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BIOCLIMATIC DIVERSITY OF THE REGIONS OF UKRAINE (METHODS, RESULTS, RECOMMENDATIONS)

Abstract: The values of bioclimatic indices for average multiyear data: ITEveg. and ITEan., IGDP, Iarid. and Ibcc - for quick estimation of conditions development of vegetation cover from 19th century till now in different regions of Ukraine have been used. Average multiyear values of indices as criteria of boundaries of natural zones - Forest and Steppe have been determined. The maps and tables of indices distribution demonstrate favourable hydrological and thermal conditions of the regions of Ukraine and their variability, particularly calculated by average multiyear meteorological data.

Key words: bioclimatic indices, evapotranspiration, geographical deficiency of precipitation, relative aridness, biotemperature.

1. Methods

The values of following indices have been calculated for average multiyear and annual data (according to observations at the standard network meteorological stations in Ukraine): 1. Hydrothermal indices: biotemperature (BT), evapotranspiration per vegetational period (ITEveg.) and annual (ITEan.); 2. Value of geographical deficiency of precipitation (IGDP); 3. Value of relative aridness (Iarid.) (Holdridge 1959; Georgiev, Udra 1990; Georgiev 1999); 4. Value of bioclimatic changes (Ibcc). The last index was calculated by formula:

$$I_{bcc} = BT_{max} - BT_{min} / \overline{BT}$$

$$I_{bcc}^* = ITE_{max} - ITE_{min} / \overline{ITE}$$

2. Results and Recommendations

Zonal and regional peculiarities of distribution of bioclimatic characteristics (ITEan. and Iarid.) for multiyear data were considered (Fig. 1a, b). The regions in which hydrological and thermal conditions are more favourable are: Ukrainian Carpathians and Sub-Carpathian region, Crimea Mountains and Foothills, some regions of Ovruch ridge, Rostochie and Opolie, some areas of Donets ridge, Toutries and north-eastern territory of Chernigov Polessie (southern spurs of Central Russian Upland and also „forest-steppe islands” in Steppe with the presence of rare and disappearing plants (more than 30 species) (Fig. 1a, b). More favourable conditions for vegetation abundance in comparison with present time are confirmed by chronicles and materials on forests spreading in 17th century (Beauplan et al. 1919; Georgiev, Udra 1990).

On the other hand there are regions and areas where hydrological and thermal conditions are less favourable and less stable because of zonal and regional variability of insolation, particularly increasing of „aridation” in southern and other less stable regions on local areas of Ukraine, the influence of relief etc. A combined effect of a number of anthropogenic processes: local thermal pollution of atmosphere by industry, negative consequence of deforestation, ploughing up grasslands, land-reclamation, etc. enhances this influence.

The regions most influenced by anthropopression as shown by multiyear data are: the northern outer part of Volyn-Podil Upland (along the line Wolodimir Volynsky-Lutzk-Rivne-Zhytomir), Sub-Carpathians (along the line Sambor-Striy and Ivano-Frankivsk) and also „steppe islands” in Forest-Steppe especially in industrial Prydniprovye. The values of mentioned hydrothermal indices in the centre of such areas are increased.

The values of the bioclimatic parameters at the representative meteorological stations of the region of Ukraine were averaged for various periods, which permitted to reveal the following tendencies. There was a cooling after 1938, followed by the warming after 1965. It was documented by the decrease or increase of values and even the reversal of IGDP. It was found out that the least values of the bioclimatic indices (Tab. 1), including Ibcc (0.2-0.6) took place in the regions with favourable hydrological and thermal conditions for development of plants, including relict and dominant species. These regions are presented as shaded on the maps of distribution of ITEan. and Iarid. (Fig 1a, b) to characterise zones with more favourable hydrothermal conditions. As a whole the bioclimate of Ukraine can be classified into five types: 1 - mountainous (Ukrainian Carpatians and Crimian mountains); 2 - sub-mountainous (mainly the south slopes); 3 - plateau (with the sites of rare and extinct species (Fig. 1a,b); 4 - plains (here the relict and dominant species almost disappear because of intensification of anthropogenic influence; 5 - microclimate of isolated localities on the south slopes, which are protected from winds and are characterised with peculiarities of chemical composition of the soil connected with limestone outcrop (types 1-3).

