CLIMATIC REGIONALIZATION BETWEEN *YESTERDAY* AND *TOMMORROW*. STUDY CASE: THE BANAT PLAIN

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ABSTRCT - Climatic regionalization is an important activity of many Romanian and foreign researchers. This research work has been done for more than 100 years. For the last 30 years Romania has been divided into climatic domains, regions and districts, according to the landscape characteristics of the air mass circulation (wind characteristics) and vegetation (other important genetic climatic factors were taken also into account, such as the impact of human society over the natural environment).

Theoretically, the latest global and regional climate changes have not modified the entire climatic regionalization taxonomy. It is divided into the same domains, regions, and districts. This 30 year-old taxonomy is still in use, but, practically, the values of the major climatic elements have changed, mostly at the micro- and topo-climatic level and, especially, in the case of urban topo-climates. *Tomorrow*'s climatic regionalization will take more into account human impact and economic activities. This will be a factor with an increasing impact on the genesis of the climate, at the micro- and topo-climatic level and at the regional and local level. In the Banat Plain Area, these changes are mostly noticed at a local level, because of the topo-climatic appearances or modifications.

The present study analyses temperature and precipitation parameters in the Banat Plain Area, in 2000, 2001, and 2002 in comparison to the multi-annual value from The CMR Banat-Crişana Archives and listed at the meteorological observation stations from Sânnicolau Mare, Jimbolia, Timişoara, Banloc and Lugoj.

Key words: climate regionalization, the Banat Plain area, monthly average value and multi-annual average value of temperatures and precipitations

General considerations on climatic regionalization in Romania

If we analyze the parameters of the temperate-continental climate in Romania we can observe concrete regional climatic differences influenced by the geographic systems (this influence is not, however, the same all over the Romanian territory) and by altitude. Thus, specialists talk about climatic sectors, when regionalization is based on the baric system influence criterion, and about climatic altitudinal floors (plains, hills, and mountains), when regionalization is based on the orographic influence criterion.

According to the importance of each genetic factor, the following taxonomic steps are used in the climatic and topo-climatic regionalization of Romania (according to Geografie Fizică / Physical Geography, I, 1983): the climatic zone (according to the distribution of solar radiations on Earth), climatic province sectors (according to the influence of the general atmosphere circulation). In this latter case, there is the province sector of oceanic influences, the sector of submediterranean influence, the transition sector from oceanic and submediterranean influences to arid ones, the sector of arid influences, the sector of Baltic and Pontic influences). One should also add to these sectors the climatic regions (superimposed on the major altitudinal floors), the climatic sub-regions (individualized according to the general climatic characteristics of every altitudinal step and typical to the major relief/landscape units), and climatic districts (differentiated according to relatively homogeneous climatic conditions which generate the development of a certain spontaneous vegetation type). The complex topo-climates were delimitated inside the climatic districts according to relatively similar climate conditions. Elementary topo-climates belong to complex topo-climates with relatively similar climatic conditions. These are characteristic of the elementary geographic landscape with a relatively homogeneous active surface.

According to the vertical zone criterion we can differentiate between the climates of the plains, the hills, and the mountains. The plain climate is typical to the Tisa Plain, the Romanian Plain, also to the Western area of the Getic Foot Hills Plain and the Dobrogea Plateau (Rosu Al., 1973). The climate of the hills makes the transition from the plain climate to the mountain climate. The extension of these relief forms determines evident modifications of meteorological factors. Baric influences lead to regional nuances: the Western Hills subtype climate with oceanic nuance, the sheltered climate subtype in the Transylvania Depression with an oceanic nuance, the extra-Carpathian heights climatic subtype transitional to a continental climatic nuance, and east of the Carpathians, the hill subtype climate with an increased continental nuance. The mountain climate is divided into several climatic subtypes: the mid-mountain subtype and the alpine heights subtype.

From the point of view of the climate-genetic factors, the Banat Plain relief is a large smooth area (altimetric amplitude between 20 and 80) with a relatively uniform disposal of climatic elements. However, there is a difference from the east (near the hills) to the west besides the latitudinal difference from the south to the north. There is also a great topo-climatic and micro-climatic variety because the diversity of the relief forms brings about a great climatic variety. In the natural subunits of the Banat Plain there are complex and elementary topo-climates and microclimates. Besides the natural subunits, we may add the anthropic ones, which are determined by the presence of human settlements and human impact in the plain.

