ASSESSMENT OF BIOCLIMATIC RESOURCES IN THE COASTAL ZONE OF ODESSA REGION

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ABSTRACT. – Assessment of bioclimatic resources in the coastal zone of Odessa region. Due to rapid growth of pace of life, tension and stress, recreation and recuperation with natural curative resources are becoming more popular nowadays. The purpose of this work is to estimate bioclimatic resources as crucial components of natural recreational potential and as a basis for the development of recreational activities in the coastal zone of Odessa region. Climate and weather primarily affect the thermal regime of the organism and its functional activity largely depends on the conditions of heat exchange with the environment. Therefore complex indicators that reflect thermal condition of a human are used for bioclimatic assessments. The authors used a system of calculated effective temperatures: equivalent-effective (EET), normal equivalent-effective (NEET), biologically active (BAT) and radiation-equivalent-effective (REET) temperatures. Analysis of the results enabled to identify opportunities for integrated use of bioclimatic resources in the coastal zone of Odessa region, which are determinant factors for the development of tourism and recreational activities of various fields: medical, health, sports and others.

Keywords: meteorological factors, bioclimatic indices, recreation.

1. INTRODUCTION

The unique combination of geographical and climatic conditions and diversity of recreational resources of Odessa region has to provide development of resort and recreational activities of different areas: medical, health, sports, scientific etc. Weather and climatic conditions are important for recreation and tourism as they are promoting and limiting factors. Special importance is acquired by the researches aiming to evaluate bioclimatic resources and carry out territorial differentiation of bioclimatic conditions at the regional level.

Influence of climate and weather on human well-being and health was noticed long ago. Usually it reflects in the psycho-emotional reactions to the weather, climate change, the abnormal changes of physiological processes in the body that lead to deterioration of health, occurrence of clinical disorders, aggravation of illness and even death. Healthy people, as a rule, do not notice changes in the weather. If adaptive mechanisms in a body are not properly coordinated, even a healthy person can experience meteotropic reactions in the form of a lung ailment and decline of health. Adaptive mechanisms do not

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compensate physiological disorders to a patient and a weakened human (especially with age) (Katerusha O.V. and Safranov T.A., 2010).

Impact of meteorological factors on the human body is multifaceted and it is displayed through the particular weather conditions. For instance, the temperature of the air affects the depth and frequency of breathing, blood circulation speed, character of supply of the oxygen to the cells, peculiarities of carbohydrate, salt, fat and water metabolism and muscle work. The influence of humidity on the human body is associated with the regulation of water metabolism. Wind affects comfortable state of a human in warm and cold periods of the year, because it can significantly change the rate of convective heat transfer of the body.

Proper information on weather and climatic conditions is essential for tourist industry. Tourists are interested in it primarily before and during the vacation period. In this work we have studied the issue of estimation of bioclimatic resources as substantial constituents of natural recreational potential and as a basis for the development of tourism and recreational activities in the coastal zone of Odessa region.

2. METHODS OF RESEARCH

Complex bioclimatic indices reflect human heat condition since climate and weather primarily affect thermal regime of an organism and its functional activity largely depends on the conditions of heat exchange with the environment. These indicators enable us to estimate bioclimatic resources of definite areas, to determine their recreational potential, solve a series of different issues related to the optimization of bioclimatic conditions (Kobysheva N.V. et al., 2008).

Generally bioclimatic indices define a range of figures of meteorological factors under which a person feels comfortable or uncomfortable. Thus bioclimatic indices are indicators of subjective perception of comfort/discomfort. Thermal comfort occurs when there are such meteorological conditions under which the thermoregulatory system of the body is exposed to the slightest pressure, i.e. there is a physiological rest. One of the most objective indicators of discomfort is a skin state (tremor, redness, excessive sweating, etc.) (Isaev A.A., 2001).

In bioclimatology for evaluation of complex meteorological conditions that determine heat perception of a human primarily system of effective temperatures is used: equivalent-effective (*EET*), radiation-equivalent-effective (*REET*) etc.

