CONSIDERATIONS UPON THE TEMPERATURE HUMIDITY INDEX IN OLTENIA IN THE PERIOD 2000-2007

ION MARINICĂ, CORNELIA CHIMIŞLIU

Abstract. *This paper analyses the temperature humidity index (THI), frequently used in the last 9 years in meteorological bulletins with the purpose of informing the population. We analyse the evolution of the values of this bioclimatic index in relation with heat waves, absolute maximum temperatures, monthly average temperatures, canicular days and drought in the period 2000-2007. This paper can be successfully used by specialists in climatology, meteorology, biology, by those who try to achieve a master or a doctor's degree, by students and in general by all who are interested in the problems of climatic evolution and its effects on the biosphere.*

Keywords: *considerations, temperature humidity index (THI), Oltenia, the period 2000-2007.*

Rezumat. Consideraţii privind indicele de temperatură umezeală (ITU) în Oltenia în intervalul 2000-2007. *Lucrarea prezintă Indicele de temperatură umezeală ITU, frecvent utilizat în buletinele meteorologice pentru informarea populaţiei în ultimii 9 ani. Este analizată evoluţia valorilor acestui indice bioclimatic, corelată cu valurile de căldură, temperaturile maxime absolute, temperaturile medii lunare, canicula şi seceta, în perioada anilor 2000-2007. Lucrarea este utilă specialiştilor în domeniul climatologiei, meteorologiei, biologiei, doctoranzilor, masteranzilor, studenţilor şi tuturor celor interesaţi de problemele evoluţiei climatice şi efectele ei asupra biosferei.*

Cuvinte cheie: *consideraţii, indicele de temperatură umezeală ITU, Oltenia, perioada 2000-2007.*

INTRODUCTION

The climate of a territory is a true resource-as the production of things necessary for the existence of the human society depends on it, this is why knowing the climatic conditions needed for the best development of multiple activities (like agriculture, viticulture, pomiculture, pisciculture, tourism) is imperative. When evaluating the climatic conditions the characteristics of diverse climatic elements are to be considered. The impact of weather and climate conditions on living organisms, including people, is monitored by bioclimatology, which studies the bioclimate.

The living organisms, the climate and the weather are complexly correlated, as the human body is constantly adapting to the environment in order to maintain its homeostasis. At present, in order to characterize the real climate conditions which might or might not be favourable to activities specific for the human society, a multitude of climatic indexes are defined and used.

Among those, the temperature humidity index (THI) or the thermal comfort index temperature humidity which is frequently used in meteorological bulletins in the warm season, has a special meaning in what concerns the effect of high temperatures on the human organism and not only. The temperature humidity index (THI), as a bioclimatic index, is a unit which indicates the human thermal comfort or discomfort, also depending on the water vapours in the atmosphere.

Starting with the summer of 2000, ANM Bucharest and the regional meteorological centres emit meteorological warnings mentioning the reaching and exceeding of the critical threshold of the thermal comfort index. These warnings are passed over to Prefectures and mass-media so that the needed protection measures mentioned in the Emergency Ordinance No 99/2000 can be taken.

The thresholds of the important values of this index and their meanings in the warning system are the following:

THI ≤ 65-low risk, the values between 60 and 65 are considered comfortable. 66≤ THI ≤ 79-state of alert. THI ≥ 80-high risk. The physiological meaning of the THI is shown in Table 1:

Table 1.The meaning of the THI in relation to the physiological sensation.
Tabel 1. Semnificaţia lui ITU după senzaţia fiziologică.

Values of the THI	Physiological Sensation
>85	Suffocation
80-85	Extreme Heat
75-80	Heat
60-75	Comfort
50-60	Cool
40-50	Chill
<40	Cold

As a bioclimatic index, the THI is used in Romania to establish the risk situations during the canicular days of summer. In general, in meteorological bulletins the THI is expressed adimensionally, but, concerning the physical meaning of this index we mention that it represents the temperature felt by the human body, which is calculated by dividing the value of the THI by 2. The resulting value-which exceeds the real temperature by little, is the actual

temperature felt by the human body in days with air temperatures higher than 25°C (meaning the summer days). The difference between the felt temperature (half of THI) and the actual temperature shown by thermometers in meteorological shelter, appears because of the Greenhouse Effect created by the important percentage of water vapours in the atmosphere, which, in addition, in the canicular days frequently leads to an improper ventilation of the human body, as the evaporation of the perspiration of the organism is prevented.

MATERIAL AND METHODS

The materials which represented the base of this paper are the existent data in the archives of CMR Oltenia for the years 2000-2007 and the references to other speciality papers we consulted (BOGDAN & MARINICĂ, 2007; MARCHAND, 1986; MASTERSON & RICHARDSON, 1979; MARINICĂ & CHIMIŞLIU, 2008; MARINICĂ & MARINICĂ, 2008; STRAHLER, 1973). In the following we will present the registered temperature data in the canicular periods of 2000 and 2007. We will mention the air temperature and precipitation values which are used in the evaluation of the temperature-humidity index (THI).