The Banat Plain is divided into the Mureş Plain (with the following main subunits: the Arad Plain, the Jimbolia Plain, the Nădlac Plain, the Aranca Plain) and the Timiş Plain. This plain is a uniform surface with many winding riverbeds, and many former marshes, nowadays dredged and drained, which makes the subunits less evident. However, as a consequence of the longitudinal uniformity given by the present course of the Bega Canal and the Timiş River, there are 4 separate units: the Timişoara Plain, the Old Bega Plain, the Small Bega Plain, the Birda Plain, and the Moravița Plain (*Geografia României*, IV, 1992). The Lugoj Golf Plain is made up of two low plains, three terrace plains and glacises. The Bârzava Plain is an old glacis complex divided into three other plains (Buziaş, Tormac, and Gătaia) by the large valleys of the Poganiş and the Bârzava Rivers (*Enciclopedia geografică a României*, 1982).

In this study, we have used climatologic data from the CMR Banat-Crişana Archives. The monthly average values in 2000, 2001, and 2002 have been compared to 30-year multi-annual average values from the following meteorological stations: Sânnicolaul Mare, Jimbolia, Timişoara, Banloc, and Lugoj. We have analyzed the following climatic parameters: air temperature and precipitations. For the city Timişoara, we have used the same parameters, which we have analyzed for 10 years in comparison with the multi-annual average values from the Timişoara meteorological station since its foundation.

We have researched the differences between what was happening 30 years ago and the present climate in order to see whether these climatic changes affected the taxonomy of the region and if so how they affected it.

ON THE NOWADAYS CLIMATIC CHANGES IN THE BANAT PLAIN

Once, the Banat climate was tropical, just like the climate of all Europe. Today, according to the technological modernization rhythm, researchers are looking for solutions to diminish global warming.

Tomorrow's climate was the topic proposed by OMM for its 2003 scientific events on climate protection. The message of OMM emphasises that now there are proofs that the climate is warming up and that this already manifest phenomenon can affect everyone's life and health.

In the last 30 years there were unusual meteorological events: floods, tropical cyclones, drought and dryness in different areas of the world. 1998 was the warmest year in the history, followed by 2001. The 1990s was the warmest decade in the 20th century and the heating rate and amplitude in the 20th century may have been bigger than any other period during the last 1000 years. This heating is caused by the increasing concentration of the greenhouse emission gas in the atmosphere. This is the result of the unprecedented increase in the global energy consumption in the last century. Although there are complex technologies, 90% of global energy is obtained from fuel combustion (with high levels of air pollution). Cars add one degree to temperature increase. Gas emissions are harmful to plants and animals, and also to people. Human settlements are an important component of the environment and they put pressure on the natural system. Deforestation cannot be overlooked. Nowadays, forests represent only 30% of the Earth's surface.

Our country has a continental climate with excessive nuances, so that is why almost every year high temperatures are recorded. Lately summers have been hotter than usual. For example, in July 2000 there was a record 43.5 C at Giurgiu and 42.6 C in Bucharest. In the summer of 2003, a temperature of 38.2 C was

recorded at Jimbolia, Sânnicolaul Mare and Moldova Veche on the 14th august, while at Timişoara, the temperature was 37.9 C on the same day.

As witnesses of these phenomena we can wonder: What lies for us in the future?

A team of specialists from the University of Texas at Austin noticed that in the last 10 years 1,700 species of wild animals migrated 6.1 km to the artic zones or they have climbed the mountains. Researchers from Australia, Germany, and UK have also reported changes in the natural processes, which, until now, were specific only to springs: the earlier migration of birds and butterflies, plants budding sooner, etc. This team of researchers have published their results in the journal *Nature*. They emphasised that "we are certainly at the beginning of a climate heating process on the whole planet" and this change needs a clear and visible ecological response. Probably, not accidentally, it has snowed in some Arab countries which have a warm climate and where snow used to be unknown. Now you can bathe in the Baltic Sea as on the Romanian seaside, whereas 15 years ago this was very difficult to do because the water was very cold.

In the future, the accelerated rhythm of technology will diminish uncertainties and thus will greatly influence the way in which climatic problems will be solved. Because of the implications of this phenomenon, international legal regulations were adopted at the conference in Rio, in 1992. In 1997 the Kyoto Protocol on climate change was signed. The purpose was to reduce the greenhouse emission gas from the atmosphere, according to a great technical and scientific project, which should diminish climate change.

The CMR Banat-Crişana data from the 5 meteorological stations on the plains show the variations of the two parameters under consideration, the positive or negative deviations of the monthly average are compared to the 30-year multi-annual average.

