

Comparative analysis of hydroclimatic characteristics on the territory of the Amur, Angara-Yenisei and drainage Torey basins (Eastern Transbaikalia)

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Abstract. A comparative analysis of hydroclimatic characteristics was carried out on the territory of the Amur, Angara-Yenisei and Torey closed drainage basins of Eastern Transbaikalia. According to monitoring weather stations, high rates of air temperature growth have been established for the territory of the mountain-taiga zone of the Angara-Yenisei basin, where the linear trend was 2.2, while for the arid steppe zone of the Torey endorheic basin – 1.8. The smallest linear trend of 1.5 was identified for the territory of the Amur Basin. In all studied basins, synchronous cyclicality of precipitation and water levels was revealed against the background of their average annual decrease.

1 Introduction

Currently, all ecosystems of the planet are experiencing increasing natural and anthropogenic impact. Rapid climate change and large-scale human impact on natural resources lead to the degradation of aquatic and terrestrial ecosystems and disrupt their natural evolution for a long time.

The dynamics of climate change in Central Asia are determined by a combination of atmospheric circulation systems and a number of regional factors. For the territory of Eastern Transbaikalia with its sharply continental climate, this is expressed in significant differences in the humidity of the territory. And for some of its areas, such as the endorheic Torey basin, water acts as a limiting factor for the territory. Taking into account the diversity of the natural territory of Eastern Transbaikalia, an important element of research is understanding the direction of hydroclimatic changes and its forecast.

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2 Materials and methods

The research material was a comparative analysis of the main hydroclimatic variables - air temperature, precipitation and the level of rivers and lakes in the territory of the basins of Eastern Transbaikalia - the Amur, Angara-Yenisei and drainage Torey (Figure 1).

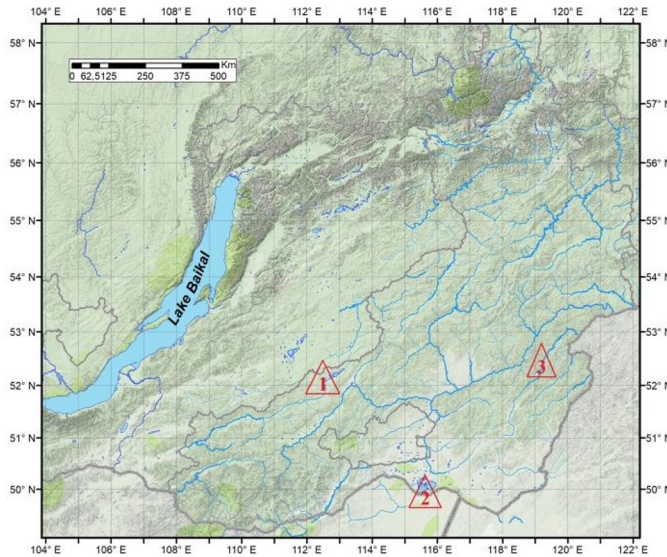


Fig. 1. Monitoring weather stations in the studied basins of the territory of Eastern Transbaikalia: 1 – Beklemishevo (Angara-Yenisei basin), 2 – Solovyovsk (Torey drainless basin), 1 – Batakan (Amur basin).

We selected weather stations for work, which we conditionally defined as monitoring ones. These are weather stations located on the territory of the Amur basin - the Batakan weather station, the Angara-Yenisei basin - the Beklemishevo weather station and the Torey drainless basin - the Solovyovsk weather station. The Lena Basin region is promising for future research. Previously, palynological studies were carried out in areas close to the selected weather stations. The data is currently being deciphered and dated. In addition, these weather stations have indicators close to the average annual indicators for the territory of the studied basins, which is important for understanding the main directions of hydroclimatic fluctuations in these territories.

The work uses data from instrumental observations of weather stations (hydrological posts) from 1960 to the present. The study was conducted using various quantitative methods of analysis. The reliability of the result was determined by statistical methods. Using correlation analysis, the spatiotemporal correspondence of temperatures, precipitation and water levels was assessed.

3 Results and Discussion

Eastern Transbaikalia is a unique natural area. This is expressed in the specific latitudinal zonality and altitudinal zonation of the territory, the biotopic diversity of reservoirs and watercourses. The special continental position of the territory of Eastern Transbaikalia led to the formation here of the largest hydrographic node from a system of upper tributaries and lakes that supply large water arteries of Siberia and the Far East with fresh water. It is on this territory that the world watershed passes between the basins of the Arctic (Lena, Angara-Yenisei basin) and the Pacific oceans (Amur basin), as well as the drainless Central Asian region (Torey basin).

The hydroclimatic regime of the territory has various components, which is expressed in the characteristics of the water regime of rivers. Thus, the rivers of the Amur basin, by the nature of their water regime, belong to the rivers of the Far Eastern type with pronounced rain feeding. According to the authors [1], in the total volume of annual runoff, a large share of 47-85% is rain recharge, while snow recharge accounts for only 2-26%, and underground recharge - 9-31%. The main source of nutrition for water bodies of the Angara-Yenisei basin is liquid precipitation - up to 60-80% in the south and up to 30-40% in the southeast. At the same time, in the south the composition is dominated by rain runoff, and in the southeast an equal participation of rain and melt water runoff is recorded. In the north, the waters are characterized by a predominance of up to 50-60% melt water [1]. For water bodies of the Torey basin, a large share of the annual runoff is rainfall recharge - up to 80-90%, underground recharge accounts for up to 10-20%.

