12.1	17.5	21.2	23.3	22.5	17.8	11.8	5.4	+0.6
ΔT°C	+1.0	+1.0	+0.3	+0.9	+0.4	+0.3	+0.2	+0.1	-0.4	-0.2	-0.2	+0.1

Period	Year	Cold Sem.	Warm Sem.	Winter	Summer
1896-1955	11.3	+3.4	19.1	-0.5	22.2
1961-2007	11.5	+4.0	19.1	+0.2	22.3
ΔT°C	+0.2	+0.6	0.0	+0.7	+0.1

Source: Data adapted after The climate of RSR, II, 1966 and the Archive of ANM, Bucharest

The most intense warming process appears in ***the coldest year months – January and February,*** with positive deviations of +1.0°C. They are followed in a decreasing order by: ***spring months and the first month of summer*** (June), with deviations of +0.3…+0.9°C (the highest values in April); ***summer months*** (July and August), and also ***the first month of winter*** (December), with the smallest deviations (+0.1°C). ***The autumn months*** (September, October and November) present ***negative deviations*** (-0.2°…-0.4°C) (la lowest values appeared in September).

Similar situations appeared for the seasonal, semestral and annual deviations. ***The highest positive deviations*** appeared in ***the cold semester*** - +0.6°C, and also in ***winter*** - +0.7°C. ***In the warm semester and in summertime,*** when the positive differences alternated with the negative ones, the deviations were small, from 0.0°C to +0.1°C. Also, the ***annual average temperature of the Oltenia Terrace Plain*** from the period 1961-2007 was only 0.2°C higher than the one from the period 1896-1955, respectively 11.5°C versus 11.3°C (Table 1).

3.2 Thermic differences between 2001-2007 and 1961-1990

The comparative analysis of the thermic parameters average values and of the deviations from the two periods (Table 2) shows the way warming process has manifested in the study area. It can be observed that ***all deviations*** that appeared in

the period 2001-2007 versus the values from the reference period (1961-1990) ***are positive*** and ***all exceeded the centennial trend with +0.6°C. The warm semester and the summer*** from the period 2001-2007 were warmer than the cold semester and the winter. The deviations were +1.2°C and +1.3°C, in comparison with +0.9°C and +0.7°C (Table 2).

Table 2. The deviation (ΔT°C) of the main thermal parameters from the period 2001-2007 versus the reference period (1961-1990) în The Oltenia Terrace Plain

Period	Year	Cold sem.	Warm sem.	Winter	Summer	January	July
1961-1990	11.3	+3.8	18.8	-0.1	21.8	-1.7	22.8
2001-2007	12.1	+4.7	20.0	+0.6	23.1	+0.3	24.4
ΔT°C	+0.8	+0.9	+1.2	+0.7	+1.3	+2.0	+1.6

Instead, the situation of the ***extreme months (January and July)*** was reversed. The warmest month was the coldest one, ***January*** (+2.0°C), and then the warmest year month, ***July*** (+1.6°C).

The annual average temperature presented a deviation of +0.8°C, with +0.2°C above the centennial trend. It can be observed that only in 7 years the centennial trend (+0.6°C) was much exceeded for all parameters.

If there are taken into account ***all the monthly deviations from the period 2001-2007,*** versus those from the reference period (1961-1990) (Table 3), some exceptions can be observed. There appeared some ***negative deviations*** in April (-0.1°C) and September (-0.4°C).

