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THE IMPACT OF CLIMATE CHANGE ON THE EUTROPHICATION OF WATER ECOSYSTEMS IN THE SOUTHERN PART OF THE REPUBLIC OF MOLDOVA

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Key words: climate change, eutrophication, water temperature, atmospheric precipitation

Abstract The accelerating pace of climate change mainly on the adjacent territory of the Danube basin, contribute to the essential eutrophication of water basins within the region. The results indicate that air temperature recorded a double warming compared to territories from the central part of the country. On the background the accelerated warming there is a declining trend and of annual rainfall amounts. These climate changes, especially in recent decades have led to significant increase of water temperature in rivers and lakes. Thus, it constituted in the years 1990-2000 by 0.7 and 1.5^0C compared to the period 1980-1990, and by 1.0...2,0^0C accordingly in the years 2000-2013 compared to the previous decade. The significant increase of temperature during the last decade contributed to the intensification of algae growth and together with other factors contributed to the increase by about 20% of the nitrogen content, thus ensuring the "flowering" with 50% of the water bodies' volume.

Introduction

Fast tempo of global warming during the XXth century and especially in the early XXIst largely determines the formulation and implementation of national policies related to climate change and its consequences, taking into account national interests. Previous investigations show that adjacent territory from the Danube basin is located "under the influence of maximum global warming". Current pace of warming contributes to establish favourable conditions for the emergence of many invasive species within this area, also there are frequent

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manifestation of droughts- especially intensive ones, and to essential eutrophication in water basins within the region. All these changes in the climate system in the Danube basin can have a significant influence in maintaining ecological security in the region.

1. Investigation materials and methods

Information Data Base concerning temperature and atmospheric precipitation regime in the Danube Basin were statistically processed in the Statgraphics Centurion XV program, Excel (a component of Microsoft Office Professional). Spatial interpretation of the data was conducted through several interpolation methods available in the SURFER 8 and ArcGIS software.

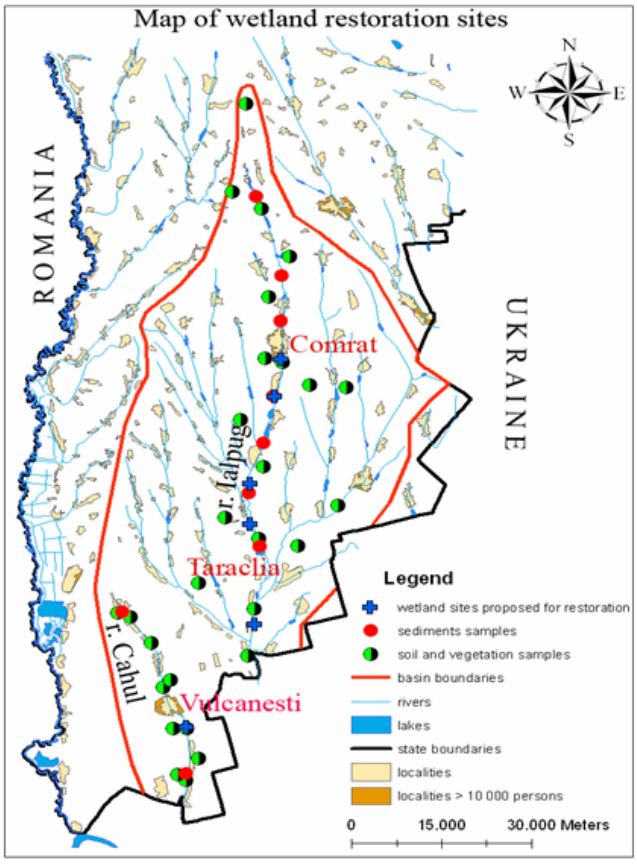

Fig. 1. Collection points of samples on the Republic of Moldova territory

The starting ground material served data regarding average of monthly and decadal temperature, average monthly amounts, daytime maxims, deficit of saturation, number of dry days, and selected samples in different sectors of water basins in order to highlight their eutrophication (fig. 1). The time data series were divided into several periods 1961-1990 and 1980-1999 (according to the IPCC, 2007, 2013), and the period of decades 1989-1999 and 2000-2010 - which according to estimations (Nedealcov M, 2012) are considered the warmest decades in the regional climate. Since the human impact on climate is observed over the republic since the 60s of the XXth century (Constantinov T., 2005), the period of instrumental data series has been conventionally divided into two periods: the natural one (1887-1959) and natural-anthropogenic (1960-2010). Climate evolution from the Danube basin was analyzed compared to the national average.