Air temperature and precipitation values of June 2000

In June 2000 three canicular periods were registered : June 4-10 (the canicular days were characteristic mainly to the South of Oltenia), June 13-16 and June 21-25 (BOGDAN & MARINICĂ, 2007).

The hottest days in almost all of Oltenia were on June 23, 24 and 25. The highest temperature value was 38.7°C registered at Băileşti on the 23rd of June. The highest number of canicular days of June was 12, registered in Caracal. The canicular days of June determined the apparition and the installation of drought.

All the monthly average values of temperature in June 2000 exceeded the normal average values with positive differences: +1.3°C at Bechet and Calafat in Dolj County and values of almost +4.3°C at Apa Neagră in Gorj County and Bâcleş in Mehedinţi County.

The minimum values of precipitations (< 5 l/m^2) were registered at Vârful Cozia, Târgu Jiu, Râmnicu Vâlcea, Drobeta Turnu-Severin, Halânga, Bâcleş, Slatina, Caracal (and, on the whole, in the entire Olt County), mostly in the first few days of the month (and there were even areas where rains have fallen only on the 1st of June). Generally, the rains have fallen in just one day, so their effects were too small to be considered.

The highest monthly average temperature value of June was 23.3°C registered at Bâcleş.

The smallest number of days with precipitations was 1, in the hills of Mehedinţi, at Bâcleş on the 1st of June 2000. The highest number of days with precipitation was 9 in Craiova, at the southern limit of the hilly area, but here the total monthly value was of only 12.0 l/m^2 (out of which 10.0 l/m^2 have fallen on 1st of June 2000). In 47.8% of the localities of Oltenia, most of the precipitations have fallen on 1st of June 2000. In 39.1% of the localities of Oltenia, most of the precipitations have fallen in the last three days of the month.

In 30.4% of the localities of Oltenia, the total monthly precipitation values were less than 10 l/m^2. Precipitations reaching and exceeding 30 l/m^2 were registered only in the mountain area. None of the total monthly values exceeded 40 l/m^2 (40.0 l/m^2 being reached at only one station, Vf. Negovanu). In 52.2% of the localities of Oltenia, the precipitations were less than 20 l/m^2 in all June (Source-Processed Data) which in conditions of a very warm month are not to be considered.

Air temperature and precipitation values of July 2000

In July 2000, two extremely intense canicular periods were recorded: the period 2-12 and the period 22-27.

The maximum temperatures reached and exceeded 43°C (43.0°C at Bechet, 43.1°C at Băileşti, 43.2°C at Calafat). The maximum temperature of July 2000 for Oltenia was 43.2°C registered on the 4th of the month, at Calafat, a value very close to the absolute maximum of July, which represented a new thermal record for Oltenia (Table 2).

The highest number of days with maximum temperatures ≥ 30°C was 19 at Halânga-Mehedinţi County, Băileşti in Dolj County and Caracal in Olt County. The highest number of days with maximum temperatures ≥ 33°C was 15 registered at Bechet in Dolj County. The maximum values of temperature of the canicular days of July 2000 are shown in Table 2.

The highest number of days with maximum temperatures ≥ 35°C was 12 registered at Calafat and Bechet, in Dolj County.

The highest number of days with maximum temperatures ≥ 40°C was 5 registered in Bechet, in Dolj County.

The hottest days in Oltenia were the 4th and the 5th of July 2000, when the maximum temperatures exceeded 40°C in all Oltenia except the mountain area.

Toward the East and South-East of Oltenia this was the most intense canicular period in the whole meteorological observations period.

It is notable that the old absolute maximum of July in Oltenia-41.8°C, which was registered at Strehaia, Mehedinţi County, in 1916 on the same date-the 5th of July, was reached and exceeded in many localities of Oltenia as it follows: 41.8°C/the 4th of July 2000 at Apa Neagră in Gorj County, 42.1°C/ the 4th of July 2000 at Halânga in Mehedinţi County, 42.3°C/ the 4th of July 2000 at Caracal in Olt County, 42.4°C/ the 4th of July 2000 at Vânju Mare in Mehedinţi

County, 42.6°C/ the 4th of July 2000 in Drobeta-Turnu Severin in Mehedinți County, 43.0°C/the 5th of July 2000 at Bechet, 43.1°C/ the 4th of July 2000 at Băileşti, 43.2°C/ the 4th of July 2000 at Calafat, all these in Dolj County.

For Oltenia the hottest day of the summer of 2000 was the 4th of July 2000, which is, actually, the hottest day of July in the last 84 years. 43.2°C is a value very close to the absolute maximum of July.

Table 2. The maximum values of temperature in the canicular days of July 2000.
Tabel 2. Valorile maxime de temperatură din perioadele de caniculă ale lunii iulie 2000.