Table 3. The deviation (ΔT°C) of the monthly average temperatures from the period 2001-2007versus the reference period (1961-1990) in the Oltenia Terrace Plain

Period	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	An
1961-1990	**-1.7**	**+0.6**	**+5.6**	**12.2**	**17.3**	**20.8**	**22.8**	**21.9**	**17.9**	**11.8**	**+5.6**	**+1.1**	**11.3**
2001-2007	**+0.3**	**+1.3**	**+7.0**	**12.1**	**18.5**	**22.0**	**24.4**	**23.3**	**17.5**	**12.1**	**5.8**	**+0.3**	**12.1**
ΔT°C	**+2.0**	**+0.7**	**+1.4**	**-0.1**	**+1.2**	**+1.2**	**+1.6**	**+1.4**	**-0.4**	**+0.3**	**+0.2**	**-0.8**	**+0.8**

3.3 Thermic differences between the periods 2001-2007 and 1961-1990

Because the reference period named by the IMO is of only three decades, we took into account four decades (1961-2000) and we recalculated the deviation (Table 4).

Table 4. The deviation (ΔT°C) of the main thermic parameters in the period 2001-2007 versus the values those from the period 1961-1990

Period	Annual average	Cold sem.	Warm sem.	Winter	Summer	January	July
1961-2000	11.4	+3.9	19.0	+0.1	22.1	-1.4	23.0
2001-2007	12.1	+4.7	20.0	+0.6	23.1	+0.3	24.4
ΔT°C	+0.7	+0.8	+1.0	+0.5	+1.0	+1.7	+1.4

Compared with the previous period, it can be observed that the deviations are 0.1…0.3°C smaller. This fact is caused by the integration in the reference period of the decade 1991-2000, which is warmer than the previous ones, fact that increases the average values from the period 1961-2000, above those from the period 1961-1990. So the deviations from the period 2001-2007 are smaller than those from the period 1961-2000. It can be observed that ***warm semester and the summer*** presented higher deviations (+1.0°C) than ***the cold semester*** (+0.8°C) ***and the winter*** (+0.5°C). The ***extreme months*** present a reversed situation: ***January*** +1.7°C and J***uly*** +1.4°C (Tables 4 and 5).

Table 5. The deviation (ΔT°C) of the monthly average air temperatures in the period 2001-2007 versus those from the period 1961-2000

Period	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	An
1961-2000	**-1.4**	**+0.9**	**+5.7**	**12.1**	**17.4**	**21.1**	**23.0**	**22.3**	**17.8**	**11.8**	**5.4**	**+0.8**	**11.4**
2001-2007	**+0.3**	**+1.3**	**+7.0**	**12.1**	**18.5**	**22.0**	**24.4**	**23.3**	**17.5**	**12.1**	**5.8**	**+0.3**	**12.1**
ΔT°C	**+1.7**	**+0.6**	**+1.3**	**0.0**	**+1.1**	**+0.9**	**+1.4**	**+1.0**	**-0.3**	**+0.3**	**+0.2**	**+0.5**	**+0.7**

Source: Data adapted after the Archive of ANM and CMR-Craiova

The annual average temperature presented a deviation of +0.7°C. So, all the deviations exceeded the centennial trend, except the deviation from the winter, which was smaller (+0.5°C).

If we analyse ***all the monthly deviations from the period 2001-2007,*** versus those from the period 1961-2000, it can be observed that the same months (as in the previous case) – April (0.0°C) and September (-0.3°C) presented negative deviations (Table 5 compared with Table 3)

3.4. Thermic differences between periods 2001-2007 and 1896-1955

In order to establish how intense the warming process was in the period 2001-2007, we compared the values from the beginning of the XXIth century and those from the end of the XIXth century and the beginning of the XXth, respectively the period 196-1955, and we computed the deviations of the parameters analysed in the study (Tables 6 and 7).

It can be observed ***the more pronounced heating process in the cold year period*** from the period 2001-2007, as following: 1.3°C in ***the cold semester,***

+1.1°C ***in winter*** and +2.4°C in ***January;*** compared with this, the warm period presents lower deviations values, as: +0.9°C in the ***warm semester*** and in ***summer***, and +1.3°C in ***July***; the ***annual average temperature*** presented a deviation of +0.8°C (Table 6).