Table 1. Monthly characteristics of temperatures and precipitation

	TEMP °C PP MM	**AVERAGE VALUE**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**
Jimbolia	Temp	Monthly average values	16.7	18.6	21.9	21.6	24.2	16.7
		Multi-annual average values	11.9	16.0	19.4	21.4	20.7	16.7
	Precip.	Monthly average values	32.6	13.1	43.6	16.2	1.4	15.5
		Multi-annual average values	45.0	58.2	70.8	51.7	50.6	41.2
	Deviation Pp		-12.4	-45.1	-27.2	-35.5	-49.2	-25.7
Timişoara	Temp	Monthly average values	14.8	18.7	21.7	22.0	24.0	16.7
		Multi-annual average values	11.2	16.3	19.4	21.1	20.4	16.5
	Precip.	Monthly average values	34.3	31.5	40.9	25.3	8.6	23.7
		Multi-annual average values	48.7	64.6	76.1	63.0	49.8	40.3
	Deviation Pp		-14.4	-33.1	-35.2	-37.7	-41.2	-16.6
Lugoj	Temp	Monthly average values	13.8	17.8	21.0	21.4	23.3	16.3
		Multi-annual average values	10.9	15.8	18.7	20.4	19.8	15.9
	Precip.	Monthly average values	82.8	46.2	35.3	60.0	24.9	37.0
		Multi-annual average values	55.4	79.8	90.8	63.5	56.7	47.1
	Deviation Pp		+27.0	-33.6	-55.5	-3.5	-31.8	-10,1
Banloc	Temp	Monthly average values	14.4	18.4	21.7	22.0	24.2	16.8
		Multi-annual average values	11.1	16.4	19.5	21.1	20.6	16.7
	Precip.	Monthly average values	33.0	42.2	33.1	29.0	6.1	33.3
		Multi-annual average values	49.4	72.0	79.4	55.9	57.5	41.3
	Deviation Pp		-16.4	-29.8	-46.3	-26.9	-51.4	-8.0
Sânnicolaul Mare	Temp	Monthly average values	14.4	18.9	22.0	21.7	24.4	17.0
		Multi-annual average values	11.0	16.3	19.5	21.1	20.6	16.7
	Precip.	Monthly average values	30.4	15.4	47.6	27.7	19.8	24.6
		Multi-annual average values	42.5	55.3	70.6	53.7	48.2	36.6
	Deviation Pp		-12.1	-39.9	-32.0	-32.0	-28.4	-12.0

In 2000, during the entire hot season, all the 5 meteorological plain stations recorded a negative deviation of the monthly means of precipitations in comparison to the multi-annual means. In 2000 drought occurred during the entire year (both in the cold and in the hot season).

The monthly mean temperatures recorded positive deviations, much higher values than the multi-annual mean temperatures.