Station Meteo	No of days with Tmax.≥…				Variation of T max. (°C) in the period		T max. °C /data
	≥30°C	≥33°C	≥35°C	≥40°C	I : 2-12.07.2000	II: 22-27.07.2000	
Petroşani	7	4	1	0	23.6≤Tmax≤35.8/July 4	23.0≤Tmax≤34.0/July 27	35.8/July 4
Obârşia Lotrului	0	0	0	0	21.0≤Tmax≤29.0/July 5	10.0≤Tmax≤27.4/July 26	29.0/July 5
Cozia Peak	0	0	0	0	17.4≤Tmax≤29.6/July 4	14.8≤Tmax≤25.0/July 26	29.6/July 4
Voineasa	11	6	2	0	27.2≤Tmax≤36.7/July 4	24.2≤Tmax≤33.9/July 26	36.7/July 4
Parîng Peak	0	0	0	0	20.4≤Tmax≤27.0/July 4	18.0≤Tmax≤25.4/July 26	27.0/July 4
Negovanu Peak	0	0	0	0	9.8≤Tmax ≤21.0/July 4	10.1≤Tmax≤21.3/July 26	21.3/July 4
Târgu Jiu	18	11	6	1	29.4≤Tmax≤**40.6**/July 4	27.0≤Tmax≤37.8/July 26	**40.6**/July 4
Apa Neagră	17	12	6	1	33.2≤Tmax≤**41.8**/July 4	30.8≤Tmax≤37.8/July 26	**41.8**/July 4
Polovragi	15	6	4	0	31.0≤Tmax≤39.2/July 4	29.0≤Tmax≤35.4/July 26	39.2/July 4
Rm. Vâlcea	17	12	5	2	32.5≤Tmax≤**40.6**/July 4	29.4≤Tmax≤36.0/July 26	**40.6**/July 4
Târgu Logreşti	14	7	5	1	32.2≤Tmax≤**40.0**/July 4	29.5≤Tmax≤36.0/July 26	**40.0**/July 4
Drăgăşani	18	12	7	1	31.4≤Tmax≤**40.7**/July 4	30.0≤Tmax≤37.7/July 26	**40.7**/July 4
Dr. Tr. Severin	18	13	10	2	34.1≤Tmax≤**42.6**/July 4	31.8≤Tmax≤39.7/July 26	**42.6**/July 4
Halînga	19	13	7	3	34.1≤Tmax≤**42.1**/July 4	32.0≤Tmax≤**40.0**/July 26	**42.1**/July 4
Bîcleş	15	11	6	2	32.5≤Tmax≤**40.0**/July 5	29.6≤Tmax≤37.3/July 26	**40.0**/July 5
Bălceşti	16	12	6	2	31.7≤Tmax≤**41.0**/July 4	30.2≤Tmax≤37.0/July 26	**41.0**/July 4
Vînju Mare	17	13	9	2	34.1≤Tmax≤**42.4**/July 4	30.5≤Tmax≤39.0/July 26	**42.4**/July 4
Slatina	18	12	9	2	32.0≤Tmax≤**41.4**/July 4	30.4≤Tmax≤38.6/July 26	**41.0**/July 4
Caracal	19	14	10	4	33.5≤Tmax≤**42.3**/July 5	31.3≤Tmax≤**40.6**/July 26	**42.3**/July 4
Craiova	15	11	7	2	34.0≤Tmax≤**40.5**/July 4	29.4≤Tmax≤37.6/July 26	**40.5**/July 4
Băileşti	19	14	11	2	36.0≤Tmax≤**43.1**/July 4	31.1≤Tmax≤39.9/July 26	**43.1**/July 4
Calafat	18	13	12	3	35.6≤Tmax≤**43.2**/July 4	31.5≤Tmax≤**40.3**/July 26	**43.2**/July 4
Bechet	16	15	12	5	34.5≤Tmax≤**43.0**/July 5	32.0≤Tmax≤**41.0**/July 26	**43.0**/July 4

In the second canicular period of July 2000 (22nd-27th), values close to the maximum value of the THI were reached at: Bechet 88.1 on the 25th; 89.2 on the 26th; 86.6 on the 26th at Calafat and 86.0 on the 26th at Caracal (in conformity with the processed data in the achieves of CMR Oltenia).

In this second period, the canicular days affected intensely the South of Oltenia and in the first period the extremely intense canicular days affected almost all of Oltenia. On the whole, in July, 16 canicular days were registered.

By a comparison between the average values of temperature of the two canicular periods we are able to notice positive deviations of 1-4°C, the smallest being +0.8°C at Tg. Logreşti, and the highest, in the mountain area, +3.9°C in Parâng.

The very high temperatures of above 40°C in the plain, piedmont and Sub-Carpathian region, above 35°C in intermountain depressions and of above 25°C in the mountain regions caused and determined the apparition of drought. In July 2000, the drought was particularly intense for long periods of time. Significant precipitations have fallen in the noon of the 12th of July 2000, the night of the 12th/the 13th of July 2000 and also on the 13th of July 2000 (at an exact distance of a year from the torrential rains in Mehedinți and Gorj County which, in 36 hours, have reached values close to the absolute maximum of July, yet with no effect on the already-compromised farming cultures).

Air temperature and precipitation values of August 2000

August 2000 has brought, also, canicular periods and drought. Regarding this aspect, in August 2000, two canicular periods were registered – between the 3rd and the 7th and between the 18th and the 24th. *The highest number of days with* maximum temperatures ≥ 30°C was 26 days registered at Drobeta-Turnu Severin and Halânga.