Table 6. The deviation (ΔT°C) of the main thermic parameters from the period 2001-2007 versus those from the period 1896-1955

Period	Annual average	Cold sem.	Warm sem.	Winter	Summer	January	July
1896-1955	11.3	+3.4	19.1	-0.5	22.2	-2.1	23.1
2001-2007	12.1	+4.7	20.0	+0.6	23.1	+0.3	24.4
ΔT°C	+0.8	+1.3	+0.9	+1.1	+0.9	+2.4	+1.3

Table 7. The deviation (ΔT°C) of the monthly average air temperatures from the period 2001-2007versus those from the period 1896-1955

Period	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	An
1896-1955	**-2.1**	**0.0**	**+5.6**	**11.2**	**17.1**	**20.9**	**23.1**	**22.4**	**18.2**	**12.0**	**+5.6**	**+0.5**	**11.3**
2001-2007	**+0.3**	**+1.3**	**+7.0**	**12.1**	**18.5**	**22.0**	**24.4**	**23.3**	**17.5**	**12.1**	**+5.8**	**+0.3**	**12.1**
ΔT°C	**+2.4**	**+1.3**	**+1.4**	**+0.9**	**+1.4**	**+1.1**	**+1.3**	**+0.9**	**-0.7**	**+0.1**	**+0.2**	**-0.2**	**+0.8**

If we take into account ***all the monthly deviations*** from the period 2001-2007 versus those from the period 1896-1955, it can be observed that, even this time, the smallest deviation values appear in the months situated at the year's end, with September and December presenting negative deviations (-0.7°C and, respectively, -0.2°C) (Table 7).

3.5. The thermic differences between 2007 and the period 1896-1955

If we compare the deviations from the period 2001-2007 and those from the period 1896-1955, the deviations from the year 2007 were two to four fold than the same period, as following (Table 8): +1.9°C above ***the annual average***; +2.4°C in the ***cold semester***, +4.3°C in ***winter*** and +8.1°C in ***January***; the last one was the highest deviation registered in this month in the entire history of meteorological observations in Romania, as in the winter of 2006-2007 (Bogdan, Marinică, 2007, p. 105); after that follows ***the warm semester*** with a deviation of +1.7°C, ***summer*** with +2.7°C and ***July*** with +3.8°C – a very hot summer with 6 heat waves of more than 44°C (maximum temperatures) registered at 5 national meteorological stations, 3 of them in this plain – this represented another thermic record in the history of meteorological observations.

Table 8. The deviation (ΔT°C) of the main thermic parameters from 2007 versus those from the period 1896-1955in the Oltenia Terrace Plain

Period	Annual average	Cold sem.	Warm sem.	Winter	Summer	January	July
1896-1955	11.3	+3.4	19.1	-0.5	22.2	-2.1	23.1
2007	13.2	+5.8	20.8	+3.8	24.9	+6.0	26.9
ΔT°C	+1.9	+2.4	+1.7	+4.3	+2.7	+8.1	+3.8

However, the autumn months (***September, October and November***) presented ***negative deviations,*** with -0.5°C in October – the highest, and +1.7°C in November – the smallest (Table 9).

Table 9. The deviation (ΔT°C) of the monthly average air temperatures from 2007 versus those from the period 1896-1955

Period	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	An
1896-1955	**-2.1**	**0.0**	**+5.6**	**11.2**	**17.1**	**20.9**	**23.1**	**22.4**	**18.2**	**12.0**	**+5.6**	**+0.5**	**11.3**
2007	**+6.0**	**+4.8**	**+8.4**	**13.7**	**19.6**	**24.0**	**26.9**	**23.7**	**16.6**	**11.5**	**+3.9**	**+0.6**	**13.2**
ΔT°C	**+8.1**	**+4.8**	**+2.8**	**+2.5**	**+2.5**	**+3.1**	**+3.8**	**+1.3**	**-1.6**	**-0.5**	**-1.7**	**+0.1**	**+1.9**

The deviations from the other months of the year 2007 maintained the same scale, being two to four folds higher than the monthly average deviations from the period 2001-2007 versus the period 1896-1955 (Table 13 compared with Table 9).