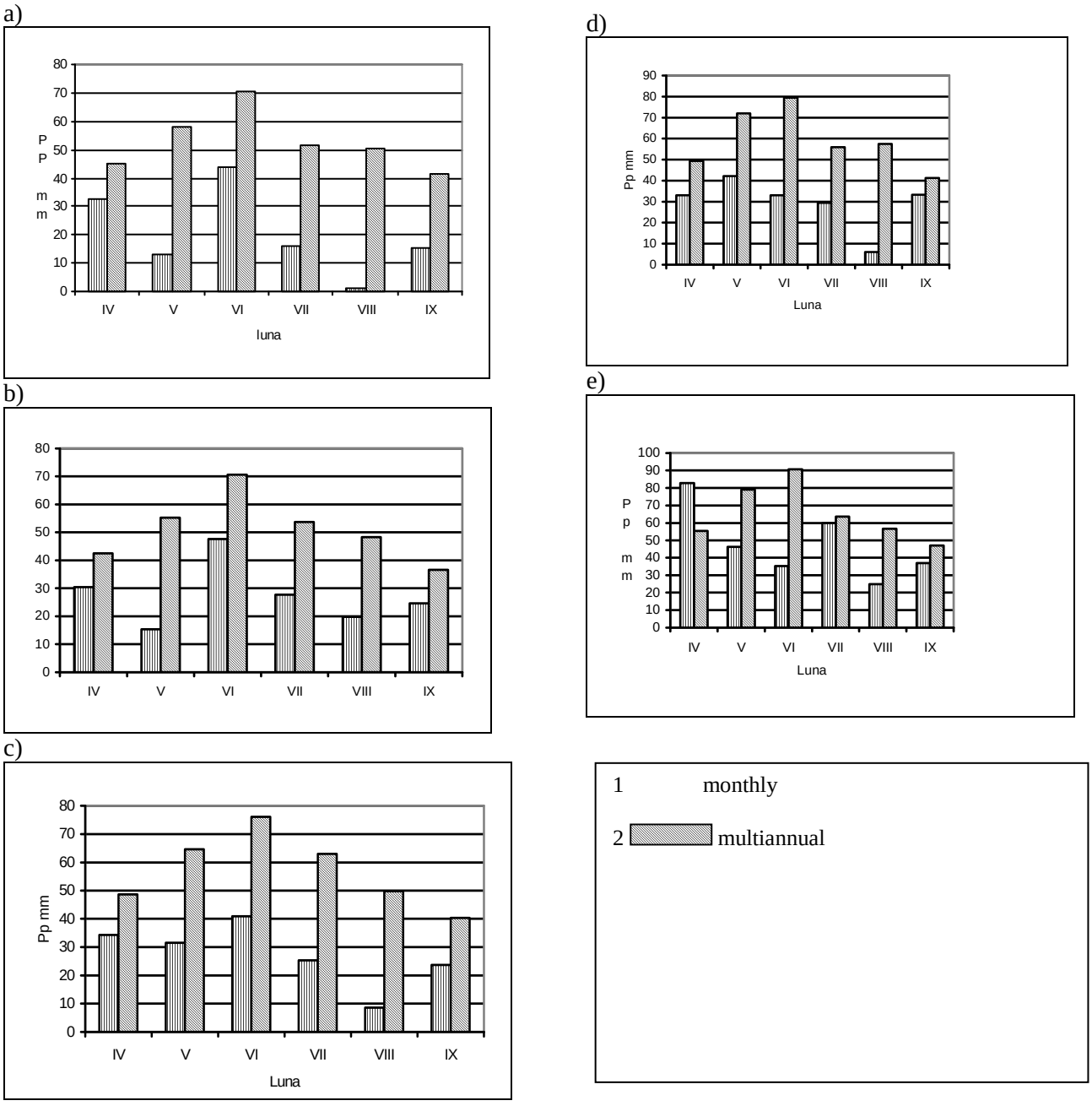

Fig. 1 Variations of precipitations (monthly average values and multi-annual average values) in the Banat Plain in the hot season of the year 2000
a. Jimbolia; b. Sânnicolaul Mare; c. Timişoara; d. Banloc; e. Lugoj.

The comparative analyses of the monthly average values of precipitations in the year 2000 with the multi-annual means reveals negative deviations at all the meteorological stations. The year 2000 was very dry, the drought was extreme: 2000 was the second driest year in the 20th century after 1947.

Table 2. Mean air temperature average and monthly deviations according to the multi-annual mean temperatures

LUNA	TIMIŞOARA		BANLOC		JIMBOLIA		SÂNNICOLAUL MARE		LUGOJ	
	Average	**Deviation**	**Average**	**Deviation**	**Average**	**Deviation**	**Average**	**Deviation**	**Average**	**Deviation**
Ian	2,3	+3,9	2,8	+3,4	2,3	+3,8	2,0	+4,0	3,1	+4,5
Feb	3,3	+2,2	3,0	+1,7	3,2	+2,0	2,9	+2,0	3,1	+1,8
Mar	9,4	+3,6	9,5	+3,8	9,2	+3,3	8,9	+3,5	9,5	+3,9
April	10,7	-0,5	10,7	-0,4	10,7	-1,2	10,6	-0,4	11,1	+0,4
Mai	17,8	+1,5	17,3	+0,9	17,8	+1,8	17,7	+1,4	17,2	+1,4
Iunie	18,7	-0,7	18,3	-1,2	18,6	-0,8	18,6	-0,9	18,1	-0,6
Iulie	22,2	+1,1	22,3	+1,2	22,1	+1,3	22,1	+1,0	21,8	+1,4
Aug	22,9	+2,5	23,0	+2,4	22,9	+2,2	23,3	+2,7	22,5	+2,7
Sept	15,1	-1,4	15,4	-1,4	15,3	-1,4	15,3	-1,4	15,2	-0,7
Oct	13,3	+2,3	13,3	+2,1	13,4	+2,2	13,6	+2,5	13,1	+2,3
Nov	3,5	-2,1	3,5	-2,3	3,2	-2,3	2,9	-2,3	3,6	-2,2
Dec	-3,3	-4,1	-3,2	-4,1	-4,2	-4,6	-4,6	-5,1	-3,5	-4,5
An	11,3	+0,7	11,3	+0,6	11,2	+0,5	11,1	+0,6	11,2	+0,8