The highest number of days with maximum temperatures ≥ 33°C was 20 registered at Băileşti.

The highest number of days with maximum temperatures ≥ 35°C was 14 registered at Băileşti and Drobeta-Turnu Severin.

The highest number of days with maximum temperatures ≥ 40°C was 1 registered in Drobeta-Turnu Severin, *Băileşti, Calafat and Bechet.*

The hottest day of August 2000, was the 23rd, when four meteorological stations-Drobeta-Turnu Severin, Băileşti, Calafat and Bechet in Oltenia, registered temperatures of and above 40°C.

The most intense canicular period of August 2000, was 19-24.

In Oltenia, the longest canicular period was registered in Drobeta-Turnu Severin, between the 11th and the 25th, meaning 15 consecutive canicular days. It is to mention that in the South of Tg. Logreşti, in the Getic Piedmont, the second canicular period of August began on the 11th, the 12th, the 13th and lasted for 12 and 15 consecutive days.

In comparison with July, the number of days when the maximum temperatures exceeded the thresholds of 30°C, 33°C and 35°C was bigger, but the number of days, in which the temperature exceeded 40°C, was smaller, which leads us to the conclusion that the intensity of the canicular days of August was reduced relatively to the canicular days of July.

The monthly average values of temperature exceeded the normal thermal monthly averages by positive deviations between +1.3°C at Tg. Logreşti and +4.6°C at Apa Neagră in Gorj County. Significant differences were also registered at Bâcleş in Mehedinți County (4.2°C) and at Calafat in Dolj County (+4.0°C).

The evolution of the air temperature in July 2007

The maximum values of temperature registered in Dolj County on the 24th of July 2007 were outstanding at all the meteorological stations: 42.6°C in Craiova, 44.0°C at Băileşti, 44.2°C at Bechet and 44.3°C at Calafat, all of these becoming absolute maximum temperature values for July at each station, and the value registered at Calafat is the new absolute thermal maximum of July for the whole country.

The highest thermal minimum values recorded in the morning of July 25 were registered in Dolj County: 23.5°C in Craiova, 24.3°C at Bechet, 24.4°C at Băileşti and 24.7°C at Calafat. At Calafat the highest thermal minimum of July 2007 was 25.0°C registered one day earlier than the 23rd of July as a consequence of the fact that the advection of the extremely hot air mass began on the 22nd of July.

The highest daily average temperatures registered in July 2007 were reached on the 24th: 32.8°C in Craiova, 33.4°C at Băileşti, 33.6°C at Bechet and 33.9°C at Calafat (the deviations from the multiannual averages being of 11-13°C, for example, for Craiova the daily multiannual average for the 24th of July is 21.8°C), which represents absolute thermal record for the averages of July at these stations, and for the whole country the average value of 34.2°C registered at Caracal is the absolute thermal record in matters of average temperatures of July. These values equal those of a hot summer day.

Concerning the days with average values of temperature ≥30°C, we mention: 3 days at Bechet, 6 days at Băileşti, 8 days in Craiova (as well as at Caracal and Bâcleş) and 9 days at Calafat (as well as at Apa Neagră, the Sub-Carpathian depression), this last value representing a national record regarding this aspect.

When calculating the THI we have been using the following formulas given by INMH in the year 2000:

THI = $(T_{dry}.1.8 +32) – (0.55 – 0.0055U)[(T_{dry}.1.8 + 32) – 58]$; (this comes from the re-evaluation of I.c and it is the currently used formula for the THI.)

Some other formulas for finding the THI are:

I. Strahler's formulas, 1973:

I.a) THI. = $0.4 (T_{dry} – T_{wet}) +15$;

I.b) THI. = $0.55 T_{dry} + 0.2Tdew +17.5$;

I.c) THI. = $T_{dry}– (0.55 – 0.55UR) (T_{dry} – 58)$.

II) The formula used by the European model of weather prognosis (ECMWF) is:

THI = $0.81T_{dry}+ 0.01U (0.99T_{dry} – 14.3) + 46.3$.

These formulas express the THI adimensionally.

The I.c formula is easy to use for anyone, as T_{dry} is actually the air temperature measured normally, in standard conditions in meteorological shelters, and for this calculation of the THI the data in weather bulletins of radio and television are enough.

Yet another index which correlates the values of temperature and humidity is the Humidex (H_{um},) index, also used in some speciality papers.

III) The calculation formula for Humidex (H_{um},), expressed in C degrees:

$H_{um} = T_{dry} + 0,5555x (6,11xe^{5417,7530(1/273,16 – 1/TD)} – 10)$.

This formula has been established and implemented by J. MASTERSON & RICHARDSON (1979), from the Meteorological Service in a collaboration with the Health Ministry of Canada and its values and characteristic thresholds are indicated in Fig. 1.

Abbreviations we used:

T_{dry}= the air temperature at a height of 2 m, read on the dry thermometer (in Fahrenheit degrees, F);

T_{wet} = the temperature read on the wet thermometer (in Fahrenheit degrees);

T_{dew} = the temperature of the dew point (in Fahrenheit degrees);

UR=the relative humidity expressed in decimals fractions-we consider 0.35 instead of 35% (Fig. 1);

U = the relative humidity at a level of 2 m above the ground;

TD = the temperature of the dew point in Kelvin degrees, at a level of 2 m above the ground.