3.7. The decadal variation of the main characteristic thermic parameters for the Oltenia Terrace Plain in the period 1961-2007

Even though the increasing trend appears for all these parameters, their decennial variation was not uniform.

To prove this fact, there were made computations for each station – the average values of the main thermic parameters for all four decades inside the period 1961-2000, and also for the period 2001-2007, values that were used later in computing the ***decadal average values for the entire Oltenia Terrace Plain,*** and also for the ***reference period (1961-1990) and the period 1961-2000.***

In the subsequent phase, the decennial average values and those from the period 2001-2007 were related with the multiannual average values from the entire plain, computed for the periods 1961-1990 and 1961-2000, and so were obtained the ***decadal deviations*** of each thermic parameter (Table 10).

Table 10. The decadal variation of the main thermic parameters which are dominant in the Oltenia Terrace Plain in the period 1961-2007 (°C) and deviation (ΔT°C) versus the periods 1961-1990 and 1961-2000

Reference period	Annual average (^{0}C)	ΔT^{0}C	Cold sem. average (^{0}C)	ΔT^{0}C	Warm sem. average (^{0}C)	ΔT^{0}C
1961-1990/ 1961-2000	**11.3** 11.4		**3.8** 3.9°		**18.8** 19.0	
1961-1970	11.4	**+0.1**/ 0.0	3.7	**-0.1**/ -0.2	19.1	**-0.3**/ +0.1
1971-1980	11.0	**-0.3**/ -0.4	3.8	**+0.0**/ -0.1	18.3	**-0.5**/ -0.7
1981-1990	11.4	**+0.1**/ 0.0	3.9	**+0.1**/ 0.0	19.0	**+0.2**/ +0.0
1991-2000	11.7	**+0.4**/ 0.3	4.0	**+0.2**/ +0.1	19.3	**+0.5**/ +0.3
2001-2007	12.1	**+0.7**/ 0.6	4.7	**+0.9**/ +0.8	20.0	**+1.2**/ +0.7

Reference period	Winter average (^{0}C)	ΔT^{0}C	Summer average (^{0}C)	ΔT^{0}C	January average	ΔT^{0}C	July average	ΔT^{0}C
1961-1990/ 1961-2000	**-0.1°**/ +0.1°		**21.8°**/ 22.1°		**-1.7°**/ -1.4°		**22.8°**/ 23.0°	
1961-1970	-0.8	**-0.7**/ -0.9	22.2	**+0.4**/ +0.1	-2.9	**-1.2**/ -1.5	23.1	**+0.3**/ +0.1
1971-1980	+0.3	**+0.4**/ +0.2	21.3	**-0.5**/ -0.8	-1.3	**+0.4**/ +0.1	22.2	**-0.6**/ -0.8
1981-1990	+0.3	**+0.4**/ +0.2	22.0	**+0.2**/ -0..1	-0.8	**+0.9**/ +0.6	23.0	**+0.2**/ 0.0
1991-2000	+0.4	**+0.5**/ +0.3	23.0	**+1.2**/ +0.9	-0.4	**+1.3**/ +1.0	23.6	**+0.8**/ +0.6
2001-2007	+0.6	**+0.7**/ +0.5	23.1	**+1.3**/ +1.0	+0.3	**+2.0**/ +1.7	24.4	**+1.6**/ +1.4

Source: Data adapted after the Archive of ANM and CMR-Craiova

As it can be observed in this table, the ***annual average temperature*** of the Oltenia Terrace Plain in the reference period (1961-1990) was 11.3°C (and in the period 1961-2000 - 11.4°C), and also in the period 1895-1955, but it has increased with +0.7°C in only 7 years (2001-2007), reaching 12.1°C.

