Short communication

ISSN 2658-3518
LIMNOLOGY FRESHWATER BIOLOGY
www.limnolfwbiol.com

Climatic factors in the formation of the water regime in the rivers of the Southern Baikal region

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ABSTRACT. In the Southern Baikal region, we studied the long-term dynamics of anomalies of air temperatures and the monthly amount of precipitation, the key climatic factors in the formation of the water regime in rivers. An increase in the contribution of heavy rainfall in summer months determines the high probability of sudden short-term flash floods, whose formation has not yet been sufficiently studied.

Keywords: temperature anomalies, precipitation, circulation, climate.

The Southern Baikal region is one of the Russian regions most susceptible to the influence of hazardous hydrometeorological phenomena, which is due to the specifics of its geographic features, circulation and climatic conditions. During the temperature rise, evaporation and the absolute humidity of the air increase, which determines favourable conditions for an increase in the amount and intensity of precipitation (Dobrovolsky, 2015; Wasko et al., 2016). Therefore, it seems logical to associate changes in the hydrological regime with the climate dynamics and to expect a relatively higher increase in the runoff with an increase in the amount and intensity of precipitation. The example of more than 1000 basins in the USA revealed that an increase in the amount of precipitation by 1% leads to an increase in the runoff by an average of 1.5-2.5% (Sankarasubramanian and Vogel, 2003). However, no reliable regional climate models suitable for forecasting long-term variations in the water regime of rivers have yet been created. Empirical assessments of the existing trends in the main hydrometeorological indicators remain the main tool for assessing the impact of climate change on the formation of the water regime in rivers.

The formation of the summer regime of precipitation characterized not only by the maximum amount of the annual distribution but often also the maximum intensity especially reflects the relationship of the water regime in the Southern Baikal region with climatic factors. In certain periods, favourable factors influencing weather contribute to the formation of the increased humidity in an area, and an excess of the humidity over the threshold values of water runoff from river watersheds can lead to the formation of a flood.

To determine the role of climatic and circulation factors in the formation of the water regime in the rivers of the Southern Baikal region, we calculated the anomalies of the average monthly air temperatures and the amount of precipitation for the past two circulation periods that were distinguished according to the classification of B.L. Dzerdzeevsky, taking into account the influence of zonal and meridional forms of atmospheric circulation (Kononova, 2015). We compared the data on 23 weather stations located on the coast of Lake Baikal, in the mountainous areas of Hamar-Daban and East-Sayan mountains as well as on the continental stations in the northern, southern and western synoptic and climatic areas of the Irkutsk Region. The comparison included the epochs of zonal (from 1977 to 2005) and meridional (from 2008 to 2018) circulation. At all selected stations, except for the Dabady station, the results of the analysis indicated in all summer months a well-expressed trend to an increase in the average monthly temperatures owing to the intensification of meridionality of atmospheric processes. Along with the large industrial centre (the city of Irkutsk), the following Baikal stations also showed high rates of the temperature rise: Bolshoye Goloustnoye, Bolshoy Ushkaniy, Solnechnaya, and Sarma.

Despite the temperature rise in all summer months, an increase in the amount of precipitation in the past circulation epoch was significant only in June and mainly at the Baikal and high-mountain stations. In July and August, there was a trend to a decrease in precipitation, which was also the most evident at the

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Baikal stations.

A more detailed analysis of the anomalies of air temperatures and amount of precipitation on the example of the longest time series (the Irkutsk station) indicated a steady temperature rise in July (period of the maximum precipitation) since the early 1990s after a long period of the predominance of negative temperature anomalies. However, despite the continuing trend to an increase in climate aridity, the number of cases with daily precipitation maximums of ≥ 40 mm has increased since 2001. Consequently, if previously the summer precipitation maximum was due to heavy precipitation characterized by a relatively small intensity but longer duration, at present, short-term but intense rainfall can provide the monthly precipitation maximum.

The modern circulation period in the Southern Baikal region shows an increase in the contribution of meridional processes and air temperature rise in summer months accompanied by the formation of both dry and abnormally humid periods. In the past two decades, the frequency of intense precipitation has increased, which can cause sudden short-term flash floods or their series, an example of which is the situation with summer floods in the Irkutsk Region in 2019. They are at the initial stage of research and require a more detailed study of circulation and synoptic conditions of the flood-forming precipitation.

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