2. Analysis of achieved results

In the Danube basin within the territory of the Republic of Moldova, there is an increase of annual air temperature values in all analyzed time periods. At the same time, between 1961-1990 and 1980-1999 they basically are the same as the average for the whole country. In the rate of warming significant changes are observed during the first decade of the XXIst century, when it is 0.9^0 more than the rate recorded in the last decade of XXth century (tab. 1) and is the highest rate recorded on the territory (being by 0.4^0 more than the national average). So we notice that at the current stage climate change in the Danube basin becomes to be unpredictable.

Table 1. Assessment (^{0}C) of annual average air temperature change in the Danube basin

Indici statistici	1887-2010	1887-1959	1961-1990	1980-1999	1989-1999	2000-2010	Tempoul de încălzire 2000-2010/1989-1999
X	*9,6*	*9,3*	*9,6* **9,8**	*9,7* **9,7**	*10,2* **10,2**	*10,7* **11,1**	*0,5* **0,9**
σ	*0,8*	*0,7*	*0,8* **0,8**	*1,0* **0,9**	*0,8* **0,9**	*0,7* **0,6**	
X Min.	*7,2*	*7,2*	8,0 **8,2**	8,0 **8,2**	9,1 **9,1**	9,8 **10,3**	
X Max.	*12,1*	*10,7*	*11,3* **11,4**	*11,3* **11,4**	*11,3* **11,4**	*12,1* **12,2**	

Note: X- multiannual average, σ- standard deviation, X Min. – min. value X Max.-max. value
9,6 – average over the republic ; **9,8**- *Danube basin*

The analysis of mean annual temperature – an indicator of warming process, shows that it increases to $0{,}0206^0$C /year, which represents two times more than in the central part of the country.

The sliding values with a periodicity of five years reveal that if in the late 80s of XXth century it is characterized by low thermal background, in recent decades

there has been a stable tendency of growth (fig.1.a) concerning the annual average temperature.

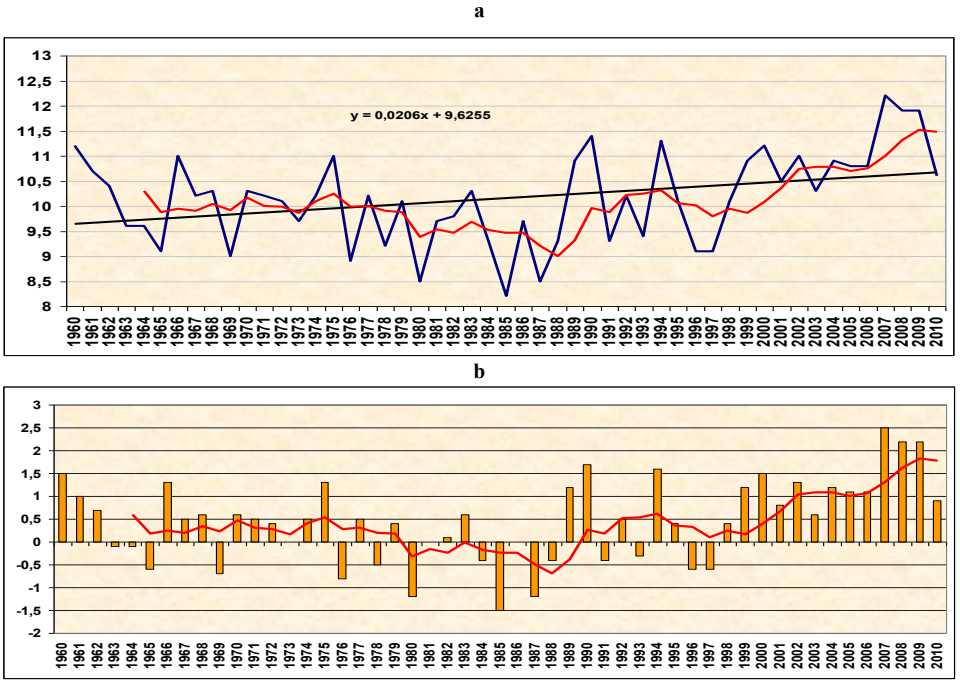

Figure1. The change tendency (1960-2010) in the average annual air temperature (a) and thermal deviations from the climatic norm 1980-1999 (b) in the Danube Basin