Considering that the values given by the VI formula are different from those given by the first five, as well as the scale of the appreciations of the effects (Fig. 1), we see useful the introduction of the Humidex index which has H_{um} as a notation, for these results.

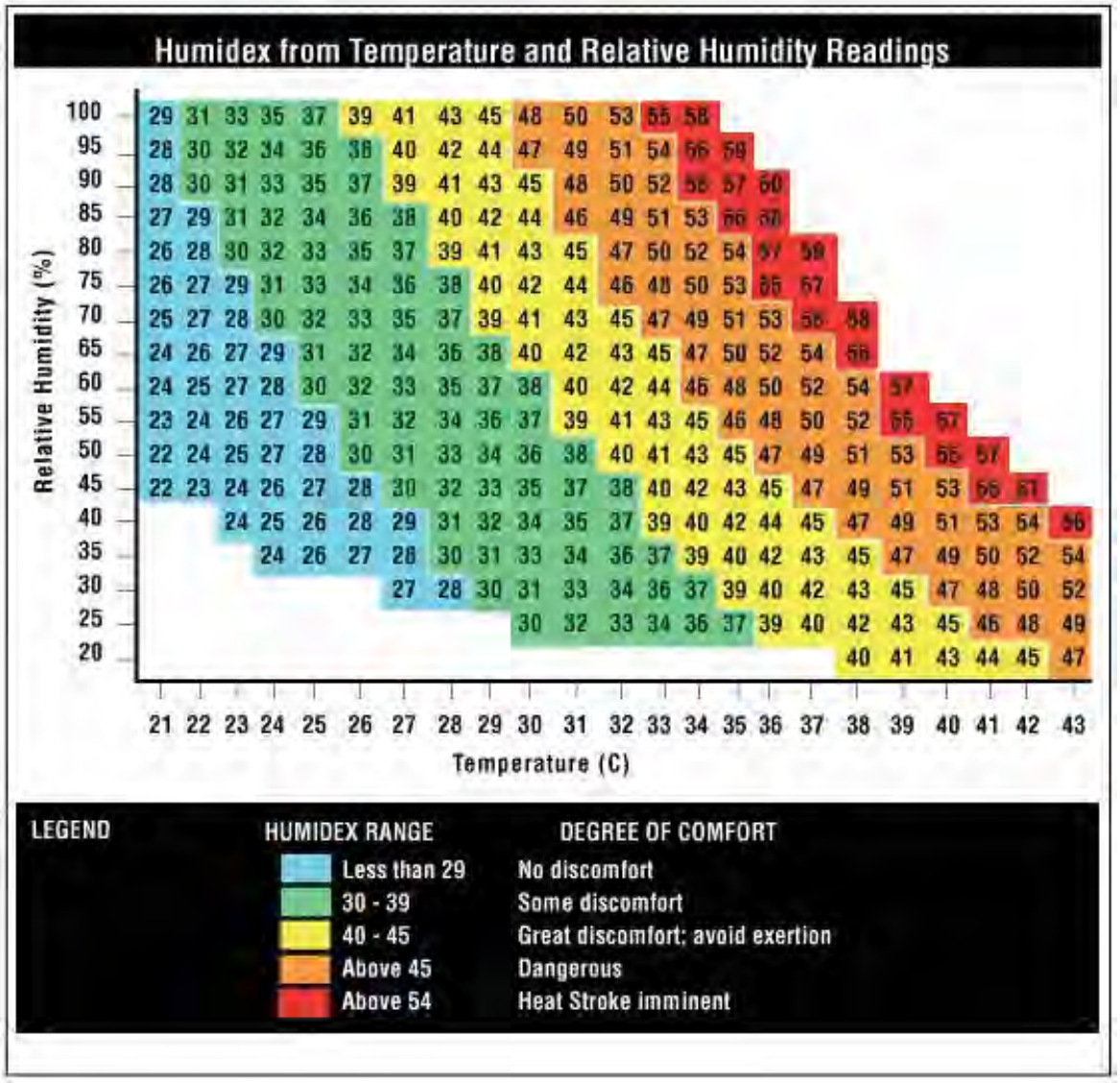

Figure 1. The Humidex (H_{um}) correlation between the temperature and the relative humidity of air (according to MASTERSON & RICHARDSON, 1979).
Figura 1. Corelaţia Humidex (H_{um}) cu temperatura şi umiditatea relativă a aerului (după MASTERSON & RICHARDSON, 1979).

RESULTS AND DISCUSSIONS

As a result of the gathering, processing and interpretation of data the next values of the THI in Oltenia were obtained:

In June 2000, in the three canicular periods, the THI exceeded 80 units in most areas of Oltenia. The highest values of the THI were reached at Slatina 85.5 on the 24th and Caracal 86.1 on the 23rd and the 24th.