EET is a temperature at which in the stationary and saturated with moisture air heat perception of a person is the same as in a given combination of air temperature, relative humidity and wind speed. Thermal perception of a dressed person and a naked one under the same meteorological conditions is different. Therefore there were developed two scales of *EET* - "a major scale" for a nude human (equivalent-effective temperature - *EET*) and "normal scale" for a human dressed in common, standard clothing (normal equivalent-effective temperature - *NEET*).

EET is usually calculated using the formula offered by Aizenshtat B.A. and Lukina L.P. (1982):

$$EET = t[1-0.003(100-f)]-0.385v_2^{0.59}[(36.6-t)+0.622(v_2-1)]+$$
$$+[(0.0015v_2+0.0008)(36.6-t)-0.0167](100-f), \quad (1)$$

where, t is air temperature, °C; f is relative air humidity, %; v_2 is wind speed (m/s) at the height of 2 m.

Normal equivalent-effective temperature (*NEET*) can be found using the following formula (Boksha V.G. and Bohutsky P.V., 1980):

$$NEET = 0.8EET + 7^{\circ}C \quad (2)$$

REET considers the effect of four meteorological factors on a human: air temperature, relative humidity, wind speed and solar radiation. In order to assess *REET* we used the equation (Boksha V.G. and Bohutsky P.V., 1980):

$$REET = 0.83EET + 12^{\circ}C \quad (3)$$

Biologically active temperature (*BAT*) takes into account the impact of the following complex meteorological parameters: air temperature, relative humidity, wind speed, total solar radiation and long-wave radiation from the underlying surface, atmosphere and all the surrounding objects (walls, green spaces, ponds, etc). Streams of long-wave radiation, which approached a human body, are almost completely (≈ 95%) absorbed by the superficial tissues, transformed into heat and thus participate in the heating of the organism. Biologically active temperature is calculated using the following equation:

$$BAT = 0.8EET + 9^{\circ}C \quad (4)$$

3. RESULTS OF THE BIOCLIMATIC ASSESSMENT

In this work we used the results of daily meteorological observations of temperature (*t*), relative humidity (*f*) and wind speed (*v*) at 12.00 o'clock (so called "weather of the moment") in summer months within five years (2003-2007) at four stations located in the coastal zone of Odessa region (Odessa, Ilichevsk, Belgorod-Dniestrovsky, Vilkovo). According to the aforecited methods we determined four bioclimatic indices: *EET*, *NEET*, *REET* and *BAT*.

Equivalent-effective temperature, which considers impact of air temperature, relative humidity and wind speed (1), is used for the estimation of meteorological conditions of aerotherapy. Interval of values of equivalent-effective temperatures within which most people feel comfortable concerning their heat perception, i.e. they do not feel either freeze or excessive heat, is called "thermal

zones of comfort". Comfort zone for healthy people by the major scale is within 17.3 – 21.7 ˚ C. *EET* values less than the lower limit of the comfort zone is a zone of hypothermia (supercooling), and more than the upper limit is a zone of hyperthermia (overheating).

The comfort zone, in which external conditions do not require a lot from thermo adaptive mechanisms, is of greatest interest. It facilitates air baths to be used more comprehensive, especially among meteolabile persons, people with weakened thermoregulatory mechanisms. The more ambient conditions differ from comfortable ones, the more expressive and irritative action is and the more limited is the range of patients, to whom are recommended air baths and other climatotherapeutic procedures.

For visibility there is shown the repeatability of comfortable and discomfortable weather in July according to *EET* (Fig. 1-4).

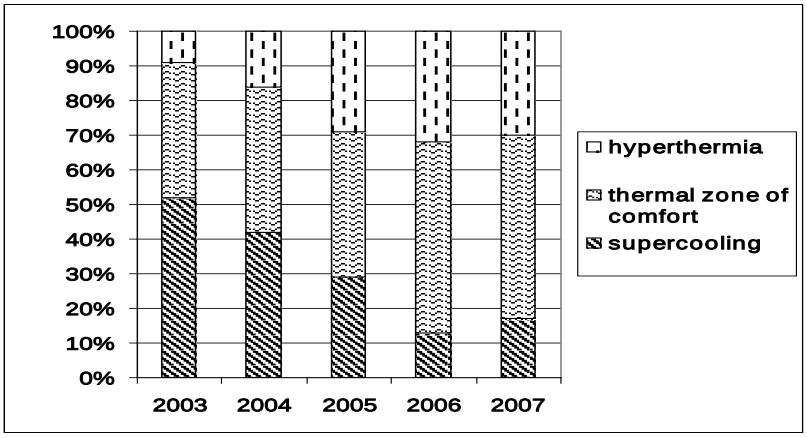

Fig. 1. ***The repeatability of comfortable and discomfortable weather in Ilichevsk***