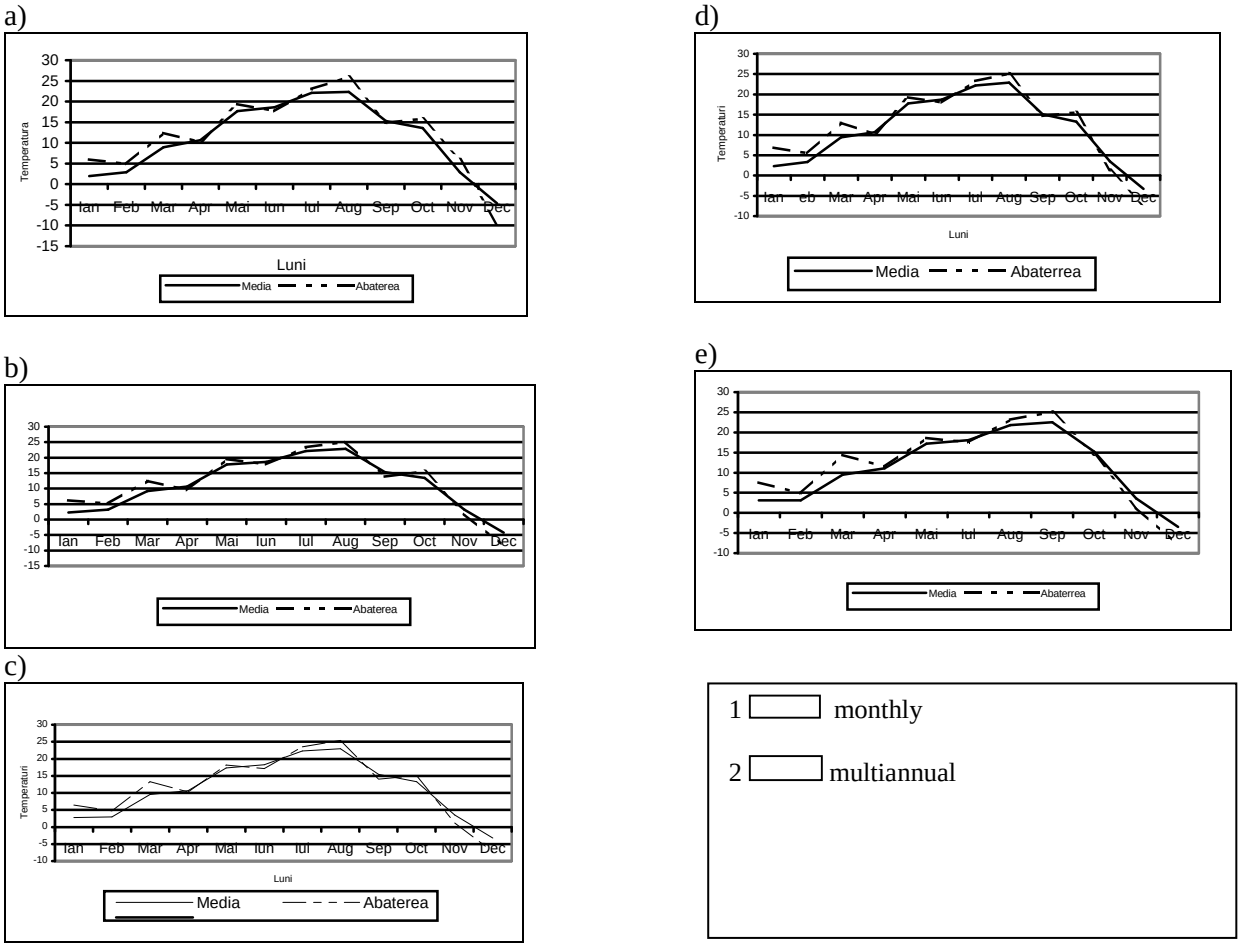

Fig. 2 Temperature variations (monthly average and multi-annual mean temperatures) in the Banat Plain, in 2001
a. Jimbolia; b. Sânnicolaul Mare; c. Timişoara; d. Banloc; e. Lugoj;

After analysing figure 2, we observe that all over the year 2001 the values of the monthly average temperatures are higher than the 30-year multi-annual average values.
2001 was a very hot year, temperatures were higher than the average both in the cold and in the hot season.