By calculating THI/2 for the meteorological station at Slatina at the maximum temperature of 36.8°C, a value of 42.7 is obtained, (ITU/2=85.5:2=42.7). The 5.9°C difference (42.7-36.8 = 5.9°C) between the value of THI/2 and the maximum temperature represents the degrees felt by the human body in addition to the maximum temperature. This difference appears as a result of the Greenhouse Effect caused by water vapours in the atmosphere.

By calculating THI/2 for the meteorological station at Caracal at the maximum temperature of 37.5°C a value of ITU/2=86.1:2=43.5. The difference of 6.0°C (43.5-37.5 = 6.0°C) between the value of THI/2 and the maximum temperature represents the degrees felt by the human body in addition to the maximum temperature. This difference appears as a result of the Greenhouse Effect caused by the high percentage of water vapours in the atmosphere**.**

For July, the highest values of the THI were: 89.7 at Bechet reached on the 5th, 89.4 at Apa Neagră (Gorj County-the 4th of July 2000), as well as at Caracal on the 5th. For Slatina, it was reached on the 4th and it was of 86.8.

By calculating THI/2 for the meteorological station at Caracal (89.4:2=44.8) at the maximum temperature of 42.3°C, a value of THI/2 =44. 8 is obtained resulting in a difference of 2.5°C due especially to the air temperature and in a small way to the percentage of water vapours in the atmosphere, which was smaller than the one of June calculated

in the previous paragraphs. At Apa Neagră, the maximum temperature of that day was 41.8°C. The difference between the THI and the maximum temperature (44-41.8) was of 3.0°C. In this case, the positioning of Apa Neagră in the Oltenia Sub-Carpathian Depression (where the air ventilation is a slowed process, determined a much bigger concentration of water vapours caused especially by the evapoperspiration process, resulting in an more important thermal difference.

By calculating THI/2 for the meteorological station of Slatina (86.8:2=43.4), at the maximum temperature of 41.4°C, the 2°C resulting difference is due especially to the air temperature and in a small share to the percentage of water vapours in the atmosphere, which was smaller than the one of June calculated in the previous paragraphs

During *the most intense heat wave which affected Romania in July* (the 24th of July 2007)**,** the THI exceeded the high risk threshold in most of the country excepting the high mountain area. On this date at Calafat, the THI reached the value of 91-the absolute record for this index in Oltenia, and the maximum temperature was 44.3°C.

By calculating THI/2 for the meteorological station of Calafat at the maximum temperature of 44.3°C (91.0:2=45.5) the 1.2°C resulting difference is due especially to the air temperature and in a small share to the percentage of water vapours in the atmosphere, which was smaller than the one of June calculated in the previous paragraphs, the air mass was particularly hot and dry (tropical continental advection from the Northern Africa).

The evolution of the THI values in Oltenia starting with the year 2000

The climatic evolutions in Oltenia marked new aspects in each year. In the following paragraphs we mention some of the important remarks for the values of the THI:

The year 2000 is best characterised by: the massive heating in the summer, intense canicular days[1], dryness[2] and drought.

The period June 1-September 1 2000 (and all the summer that followed), brought for Oltenia an intense canicular period leading to a drastic drought during which two absolute thermal records for our country were registered. The summer of 2000 meant for both Oltenia and Romania in general, long canicular and droughty periods. The drought had a slow evolution in the first three months of the year (January, February, March), the precipitation level being below its normal values. The early spring arrival in February, the late frosts of April, the droughty spring months April and May "opened" the way for the canicular days at the end of June, July and August, came with prolonged canicular periods which, in their succession, mingled with short "colder"-relatively to the canicular days temperatures-periods.

In Romania, a new thermal record for July was registered -43.5° C in Giurgiu on the 5th of July 2000, becoming the new absolute maximum of July for the whole country.

Exactly one year after the "flood" in Western Oltenia (on the July 12-13, 1999), the date is no coincidence-this is the normal cooling period of July important rain falls being registered in the whole region of Oltenia, but their effect on the already compromised farming cultures was insignificant, and in a short time the canicular days and the drought were back.

These greatly intense canicular days took place in the year of maximum Solar activity (which is roughly reached once every 11 years, yet this maximum was outstanding for its century-exceeding even that of 1946, which astronomers considered the most important), resulting in amplified thermal effects and canicular periods. The peak of the canicular period was the days of July 4 and 5, 2000.

The high air temperature brought about maximum values for the THI in the two canicular periods of August 2000. In this month the canicular period lasted for 12 days in Oltenia. The highest number of days when the maximum THI exceeded 80, in August was 23 registered in Caracal–Olt County.

On the whole, during the summer of 2000, 46 out of 92 days with temperatures of above 33°C were registered-a percentage of 50%, which leads us to the conclusion that half of the summer days were canicular or almost canicular[3].

The high air temperatures of August 2000 indicated the extreme drought the effects of which were widely amplified by the canicular periods. Some of the results obtained from the analysis are:

The highest exceeding of the monthly normal average of temperature of the summer of 2000 was registered in Apa Neagră-Gorj County in August the monthly average value exceeding the normal by +4.6°C.

Moreover, the THI has exceeded the critical thresholds for long periods of time each summer.