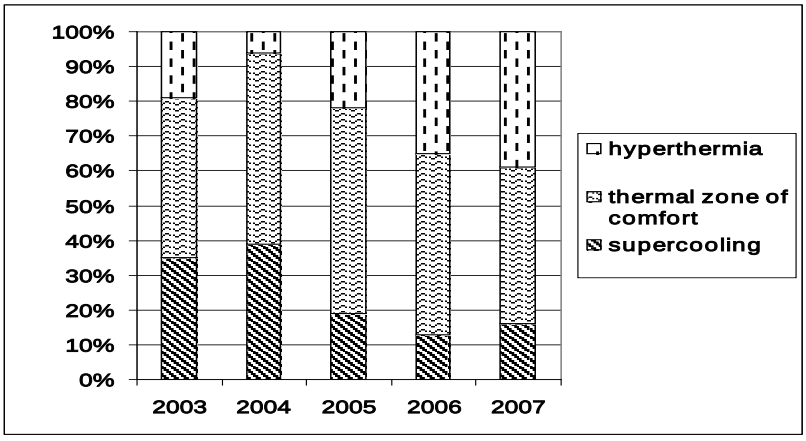

Fig. 2. ***The repeatability of comfortable and discomfortable weather in Odessa***

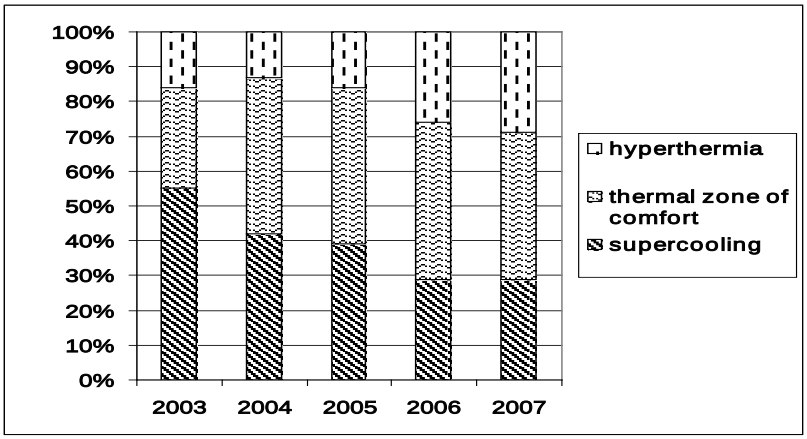

Fig. 3. ***The repeatability of comfortable and discomfortable weather in Belgorod-Dniestrovsky***

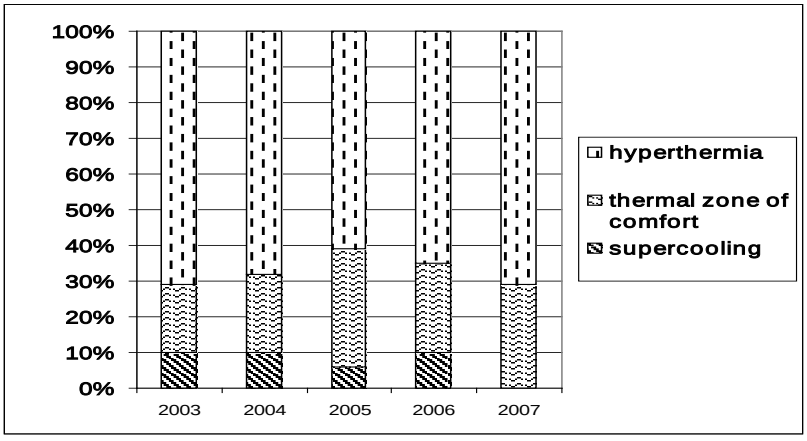

Fig. 4. ***The repeatability of comfortable and discomfortable weather in Vilkovo***