The cold semester temperature from the period 1961-1990 was 3.8°C (respectively +3.9°C), with 0.4°C higher than that from the period 1895-1955, but the values increased with 0.9°C in the 7 years, reaching an average of 4.7°C.

The warm semester was characterised by an average temperature of 18.8°C in the period 1961-1990 (and respectively 19.0°C for the period 1961-

2000), with -0.2°C below the average from the period 1896-1955 (19.1°C), but it increased with 1.2°C in the 7 years (2001-2007), reaching 20.0°C.

The winter's average temperature in this plain was -0.1°C in the period 1961-1990 (and respectively +0.1°C in the period 1961-2000), with +0.4°C higher than that from the period 1896-1955, but it increased with +0.7°C in the period 2001-2007, reaching +0.6°C.

The summer's average temperature was 21.8°C in the period 961-1991 (respectively, 22.1°C in the period 1961-2000), with -0.4°C below the average temperature of the period 1896-1955 (22.2°C), but it was with +1.3°C higher in the 7 years, reaching 23.1°C.

January presented an average temperature of -1.7°C in the period 1961-1990 (and -1.4°C in the period 1961-2000), with +0.4°C above the temperature in the period 1896-1955, ***but it reached in the 7 years (2001-2007) the highest increase, with a positive deviation of +2.0°C, reaching an average of +0.3°C.***

July presented an average temperature of 22.8°C in the period 1961-1990 (and respectively 23.0°C n the period 1961-2000), with -0.3°C below the temperature of 23.1°C from the period 1896-1955, but it increased with +1.6°C in the 7 years, reaching 24.4°C (Table 10).

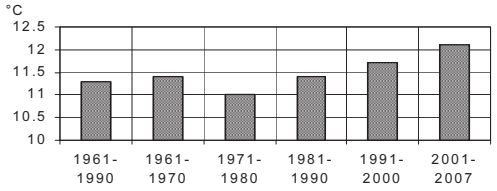

Fig. 1. The decadal evolutionof the annual average air temperature in period 1961-2007 in The Oltenia Terrace Plain

The decadal deviations and those from the period 2001-2007 were smaller than the temperatures of the period 1961-2000, as it can be seen in the Table 10. The decadal evolution of each analysed thermic parameter shows that for each annual average temperature (Fig. 1), warm semester temperature (Fig. 2), summer temperature (Fig. 3B) and for July (Fig. 4B), the coldest decade was 1971-1980; the coldest decade for the average temperature of the coldest semester (Fig. 2A), winter (Fig. 3) and of January (Fig. 4A) was 1991-2000 and reached its peak in the period 2001-2007, especially in 2007.

The year 2007 presented the two highest climatic records in the history of meteorological observations – respectively ***the warmest January month (the warmest winter: 2006-2007) and the hottest summer, with the longest and the most intense hot periods***; this year was followed by years with different thermic values, reflecting the climate's non-cyclic variability, the main cause for strong thermic contrasts, so specific for the climate's global warming process. As an example, we present the cold winter of 2011-2012 versus the hot summer of 200-

2007, and also the most recent summer, 2014, less hot in contrast with the hot summer of 2007.

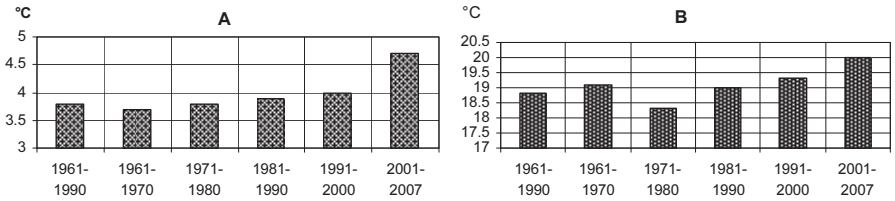

Fig.2 The decadal evolution of average temperatures in the cold (A) and hot (B) air semester,in The Oltenia Terrace Plain (1961-2007)