Table 3. Mean air temperature and monthly deviations from the multi-annual mean temperatures in 2002

LUNA	TIMIŞOARA		BANLOC		JIMBOLIA		SÂNNICOLAUL MARE		LUGOJ	
	Average	**Deviation**	**Average**	**Deviation**	**Average**	**Deviation**	**Average**	**Deviation**	**Average**	**Deviation**
Ian	-0,8	+0,8	-0,9	+0,5	-0,6	+0,9	-0,6	+1,4	-0,8	+0,6
Feb	5,6	+4,5	5,5	4,2	5,3	+4,1	5,4	+4,7	5,4	+4,4
Mar	8,3	+2,5	8,0	+2,3	8,1	+2,2	8,1	+2,7	7,9	+2,7
April	11,6	+0,4	11,2	+0,1	11,3	-0,6	11,4	+0,4	11,2	+0,7
Mai	19,4	+3,1	19,2	+2,8	19,4	+3,4	19,4	+3,1	18,9	+3,5
Iunie	21,8	+2,4	21,9	2,4	22,0	+2,6	21,8	+2,3	21,1	+2,9
Iulie	23,7	+2,6	23,4	2,3	23,7	+2,1	23,6	+2,5	23,0	+3,2
Aug	21,1	+0,7	21,1	0,5	21,5	+0,8	21,6	+1,0	20,7	+1,3
Sept	16,2	-0,3	16,0	-0,7	16,2	-0,5	16,3	-0,4	15,7	-0,2
Oct	11,4	+0,4	11,3	0,1	11,2	0,0	11,2	+0,1	11,4	+0,5
Nov	8,5	+2,9	9,0	+3,2	8,4	+2,9	8,4	+3,2	9,1	+3,4
Dec	0,3	-0,5	0,4	-0,5	-0,4	-0,8	-0,2	-0,7	0,9	0,0
An	12,3	+1,7	12,2	+1,5	12,2	+1,5	12,2	+1,7	12,0	+1,9