The values of the THI have varied between 80 and 91 in the canicular period of 2007 (Fig. 2).

In Oltenia, *in Dolj County,* at Calafat, on the 24th of July 2007 in just 10 minute from 16^{10} OVR to 16^{20} OVR[4] the air temperature raised from 43.6°C to 44.3°C (0.7°C in 10 minutes), which shows on the one hand the intensity of the advection of hot air, and on the other hand the quickness in the rise of the air temperature.

[1] When the air temperature reaches 35°C we speak about *canicular days*.

[2] **Dryness phenomena** is registered when it does not rain for 5 days in a row, or if the precipitation quantities are below the respective daily average (in conformity with Hellmann quoted by DONCIU in 1928, BOGDAN & NICULESCU, 1999).

[3] Meteorological instructions before the year 2000, qualified as "canicular day" a day in which the air temperature reached or exceeded 33°C. Subsequently, the threshold became 35°C. If the air temperature exceeds 32°C, the phenomena of **intense heat** takes place; (this term is used in agrometeorology); In intense heat days the plants frequently fade and sometimes plants even parch (irreversibly).

[4] OVR= The summer hour of Romania

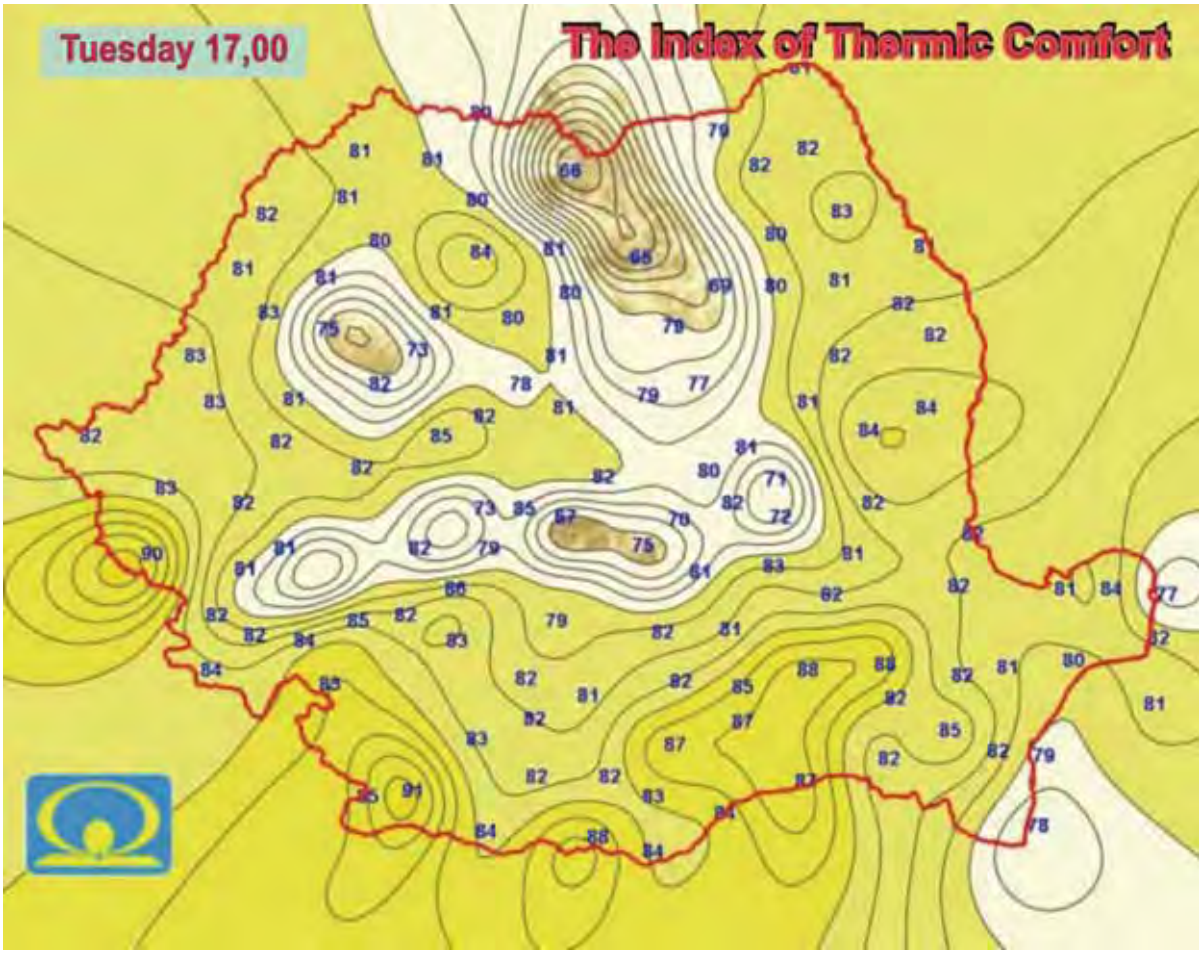

Figure 2. The values of the THI on the 24th of July 2007 17 OVR, at the peak of the heat wave. (At Calafat THI = 91, the maximum value for the whole country, bioclimatic record) (scale 1:1 000 000) (according to ANM).
Figura 2. Valorile indicelui de confort termic ITU, la 24.07.2007 ora 17 OVR, la momentul apogeului fazei maxime a valului de căldură. (La Calafat ITU = 91, valoarea maximă pentru întreaga țară, record bioclimatic) (scara 1:1 000 000) (după ANM).

