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EVALUATION OF THERMAL COMFORT DEGREE IN CANICULAR DAYS - RECORD FOR THE REPUBLIC OF MOLDOVA'S TERRITORY

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Key words: canicular days, danger level, thermal discomfort, cartographic modelling, record days.

Abstract. It is well known that in order to remove excess heat in an environment, a temperature lower than body temperature, i.e. less than 37 ^{0}C is needed. If such modalities of heat removal do not exist, the organism would be overheated, the internal temperature would rise, and above 42 ^{0}C, all proteins in the human body would be coagulated and finally heat shock would be produced. When atmospheric humidity is very high, one looses heat with more difficulty, and increased temperature is harder to endure, the air seems to be unbreathable. Some categories of sick people, for example, people suffering from asthma, heart condition, hypertension, with endocrine diseases (hyperthyroidism, hypothyroidism or with suprarenal problems), as well as people with obesity problems are substantially affected by increased humidification of air in canicular days.

Introduction

Regional climatic changes show an increase in intensity and frequency of climatic anomalies, including those of the canicular days' period [3]. We should mention that the human body removes the accumulated heat by thermal conduction (directly by contact with cooler objects), by convection (air flows), by heat radiation and by transpiration.

That is why, in the current stage, the index of thermal comfort, which indicates subjective heat perception, having at the same time objective quantifiable and measurable basis of environmental humidification degree, is used to evaluate sensorial weather conditions.

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1. Material and methodology

Thermal comfort indexes are often called Indicators of Temperature and Humidity (ITH) by meteorologists and indicate just how suffocating weather is for humans during the canicular days. The calculation of this index is based on two variables: temperature and humidity. There are two methods of calculation and evidently of expressing them: „non-dimensional" or „by units" or calibrated on temperature scale, i.e. in Celsius degrees. Thus, the necessary meteorological parameters for thermal comfort calculation (ITH), expressed both in units and calibrated in degrees, are the air temperature at 2 m of height and the relative humidity.

In this work, the index of thermal comfort calculation expressed in units was elaborated using the Statgraphics Centurion Software according to the following formula:

$$ITU= 0.81T+ 0.01HU (0.99T - 14.3)+ 46.3,$$

where T – air temperature at 2 m of height, *HU - relative* humidity on the same level.

When the ITH is under 79 units, the air is pleasant and easy to breathe, but when the ITH exceeds 80 units, an increased discomfort risk appears, the air being difficult to breathe. Such situations occur especially when temperature is high and air humidity is very high. An increased humidity can make air with not so high temperature really unbreathable. On the contrary, dry air, though canicular, may be more tolerable for the organism. The explanation is that high air humidity interferes with the natural transpiration of human body. Through transpiration, humans remove heat excess. When the air is saturated, the process of transpiration or evaporation is complicated, and heat from human body is not eliminated naturally.

2. Analysis of the obtained results

Analysis of multiyear data on thermal regime evolution shows us that in July 2007, the most significant heat waves occurred during the period of instrumental observations. [5]. According to [4, 6], considering the number of affected persons (over 210000 affected persons) in canicular days, Republic of Moldova is on the second place in Europe, after Macedonia. According to the State Hydrometeorological Service [5], the second decade of August 2010 registered a record of canicular days for this month.

All the above mentioned had conditioned the calculation of thermal comfort index on the basis of daily maximum temperatures and daily relative humidity for the period of June 17-22, 2007 and August 11-16, 2010, registered as record canicular days.

The ITH's cartographical modeling (using Surfer software with Radial Basis interpolation method) for the above mentioned periods allowed to evidence regional particularities of thermal discomfort. We should mention that both in cases of canicular days in July 17-22, 2007 (fig.1) and the ones in August, 11-16, 2010 (fig.2) the indexes of thermal comfort have exceeded the critical value of 80 units. Therefore, the authors consider that the ITH values equal to less than 84 units should be considered as *moderate thermal discomfort* and the ones above these values – as *intense thermal discomfort*.

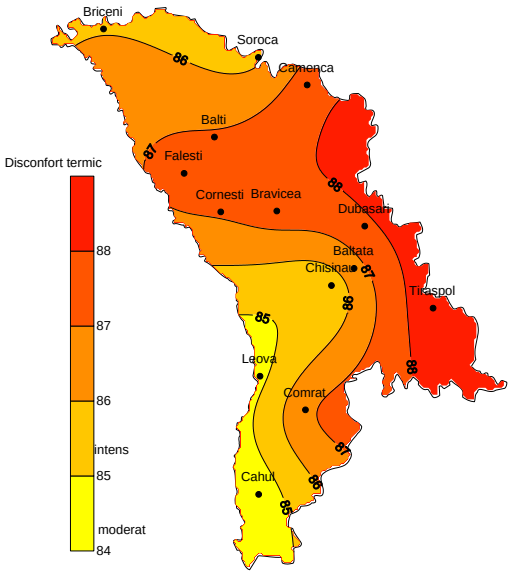

Fig.1 - Spatial distribution of the index of thermal comfort in canicular days in July 17-22, 2007

The analysis of obtained maps (fig.1, fig.2) allows stating that in both cases of canicular periods on the Republic's territory, thermal discomfort is classified as *intense*, with more intensity due to the Eastern and North-Eastern parts, which is confirmed with thermal record values registered by the State Hydrometeorological Service of Moldova in the studied periods.