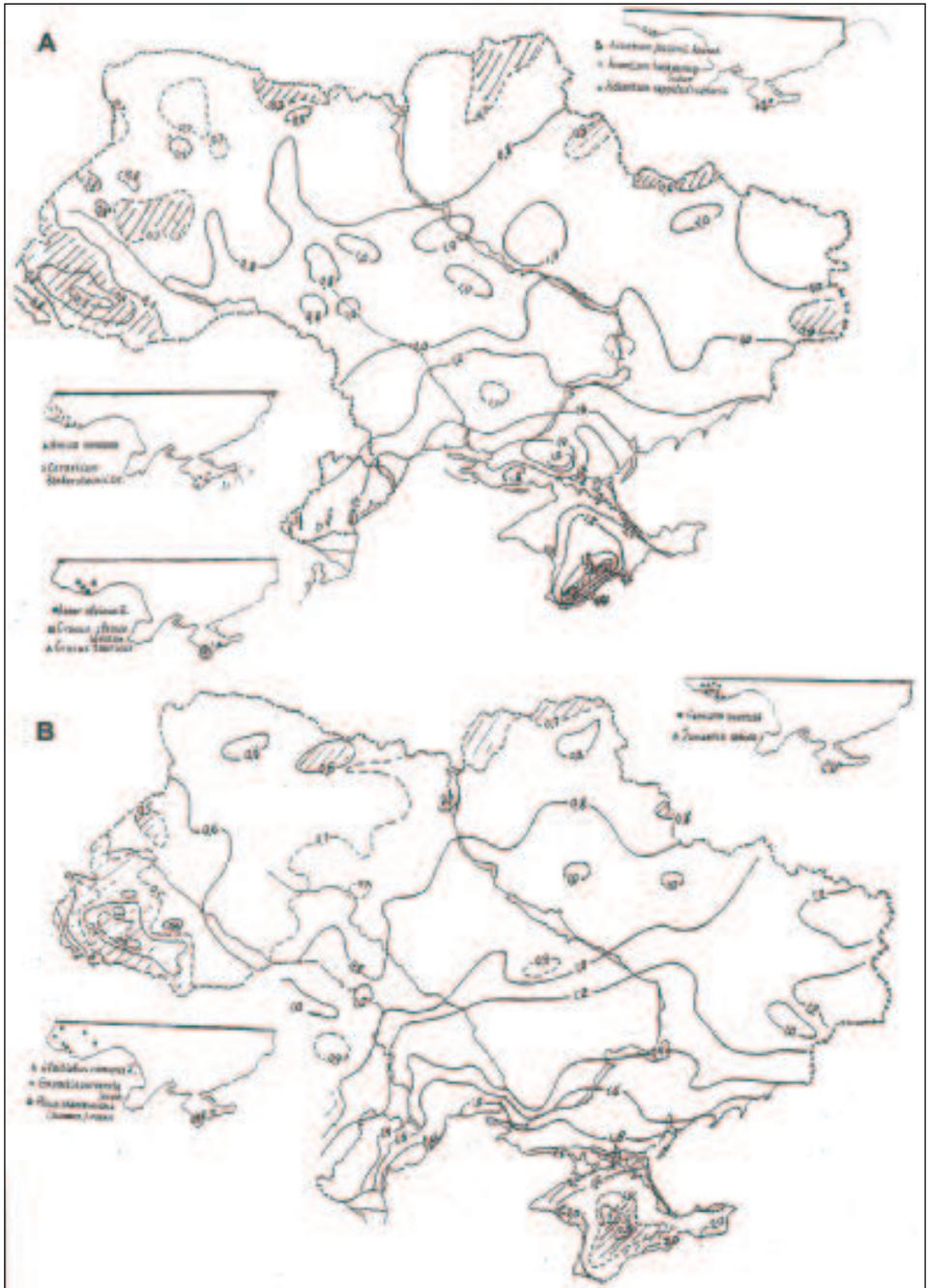


Fig. 1. Distribution of indices of potential evapotranspiration for annual (a) and of relative (b) aridity for territory of Ukraine (average multiyear data) (maps on Fig. 1a b show distribution of rare and disappearing species of plants (Chopyk et al. 1988).

Tab. 1. The multi-year average values of bioclimatic indices for the representative meteorological stations of the Ukraine (according to the "Scheme of bioclimatic division of rebraine of Ukraine" (Georgijev 1999) (calculation are executed on different periods of average multiyear data: before 1938 (1) before 1965 (2) and before 1980 (3); data in brackets - altitude of station).

Indices	Right-Bank Polissia region			Rostochia-Opolie region			Pre-Carpathian region		
	Lutzk (194 m)			Lviv (329 m)			Ivano Frankivsk (244 m)		
	1	2	3	1	2	3	1	2	3
BT	-	8.16	8.19	-	7.66	7.94	-	8.27	8.17
ITEan.	0.76	0.72	0.80	0.75	0.57	0.62	0.78	0.71	0.72
ITEveg.	0.96	0.90	0.90	0.87	0.71	0.76	0.87	0.81	0.82
larid.	-	0.66	0.66	-	0.49	0.50	-	0.57	0.53
IGDP	-160	-148	-185	-166	-347	-281	-141	-196	-192
lbcc/lbcc*	0.21 / 0.48*			0.14 / 0.71*			0.15 / 0.78*		