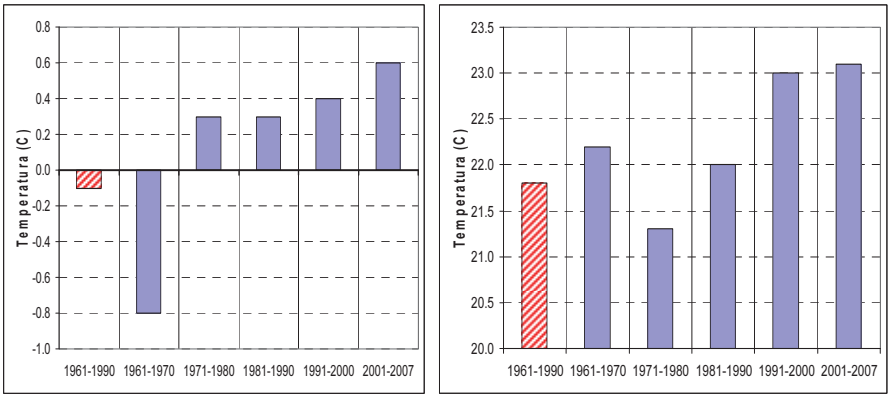

Fig.3.The decadal evolution of average temperatures in winter (A) and summer (B) in The Oltenia Terrace Plain (1961-2007).

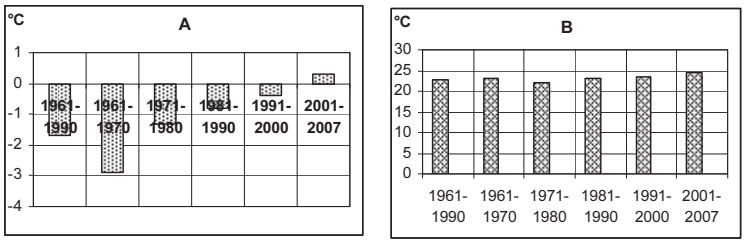

Fig. 4 The decadal evolution of the air's average temperatures in January (A) and July (B) in the Oltenia Terrace Plain (1961-2007)

Conclusions

If these conditions of the warming process continue to exist, appears the risk of climate dryness, which associated with the human impact in this plain with sandy lands, can induce desertification processes followed by rain and deflation erosion, and also the substitution of forest-steppe vegetation with steppe vegetation.

The research made on this plain by Ana Popova, Cristina Muică, 1997; Cristina Muică, Ana Popova, 1995-1996, Cristina Muică, Monica Dumitraşcu, 2001, Maria Pătroescu, 2005, Monica Dumitraşcu, 2006 ş.a., showed that the climate dryness, together with very high human pressure on this plain, which exceeded its support capacity, determined the advancement of xerophile species from south towards north even in some humid sectors, due to water retention capacity reduction into the soil. It can be also observed that the percent of xerophile species inside the mezo-xerophile vegetation has increased, due to high human impact.

Due to the National Strategy and to the Acton Program for desertification, land degradation and drought control, The Oltenia Terrace Plain is situated in the category of fragile lands, very sensitive to natural and human stress, which requires some urgent measures for sustainable development, as follows:

- initiation of special programs for high temperatures, drought and desertification control
- reforestation of sandy lands that were used in the past for deforestation and their protection against rain and deflation processes
- extension of windbreaks for climate improvement (wind speed reduction, maintaining soil humidity, limitation of evapotranspiration)
- creating forest windbreaks along the railway trays, roads, highways, using the same high temperature resistant species
- building-up irrigation systems to assure crop productive humidity
- creating forest windbreaks along irrigation channels, using species that love humidity: poplar, osier, etc.
- using species and cross-breed thermophile species (vegetables, fruit trees, etc.) that are resistant to drought and need less water for their development
- applying alternative measures, such as institutional, scientific, technical, social and political local and regional measures that must be applied in drought situations, etc.

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