The threat degree of thermal discomfort can be evaluated according to the Discomfort Index (DI) proposed by Giles [1, 2].

To estimate the discomfort index (DI) in Celsius degrees, the following equation by Giles et al. (1990) has been applied:

$$DI=Ta-0.55\ (1-0.01\ RH)\ (Ta-14.5)$$

where Ta is the hourly value of the average air temperature in Celsius degrees and RH (%) is the corresponding hourly value of the relative humidity. Discomfort increases as DI increases.

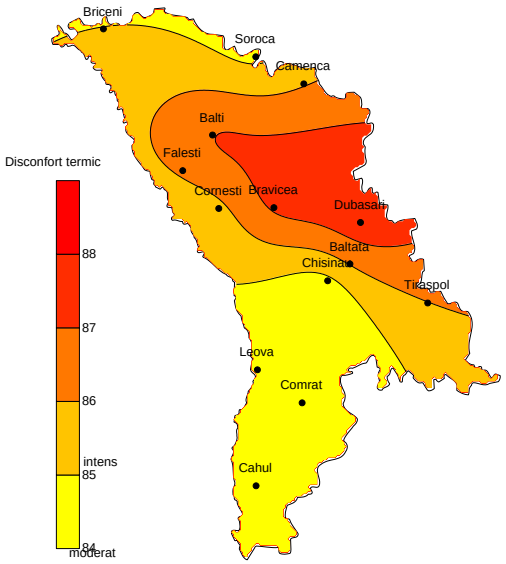

Fig. 2 - Spatial distribution of the index of thermal comfort in canicular days in August 11-16, 2010

The main feature observed in the average daily DI values is the general decline of the DI levels throughout the examined period of each monitoring site. The analysis shows that the average daily DI values remain lower than the 24^0C limit, which is the limit when more than 50% of the total population feels discomfort.

The cartographical modeling of DI was executed for record canicular days in July and August and its grading shows that in July 2007 (fig.3 a), more than 80% of the Republic's territory was at the dangerous level of discomfort.

The same spatial interpretation has DI for canicular days of August 2010 (fig.3 b), except that it has a more restricted manifestation area.

Statistical indexes calculation (tab.2) show us, that in the above mentioned periods, the values of DI have exceeded 29, which means the appearance of the severe stress condition of the population. The obtained results are confirmed by the fact that there were more than 210 000 persons affected in the Republic of Moldova, registered during severe drought manifestation in 2007 [4].

Tab. 1 - Classification of the DI values (Giles et al., 1990).

ID (0C)	Classification
ID <21	No discomfort
21≤ID<24	Under 50% population feels discomfort
24≤ID<27	More than 50% population feels discomfort
27≤ID<29	Most of the population suffers from discomfort
29≤ID<32	Everyone feels severe stress
ID≥32	State of medical emergency

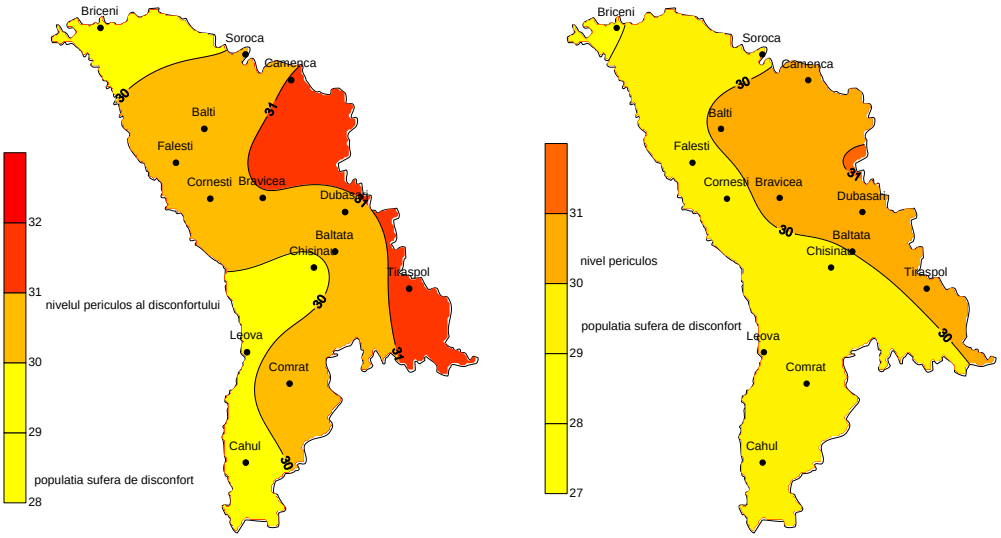

Fig. 3 - Evaluation of danger degree for the population's health according to the Discomfort Index in canicular days (a- July 17-22, 2007; b- August 11-16, 2010)

In conclusion, we state that the threat degree of thermal discomfort on the Republic's territory in record canicular days is very important and could contribute to essential population's health protection, thus reducing the number of deaths and affected people caused by the baleful influence of canicular periods.

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