According to the duration of the period, throughout which there is a comfort zone, it is possible to judge about climatotherapeutic resources of the territory. Analysis of the results of performed calculations shows that in July and August conditions of sufficient comfort (repeatability of comfort zone of *EET* is 30-50 % of all days in the month) are observed most often. And only in Odessa in July there are conditions of optimal comfort (50-70 %), and in Vilkovo - conditions of minimal comfort (less than 30 %). June is characterized with sufficient comfort except Belgorod-Dniestrovsky, where conditions of minimal comfort are observed.

Due to given figures, it is possible to trace the dynamics of comfort and discomfort conditions. Thus, in all the stations the number of comfortable days increased insignificantly, the supercooling zone decreased, and respectively the hyperthermia zone rose.

In table 1 there are given monthly mean values of *EET*.

Table 1. ***Average month rates of EET, NEET, REET and BAT (˚C)***

Month	Year	ILICHEVSK				ODESSA			
		EET	***NEET***	***REET***	***BAT***	***EET***	***NEET***	***REET***	***BAT***
June	2003	16.5	20.2	25.7	22.2	17.2	20.8	26.3	22.8
	2004	13.2	17.5	22.9	19.5	15.1	19.1	24.5	21.1
	2005	13.3	17.6	23.0	19.6	15.3	19.2	24.7	21.2
	2006	16.8	20.5	26.0	22.5	17.0	20.6	26.1	22.6
	2007	19.1	22.3	27.9	24.3	19.8	22.8	28.4	24.8
July	2003	15.9	19.8	25.2	21.8	17.7	21.1	26.7	23.1
	2004	16.2	19.9	25.4	21.9	17.7	21.1	26.7	23.1
	2005	19.0	22.2	27.8	24.2	19.8	22.8	28.4	24.8
	2006	20.7	23.6	29.2	25.6	20.3	23.2	28.9	25.2
	2007	19.7	22.8	28.4	24.8	20.8	23.7	29.3	25.7
August	2003	19.2	22.4	28.0	24.4	19.9	22.9	28.5	24.9
	2004	18.1	21.5	27.0	23.5	18.8	22.1	27.6	24.1
	2005	19.0	22.2	27.7	24.2	19.5	22.6	28.2	24.6
	2006	21.1	23.9	29.5	25.9	19.9	22.9	28.5	24.9
	2007	21.0	23.8	29.4	25.8	20.9	23.7	29.4	25.7
Month	Year	BELGOROD-DNIESTROVSKY				VILKOVO			
		EET	***NEET***	***REET***	***BAT***	***EET***	***NEET***	***REET***	***BAT***
June	2003	15.8	19.6	25.1	21.6	21.2	23.9	29.6	25.9
	2004	12.3	16.9	22.2	18.9	18.7	21.9	27.5	23.9
	2005	13.6	17.9	23.3	19.9	18.8	22.1	27.6	24.1
	2006	15.4	19.3	24.8	21.3	20.0	23.0	28.6	25.0
	2007	16.7	20.3	25.8	22.3	21.7	24.4	30.0	26.4
July	2003	15.8	19.7	25.2	21.7	21.9	24.5	30.2	26.5
	2004	16.3	20.0	25.5	22.0	21.5	24.2	29.9	26.2
	2005	17.9	21.3	26.9	23.3	22.3	24.9	30.5	26.9
	2006	18.8	22.1	27.6	24.1	22.0	24.6	30.3	26.6
	2007	19.7	22.7	28.3	24.7	23.9	26.1	31.8	28.1
August	2003	19.0	22.2	27.8	24.2	23.2	25.6	31.3	27.6
	2004	17.3	20.8	26.3	22.8	22.2	24.7	30.4	26.7
	2005	19.6	22.7	28.3	24.7	23.1	25.5	31.2	27.5
	2006	18.5	21.8	27.4	23.8	22.6	25.1	30.8	27.1
	2007	18.2	21.5	27.1	23.5	23.7	26.0	31.7	28.0

Because of the cooling effect of the wind and air humidity, equivalent-effective temperature is 5-10˚ C less than monthly mean air temperature.