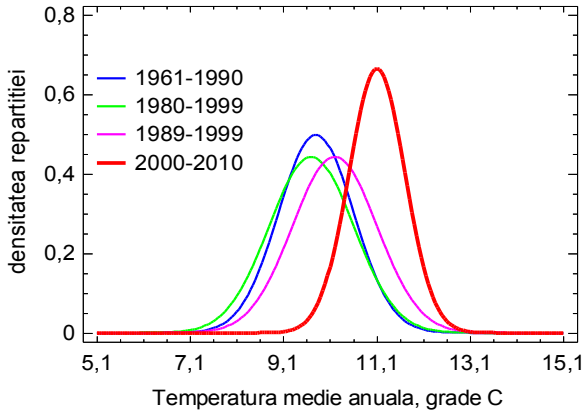

Figure 2. The average annual air temperature deformation in the different periods taken in the research

Analysis of deviations from the climatic norm calculated for the period 1980-1999; reveal that during the last 14 years the average annual temperature in the Danube basin has recorded the most significant positive deviations (fig.1.b).

Such a time-division of the average annual air temperature contributed to climate norms "deformation". The first decade of the XXI century (2000-2010) is the warmest decade for the entire series of instrumental observations, with a doubled warming pace in the last decade (1989-1999) of the XXth century (fig.2).

The main feature of atmospheric precipitation regime and their spatio-temporal distribution is the great variability and their discontinuity in time and space. Precipitation regimes emerge through the interaction of general genetic factors (at the continental level) with local factors. The annual amount of atmospheric precipitation in the region considered in the study reveals some distinct periods where it recorded a significant decline in the first decade of the XXI century (table 2) namely from 530.6 mm in the last decade of the XXth century to 475.7 mm in the first decade of the XXI century. Maximum values in atmospheric precipitation regime (818 mm) were recorded during 1960-1990. The minimum precipitations (307 mm) are recorded in the period 2000-2010.

The analysis of atmospheric precipitation manifestation tendency over the Danube Basin indicates a regional contrary tendency of manifestation, namely by reduction. Thus, for the last 50 years, the Danube basin located within the country territory there is a declining trend in precipitation with the 1.8651mm /year (fig.3.a). Analysis of precipitation deviations shows that in the XXI century; 8 from 10 years have significantly deviated from climatic norm - calculated for the period 1980-1999 (fig.3.b) these values being below 200mm.

Table 2. The assessment of change in annual atmospheric precipitation regime (mm) from the Danube Basin

Indici statistici	1891-2010	1887-1959	1961-1990	1980-1999	1989-1999	2000-2010
X	526,2	503,8	548,2 ***556,3***	555,9 ***534,1***	548,3 ***530,6***	544,2 ***475,7***
σ	122,2	133,1	100,6 ***106,0***	118,9 ***120,6***	128,7 ***151,0***	107,9 ***118,9***
Cv	23,2%	26,4%	18,3% ***19,0%***	21,4% ***22,6%***	23,5% ***28,4%***	19,8% ***25,0%***
$X_{Min..}$	271,8	271,8	361,0 ***360,0***	361,0 ***360,0***	361,0 ***360,0***	407,0 ***307,0***
X_{Max}	915,0	915,0	774,0 ***818,0***	712,0 ***813,0***	711,0 ***813,0***	735,0 ***698,4***

Note: X- multiannual average, σ- standard deviation, Cv- coefficient of variation, $X_{Min.}$ – min. Value, X_{Max}.-max. Value 544,2*—average over the republic;* ***475,7*** *– Danube basin*