Knowing the evolution of temperature is extremely important, as it is strongly related to the environment and the living organisms. We mention some of the effects of the heat waves:

For the spontaneous vegetation, but also the farming and forest cultures such situations might lead to fading and parching phenomena at a quick and irreversible pace.

In the biotope of the lakes the quantity of dissolved oxygen decreases and this often leads to the suffocation or death of vegetal and animal organisms. Their quick decay due to the rise of temperature leads to pollution with harmful substances amplifying the effects of the lack of oxygen in lakes' water. The damages can be significant or even irreversible. There is a little number of methods of fighting against these phenomena and we mention: the introduction of air in the water using special pumps, yet this action often leads to an increase of the water temperature, the pumping of cold water from underground wells-but its quantity of oxygen is reduced, a slightly more efficient solution is the pumping of river water-especially for the lakes near the Danube and other important rivers but this is not always possible.

For human population thermal discomfort appears and it increases in relation with the temperature and the humidity of air. It can induce hypocaloric shock and even death to the people with health problems. The deaths generally happen at night, when the secretion of life-maintaining hormones is minimal and the THI is high as a consequence of the high concentration of water vapours in the warm air, despite the decrease in temperature.

CONCLUSIONS

As climate changes are tackled with in many scientific papers, the use of the bioclimatic index THI in meteorological bulletins in order to inform the population about the weather situations of major risk in the warm season as well as the use of the proper colour code related to the potential risk are useful measures created to protect the people, the animals and sometimes the crops. Showing the measures that could be taken in order to enable all these actions is equally important. In the warm season the use of the THI is welcome in situations of hot weather or canicular days.

Pointing out the RED CODE situations for canicular days determined a series of special measures created to protect and inform the population, the setting up of first aid points in cities, the application of a special program for the police, firemen and rescue services etc.

The absolute record for Oltenia and the whole country of the bioclimatic index THI (91), and also of the maximum air temperature 44.3°C were both recorded in the year 2007.

The year 2000 was the starting year for the registering of heat waves associated with long-lasting canicular periods, and 2007 was the year in which the most intense heat waves of July in the history of meteorological observations in Romania was recorded (MARINICĂ & CHIMIŞLIU, 2008).

Knowing the meaning of frequently-used bioclimatic indexes in weather forecasts and warnings (which since the year 2000 has become mandatory by law-by the E.O 99/2000) is vital for a good understanding of the importance and the possible effects of heat or coolness waves.

Especially after the year 2000 in Oltenia, in the warm season, the intense heat waves became frequent marking the increase of the influence of the Mediterranean climate in this part of the country with important consequences on the biosphere (MARINICĂ & CHIMIŞLIU, 2008). It is notable the year 2007, for Oltenia, was a typical Mediterranean year on the whole.

The use of these bioclimatic indexes in weather bulletins is mandatory because of the reality of clear changes in the climate of Romania.

The canicular summer of 2000 made the Government of Romania to issue the E.O. no 99 regarding the protection of those people who work in extreme conditions, this being the first document to reflect the application of specific measures in outstanding climatic situations and also the acknowledgement of the appearance of changes in the Romanian climate (MARINICĂ & MARINICĂ, 2008).

REFERENCES

BOGDAN OCTAVIA & MARINICĂ I. 2007. *Hazarde meteo-climatice din zona temperată. Geneză şi vulnerabilitate cu aplicaţii la România.* Edit. Lucian Blaga Sibiu: 434pp.

MASTERSON J. & RICHARDSON F. A. 1979. *Humidex, A Method of Quantifying Human Discomfort Due to Excessive Heat and Humidity*. Environnement Canada. Downsview, Ontario: 45pp.

MARINICĂ I. & CORNELIA CHIMIŞLIU. 2008. *Climatic Changes on regional plan in Oltenia and their effects on the biosphere*. Muzeul Olteniei Craiova. Oltenia. Studii şi comunicări. Ştiinţele Naturii. **24**: 221-229.

MARINICĂ I. & ANDREEA FLORIANA MARINICĂ. 2008. *The heat wave of July 2007 and its effects on the biosphere*. Muzeul Olteniei Craiova. Oltenia. Studii şi comunicări. Ştiinţele Naturii. **24**: 211-220.

STRAHLER A. N. 1973. *Geografia Fizică.* Edit. Ştiinţifică Bucureşti: 596pp.

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Ion Marinică
The Regional Meteorological Center Oltenia,
Str. Brestei no. 3A, 200581, Craiova, Romania
E-mail: ionmarinica@yahoo.com.
Cornelia Chimişliu
The Museum of Oltenia Craiova
Str. Popa Şapcă, no. 8, 200 422, Craiova, Romania
E-mail: chimisliu_cornelia@yahoo.com

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