The highest values of *EET* for the whole researched period were observed in Vilkovo. This is caused by the highest air temperature comparing to other cities (its monthly average values for five years are 25.6-28.3˚ C), the lowest wind speed (2.1-2.4 m/s) and relative humidity (52-53 %). The absolute maximum of *EET* was 29.5 ˚ C, it was registered in July in 2007.

The analysis of the table shows that by *EET* the most comfortable conditions are in July and August in Odessa, Ilichevsk and Belgorod-Dniestrovsky, and in June in Vilkovo. Therefore, it's expedient to accomplish recreational procedures, including aerotherapy, within this period in these cities.

There is a classification of climatotherapy procedures, based on the comprehensive climatology. This classification is used on practice in treatment with climate (Vrublevska O.O and Katerusha G.P., 2005).

Monthly mean values of *NEET* (2) are presented in table 1. Estimation of thermal perception of a human by *NEET* is performed as follows: 0.1-6 º C - very cool; 6.1-12 º C - cool; 12.1-18 º C - moderately warm; 18.1-24 º C - warm; 24.1-30 º C - moderate heat load, > 30 º C - strong heat load (Hentschel G., 1988). Considering *NEET*, comfortable conditions were observed in all the cities during the whole summer period, except Vilkovo which is favorable only in June.

In table 1 there are also shown monthly average values of *REET* (3). Classification of *REET* characterizes abilities of heliotherapy. Heliotherapy is use of sunlight for therapeutic and preventive purposes. Heliotherapy is recommended in case of all manifestations of hypovitaminosis D, a number of skin diseases, wounds that heal sluggishly, ulcers, fractures, etc. As a preventive and tempering measure heliotherapy may be appointed to all healthy people. There were developed optimal thermal conditions that are characterized with *REET* in order to treat patients with certain forms of disease by means of heliotherapy. The results of the research showed that July and August in Vilkovo are undesirable for heliotherapy. The best conditions for it are in Belgorod-Dniestrovsky during all three summer months. Ilichevsk and Odessa are also favorable for heliotherapy, especially in June and July. Sunbathing is recommended to the patients with coronary heart disease in June in Belgorod-Dniestrovsky. And for the first stage of hypertension or protracted and chronic pneumonia of the first stage, early-stage chronic bronchitis, etc. heliotherapy is expedient throughout the summer in Belgorod-Dniestrovsky and during June and July (August is also suitable, but to a lesser extent) in Ilichevsk and Odessa.

As it was aforesaid, complex influence of temperature, relative humidity, wind velocity and radiation streams on human organism is evaluated by biologically active temperature (Table 1), which was defined by the equation (4). Categories of heat perception according to *BAT* are: optimal - from 10 to 22 ˚ C, low - <10 ˚ C and high -> 22 ˚ C (Vrublevska O.O. and Katerusha G.P., 2005). The researches showed that optimal conditions are mostly observed in June in Odessa, Ilichevsk and Belgorod-Dniestrovsky.

4. CONCLUSIONS

Assessment of bioclimatic resources at four stations located in the coastal zone of Odessa region (Odessa, Ilichevsk, Belgorod-Dniestrovsky and Vilkovo) showed that the given territory has a major recreational potential during summer period. This conduces to tourism development in this area.

Results of the research indicate suitable conditions for different touristic activities, particularly those, which are directed on relaxation and rehabilitation. Bioclimatic resources of Odessa region in summer are applicable for such methods of treatment as aerotherapy, heliotherapy and thalassotherapy. Awareness of quantitative and qualitative estimation of bioclimatic resources can be successfully used in the treatment of a wide range of cardio-vascular, respiratory diseases, etc.

The results can be useful for planning and differentiation of tourism areas and facilities. According to bioclimatic indices, more often conditions favorable for recreation are observed in July and August in Odessa, Ilichevsk and Belgorod-Dniestrovsky, and in June in Vilkovo. The southern part of Odessa region (which is here represented by Vilkovo) is characterized with quite distinct conditions, comparing to other three cities. If all differences and peculiarities are taken into account, the territory will be more attractive for tourists and it will be easier to choose the appropriate place for more efficient recreation.

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