Atmospheric precipitation is an important element of the water balance of the territory, having a significant impact on long-term fluctuations in river flow, including determining the specific hydroclimatic parameters of the territory. The distribution of atmospheric precipitation at the studied weather stations is presented in Figures 2–4.

Analysis of the distribution of atmospheric precipitation has revealed some important current trends. Average annual precipitation over a 60-year period ranged from 297.8 to 385 mm/year and was the maximum for the Amur Basin. The course of the atmospheric precipitation curve as a whole had a pronounced cyclical character. However, the indicators of the Beklemishevo and Solovyovsk weather stations attract attention. Thus, if before the period of 2000 the average annual indicators for the Torey basin, located in the steppe zone, slightly exceeded the values of the mountain-taiga zone of the Angara-Yenisei basin - 308 and 315 mm/year, respectively, then from 2000 to 2012, the picture changed towards reducing the amount of precipitation.

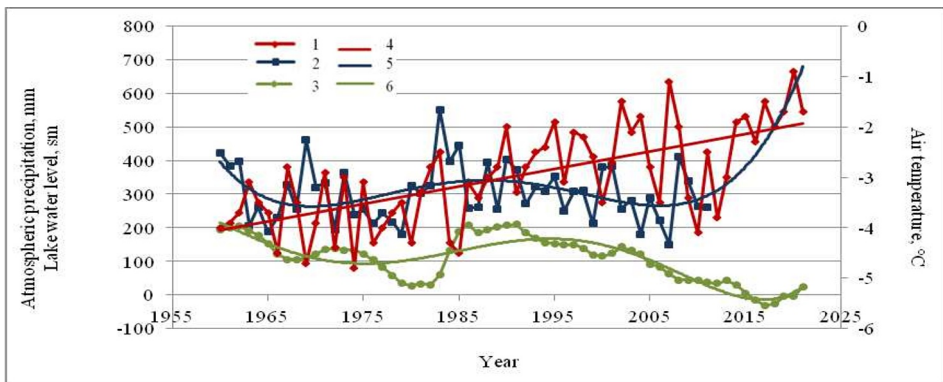


Fig. 2. Hydroclimatic characteristics of the territory of the Angara-Yenisei basin (Beklemishevo weather station): 1 – surface air temperature, 2 – precipitation, 3 – lake water level. Arakhlei, 4 – linear trend, 5,6 – polynomial trend.

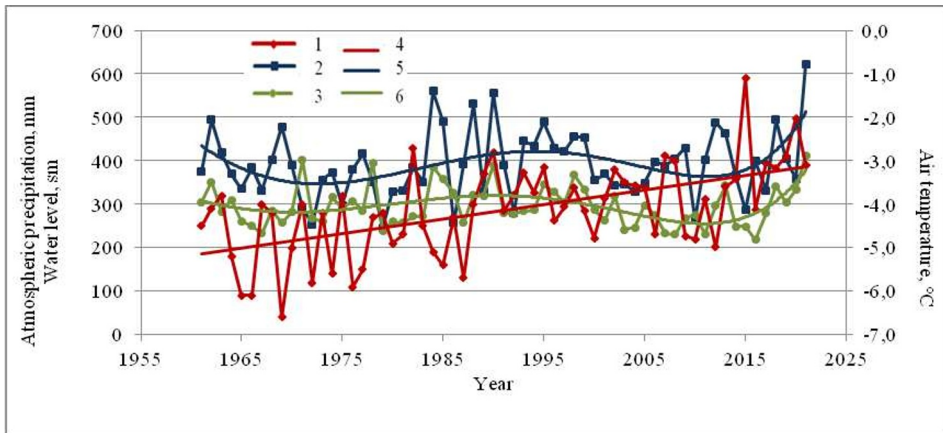


Fig. 3. Hydroclimatic characteristics of the territory of the Amur basin (Batakan weather station): 1 – surface air temperature, 2 – precipitation, 3 – water level of the river. Gazimur, 4,5,6 – polynomial trend.