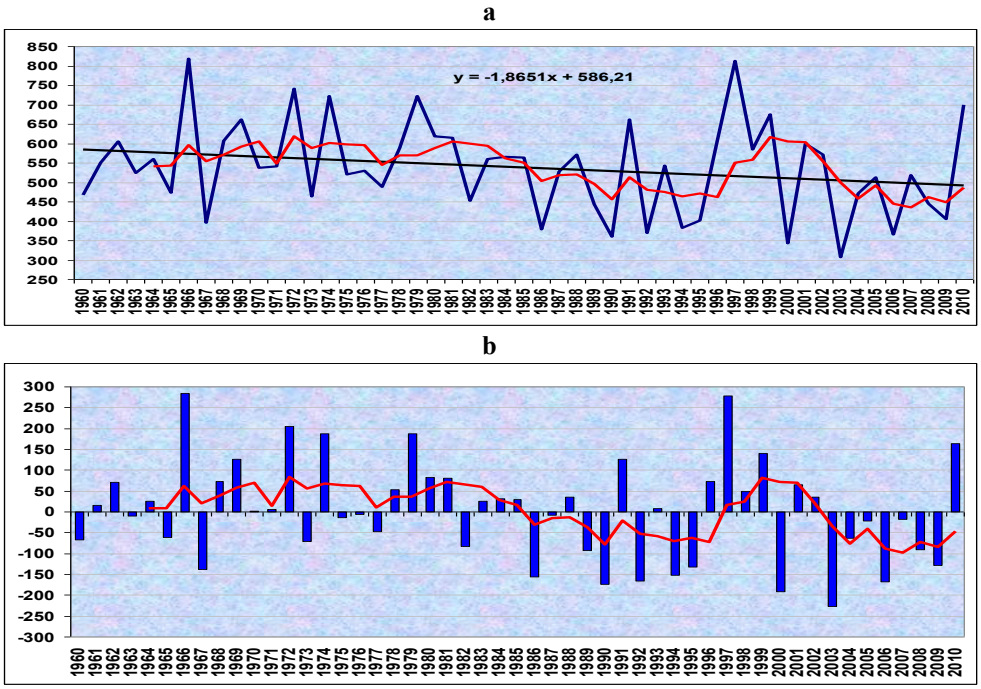

Figure 3. The change tendency (1960-2010) the of the annual amount of atmospheric precipitation (a) and precipitation deviations from climatic norm for the period 1980-1999 (b) in the Danube Basin

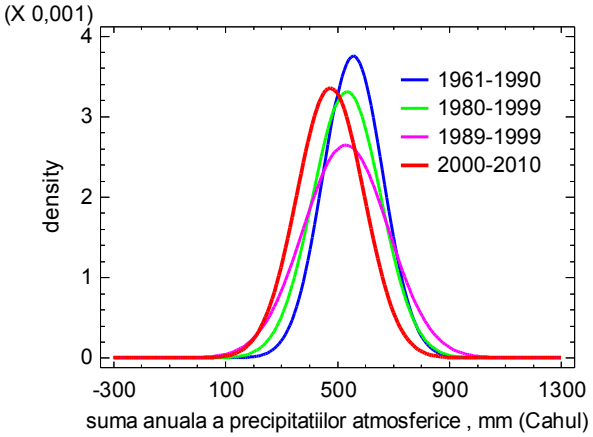

Fig. 4. Deformation of the annual amount of precipitation in different periods taken in the research

The analysis function distribution of annual amounts density that characterize precipitation regime indicates that the period 2000-2010 has a deformation to the left (fig. 4) being the most essential to climate norms, so we can conclude that early XXI century records a significant decrease in the atmospheric precipitation.

Conclusions

In conclusion we notice that changes in the thermal and atmospheric precipitation, contribute to the aridization process intensification in the region. Eventually they have led to the increase of thermal regime of water basins. Comparative analysis of the thermal regime in the Ialpug river and for the lakes located on the Ialpug river basin show its growth in the period 1990-2000 for 0,7 and 1,5 degrees respectively in comparison with the period 1980-1990. In the period 2000-2013 further growing of temperature for 1,0 and 2,0 degrees. The temperature increasing for last decade has contributed to the intensification of algae blooming and together with other factors led to higher content of nitrogen in water for around 20% for the period of last 10 years. Actually siltation covers around 50% of water bodies' volume. This means that there are around 7 mln. tones of sediments in the reservoirs (0-30 cm). The average concentration for N – are 5000 mg/kg and P – 800 mg/kg. Nutrients stocked in sediments (0-20 cm): N – 35 t, P – 6 t.

References

Constantinov, T., Nedealcov, M., Rapcea, M. (2005) *Modificările regimului termic şi condiţiile de iernare a culturilor pomicole termofile.* Chişinău: Tipografia AŞM, 2005. 124 p. ISBN 9975-62-123-6.

Nedealcov, M. (2012) *Resursele agroclimatice în contextul schimbărilor de climă.* Tipografia"Alina Scorohodova" 2012, Chişinău, 306 p.

Climate Change (2007). *The Scientific Basis, Fourth Assessment Report.* Cambridge University Press, Cambridge U. K., 940 pp.

Межправительственная группа экспертов по изменению климата, *Изменение климата* (2013). Физическая научная основа. Часть вклада Рабочей группы I в Пятый оценочный доклад Межправительственной группы экспертов по изменению климата. ISBN 978-92-9169-438-9, 222p.