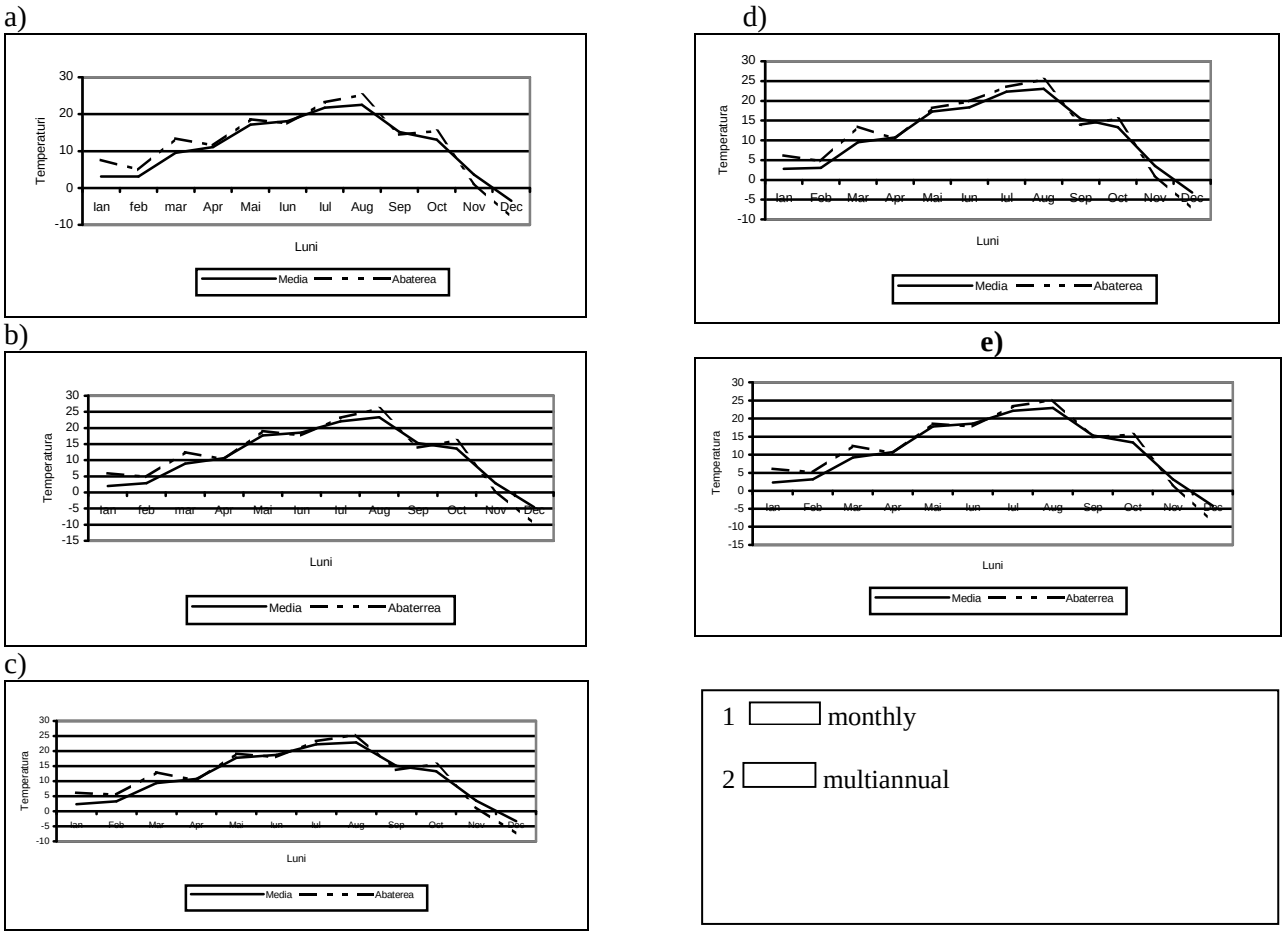

Fig. 3 Temperature variations (monthly and multi-annual mean temperatures) in 2002 in Banat Plain a. Jimbolia; b. Sânnicolaul Mare; c. Timişoara; d. Banloc; e. Lugoj.

As in 2001, for the whole year, monthly temperature means record positive deviations from the multi-annual means.

Table 4. Monthly average precipitation means and deviations from the multi-annual means in 2001

LUNA	TIMIŞOARA		BANLOC		JIMBOLIA		SÂNNICOLAUL MARE		LUGOJ	
	Average	**Deviation**	**Average**	**Deviation**	**Average**	**Deviation**	**Average**	**Deviation**	**Average**	**Deviation**
Ian	35,4	-3,7	22,3	-15,8	25,9	-11,9	29,7	-3,1	45,2	-2,7
Feb	18,6	-19,8	31,1	-6,6	10,6	-26,7	10,4	-20,4	25,6	-18,7
Mar	58,8	+24,9	45,7	+11,6	61,7	+28,9	59,2	+29,6	74,1	+35,8
April	79,6	+32,8	110,0	+61,1	86,4	+43,1	100,5	+54,6	102,0	+43,6
Mai	31,8	+31,3	40,9	-26,1	25,4	-30,1	24,2	-31,7	25,0	-34,1
Iunie	130,2	+50,6	149,6	+71,2	113,5	+38,7	154,2	+78,4	127,9	+38,4
Iulie	58,6	-3,8	51,4	-9,7	56,2	+2,3	58,0	+3,9	55,7	-11,4
Aug	30,6	-20,8	25,2	-28,6	55,7	+3,8	20,7	-30,4	40,2	-18,2
Sept	146,6	+104,5	155,5	+113,3	166,0	+128,4	115,2	+78,1	191,1	+143,6
Oct	15,4	-26,8	23,5	-16,3	14,5	-24,6	10,7	-25,8	22,7	-24,0
Nov	66,1	+16,7	64,3	+17,3	57,7	+11,0	36,9	-7,1	92,4	+41,2
Dec	14,0	+38,6	13,7	-38,8	24,2	-25,2	14,1	-33,7	26,5	+37,2
An	685,7	+84,7	733,2	+132,7	698,0	+137,9	633,8	-92,4	828,4	+137