Indices	Ukrainian Carpathian province								
	Turka (594m)			Pojijevska (1429 m)			Selyatyn (744 m)		
	1	2	3	1	2	3	1	2	3
BT	6.81	6.84	-	-	4.78	4.41	-	6.11	-
ITEan.	0.48	0.50	-	-	0.20	0.17	-	0.47	-
ITEveg.	0.59	0.62	-	-	0.29	0.27	-	0.58	-
larid.	0.37	0.40	-	-	0.23	0.18	-	0.50	-
IGDP	-443	-407	-	-	1160	-1241	-	-399	-
lbcc/lbcc*	0.14/0.54*			0.20 / 0.53*			0.27 / 0.36*		

Indices	Transcarpathian Central-Podilski region province								
	Uzgorod (121 m)			Ternopil (321 m)			Khmelnitzki (297 m)		
	1	2	3	1	2	3	1	2	3
BT	9.67	9.74	9.94	-	7.93	7.79	7.77	7.90	7.99
ITEan.	0.73	0.68	0.74	0.73	0.69	0.72	0.80	0.67	0.73
ITEveg.	0.91	0.80	0.85	0.91	0.84	0.91	0.97	0.90	0.92
larid.	0.72	0.74	0.72	-	0.60	0.58	0.62	0.61	0.58
IGDP	-212	-267	-210	-127	-211	-177	-112	-225	-178
lbcc/lbcc*	0.10 / 0.60*			0.23 / 0.85*			0.18 / 0.54*		

Indices	Central-Podilski region			Southern part of Right-Bank Ukraine			Bogoduchov-Vilchansky region		
	Vinnitsa (285 m)			Uman (214 m)			Sumy (179 m)		
	1	2	3	1	2	3	1	2	3
BT	8.11	7.95	8.15	8.28	8.38	8.38	-	8.00	8.07
ITEan.	1.0	0.75	0.81	0.96	0.84	0.85	0.92	0.76	0.81
ITEveg.	1.18	0.98	1.04	1.22	1.15	1.15	1.30	1.20	1.10
larid.	0.84	0.72	0.61	0.86	0.94	0.81	-	0.75	0.76
IGDP	+2	-153	-116	-20	-96	-84	-40	-149	-113
lbcc/lbcc*	0.18 / 0.55*			0.17 / 0.58*			0.28 / 0.49*		

Indices	Left-Bank Forest- Steppe region			Zburivsko-Kachovski region			Central Steppe region		
	Poltava (161 m)			Askania		Nova (31 m)	Klepinino (37 m)		
	1	2	3	1	2	3	1	2	3
BT	8.49	8.63	8.59	9.93	10.13	-	-	10.35	10.59
ITEan.	0.99	0.87	0.94	1.57	1.32	-	-	1.09	1.49
ITEveg.	1.29	1.21	1.20	1.90	1.82	-	-	1.25	1.80
Iarid.	0.93	0.88	0.89	1.30	1.30	-	-	1.09	1.49
IGDP	-8.0	-77	-30	+212	+146	-	-	+51	+188
lbcc/lbcc*	0.28 / 0.79*			0.20 / 0.89*			0.22 / 0.54*		

Indices	Crimea Mountains					
	Western Yaila			Eastern Yaila		
	Ai	Petri (1180 m)		Karabi	Yaila (987 m)	
	1	2	3	1	2	3
BT	-	-	6.54	-	-	7.13
ITEan.	-	-	0.35	-	-	0.58
ITEveg.	-	-	0.71	-	-	0.90
Iarid.	-	-	0.76	-	-	0.83
IGDP	-	-	-727	-	-	-303
lbcc/lbcc*	0.24 / 1.02*			0.22 / 0.59*		

Note - The values of lbcc* are larger than lbcc due to measuring mistakes of precipitation and its space distribution.

Estimation of hydrothermal conditions variability in space and time by means of Iarid.:

$$I_{arid} = 3T_{VII} / P_{rec VII}$$

in the various regions of Ukraine proved to be effective and allows to recommend this index for evaluation of the paleoclimatic conditions from palynologic materials using the modern data from the meteorological stations (localised near the points of distinguished geological sections), and using average values from standard meteorological periods.

Corresponding values of hydrothermal indices correlations were chosen for correction of boundaries of natural zones and bioclimatic taxonomic units, e.g. the northern boundary of Forest-Steppe was determined as ITEveg. = 1, TE = 480 mm, IGDP = 100 mm while the northern boundary of Steppe ITEan. = 1, TE = 540 mm, Iarid = 1, IGDP = 0. The smaller taxonomic units e.g. dry steppe regions could be determined by isoline ITEan = 1.4 and IGDP = +200 mm etc.

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