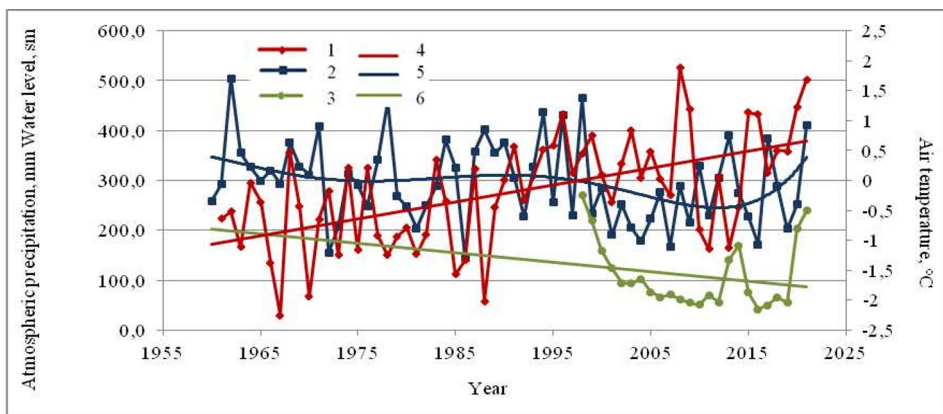


Fig. 4. Hydroclimatic characteristics of the territory of the Torey basin (Solovyovsk weather station): 1 – surface air temperature, 2 – precipitation, 3 – water level of the river. Uldza, 4, 6 – linear trend, 5 – polynomial trend.

For the territory of the Torey basin it was more pronounced - on average, the amount of precipitation decreased to 237 mm/year. The linear trend in the amount of precipitation for the Beklemishevo and Solovyovsk weather stations had a negative value: -9 and -90 mm / 60 years, respectively.

Surface air temperature in the territories of the studied basins had a general tendency to increase average annual values (Figures 2-4). The average annual air temperature from 1960 to 2021 increased at the studied weather stations by 1.5 - 2.2°C (Table 1). On average, it was -4.3 °C according to the Batakan weather station (Amur basin), -3.0 °C and -0.3°C according to the Beklemishevo (Angaro-Yenisei basin) and Solovyovsk (Torey basin) weather stations, respectively. As can be seen from Figure 4, in the territory of the studied Torey basin there are 2 periods of average annual temperatures with a transition in 1989 from average negative to average positive indicators. The surface air temperature until 1989 had a negative value and amounted to -0.8 °C/29 years. Since 1990, average annual indicators have become positive and increased over 32 years to +0.3 °C.

Table 1. Linear trend of surface air temperature for the period from 1960 to 2021. for weather stations Batakan (Amur basin), Beklemishevo (Angaro-Yenisei basin), Solovyovsk (Torey basin).

Weather Station /Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Batakan	0.8	3.3	1.8	2.2	1.2	1.8	1.2	1.7	0.7	1.3	1.3	0.5
Beklemishevo	2.4	4.4	4.7	2.6	1.8	1.6	1.8	1.6	1.5	2.0	1.4	0.3
Solovyovsk	-0.5	2.1	3.0	3.0	2.4	2.4	2.5	2.0	2.3	1.0	1.3	-0.1

During the periods studied, there was an increase in average annual temperatures: for the territory of the Amur basin from -4.7 to -3.6°C , for the Angara-Yenisei basin – from -3.7 to -2.4°C . However, for these basins the average annual temperatures remained negative.

Comparison of weather station data for all territories of the study basins (Table 1) showed the presence of a positive trend. It is important to note that the highest average linear temperature trend (2.2°C) was characteristic not for the dry steppe zone (Solovyovsk weather station), where the indicator was 1.8°C , but for the mountain taiga zone (Beklemishevo weather station), which may indicate trends in increasing warmer periods of the year and shifting the boundaries of natural zones in the altitudinal and latitudinal directions. The average linear trend indicator (1.5°C) at the Batakan weather station, which is also located in the mountain-taiga zone, is lower and does not exceed other indicators. This probably indicates the participation of the regional component in hydroclimatic variables.

The water level of watercourses and reservoirs is an integral indicator of the variables of the water balance of the drainage basin and the physical and geographical conditions of the natural zones of the territory, including precipitation and air temperature. A comparative study of the level of reservoirs and watercourses according to the data of the studied weather stations is presented in Figures 2-4.

The analysis carried out confirms the previously made conclusion [2] that there are no unidirectional stable trends in water level decline, but there are trends that change their magnitude and sign over time due to the predominance of cyclical components in its changes.

4 Conclusion

A comparative analysis of the main hydroclimatic variables - air temperature, precipitation on the territory of the Amur, Angara-Yenisei and Torey closed basins was carried out at selected monitoring stations. The previously made conclusion [2-3] was confirmed that in the complex physiographic conditions of the territory of the studied basins there is a gradual increase in surface air temperature. In the mountain taiga zones of the central part of Eastern Transbaikalia, it has an altitudinal and latitudinal orientation.

It is natural that modern changes in hydroclimatic characteristics, namely a significant increase in surface air temperature and a decrease in the amount of precipitation, occur against the background of stable cyclical dynamics of the water level of reservoirs and streams in the territories of the studied basins. However, the physical and geographical features of the basins contribute to the specificity of hydroclimatic processes in general.

In turn, the entire complex of these hydroclimatic factors will contribute to a directed change in the volume of the photic zone of a reservoir or watercourse. It is important to note that it is in these zones that active production processes take place, which are carried out by one of the most important indicators of paleo-reconstructions - phototrophic organisms (bacteria, cyanobacteria, algae, etc.) containing paleo-markers (chlorophylls, carotenoids, etc.). Thus, reconstruction of changes in the water level of reservoirs and

streams will make it possible to clarify the forecast of climate humidity in the territory in the past and can become a promising area of research.

Acknowledgement

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