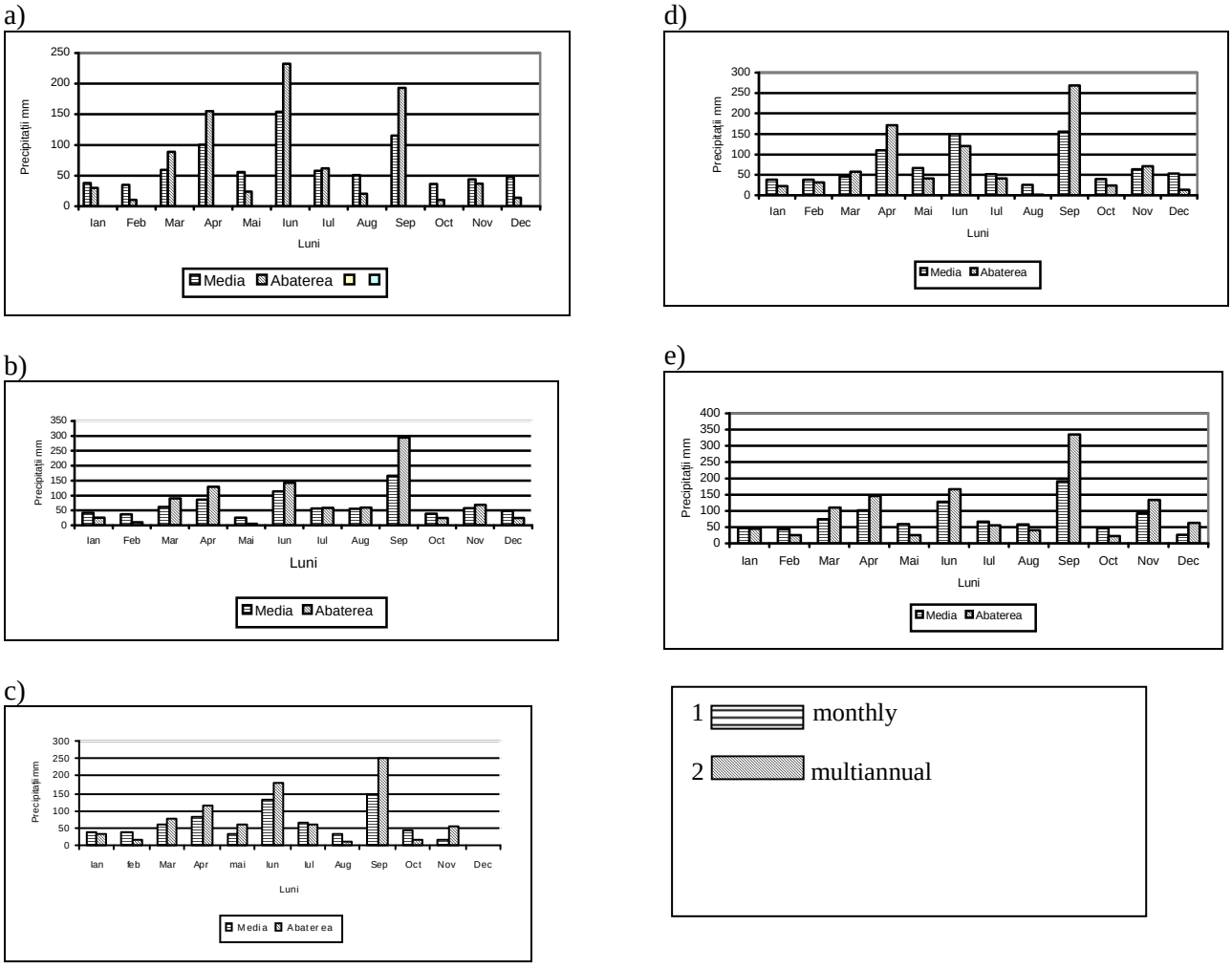

Fig. 4 Precipitation variations (monthly and multi-annual mean variations) in the Banat Plain in 2001
a. Jimbolia; b. Sânnicolaul Mare; c. Timişoara; d. Banloc; e. Lugoj;

From the point of view of precipitations, 2001 was different. During the first months of the year there was a small quantity of precipitations. In spring all meteorological stations registered unusually high humidity, the summer was very dry, and in September and October the quantity of precipitations was beyond its multi-annual mean value.

CONCLUSION

In Timişoara we have noticed climatic changes lately. Positive or negative deviations of temperatures and precipitations are recorded in comparison with the multi-annual mean temperatures and quantity of precipitations. 2000, 2001, and 2002, are the significant years for this study and for the analysis of temperatures and precipitation variations compared with their multi-annual mean values.

This is *yesterday*'s climate.

We can or cannot predict the future. The basic idea is that in this big "air ocean" where we live great changes are recorded. Most of them have negative impact on our lives and health; humans produce most of them. Because of these modifications we might believe that the old classifications of climatic regionalizations can be changed at a topo-climatic and micro-climatic level

We do not refer to changing definitions, but to changing the values of each topo-climate or micro-climatic parameters because what is happening today is very different from yesterday.

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