Assessment of the landscaple structure transformation impact on the river runoff (by example of Bellarusian Polesye)

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The main hydrological parameters of river runoff are not stable values. They continually change under the influence of various factors. The combination of these factors can be divided into natural and anthropogenic those vary in the nature and consequences of their impact on water resources. Currently on the territory of Belarusian Polesye the hydrological regime is mainly determined by the natural fluctuations of meteorological elements, but we cannot exclude anthropogenic impacts. The role of human factors is growing every year and can lead to significant errors in the determination of runoff parameters.

The purpose of this study is to analyse changes in runoff of the rivers of Belarusian Polesye for various scenarios of climate change while maintaining current trends. The annual runoffs for rivers of the Belarusian Polesye since 1951 till 2010 were used as the initial data.

Time series analysis of annual runoff of the rivers of Belarusian Polesye has shown that for certain periods the conditions of stationary are satisfied. The transition from one state to another occurs under natural conditions under the influence of external climatic factors that significantly alter the balance between rainfall and evaporation within the territory of Belarusian Polesye. In the end we can conclude about the climatic conditionality of long-term fluctuations of river runoff of the Belarusian Polesye, and the reasons for these fluctuations are caused by the processes of large-scale exchange of moisture in the system ocean – atmosphere – land. This can be a physical justification of the model of the water regime of Belarusian Polesye.

The significant differences of the statistical parameters of the rivers of Belarusian Polesye depending on the study period were identified. For example, the average annual values of runoff were changed up to 36%. Increase of the mean annual runoff mainly occurred in the last period. Change of the maximal spring runoff has a more uniform tendency. For minimum runoff the highest values occur in late 19th–early 20th century.

The calculations of the intra-annual distribution of runoff for various periods show some transformation of annual runoff. So for the river Pripyat during very dry years the winter water level is somewhat decreased, but increased the water level of summer-autumn period. During very wet years the increasing of water level of the winter period, at the same time the summer-autumn water level has almost not changed, but there is a decreasing of runoff in spring months.

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The maximal change of the annual runoff occurs in basins located within lowlands with wide boggy plains, and does not depend on the size of the basin area. The more the waterlogged area was, the larger the magnitude of changes in annual runoff after reclamation was investigated. It increases with increasing of the proportion of drained wetlands. But since annual runoff is the average value, then the change of the correlation coefficient was relatively small (13%).

Figure 1 presents multi-year trend of average annual runoff changes in the water regime of the Pripyat River. As can be seen from the figure, there is some tendency of growth of the annual runoff.

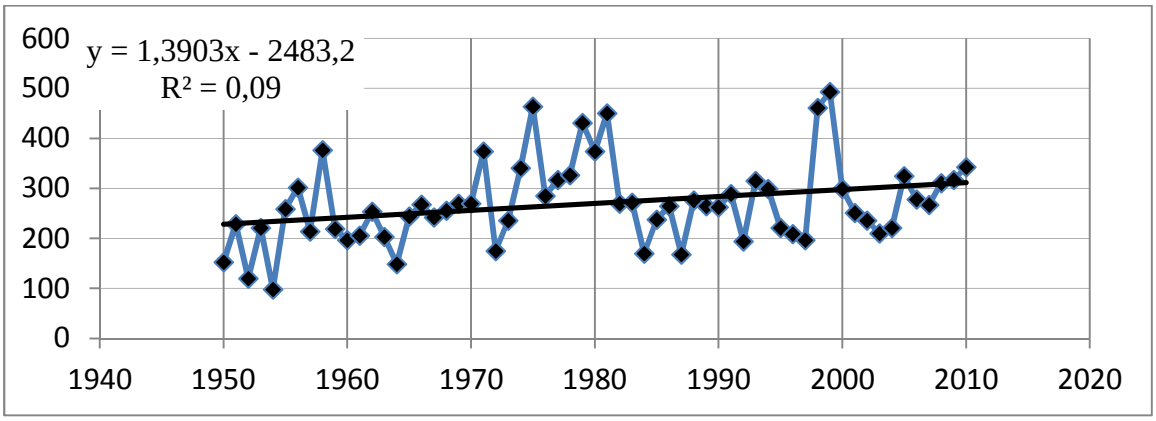

Fig. 1: Multi-year trend of average annual runoff of the Pripyat River, m^3/s

Figure 2 presents the averaged hydrographs for the period since 1951 till 2010. The largest differences are observed in spring. The highest water level was in the period since 1971 till 1980, and the following period since 1981 till 1990 has the lowest runoff level. Thus, we can conclude that the changes of intra-annual distribution of river runoff on the territory of Belarusian Polesye are natural.

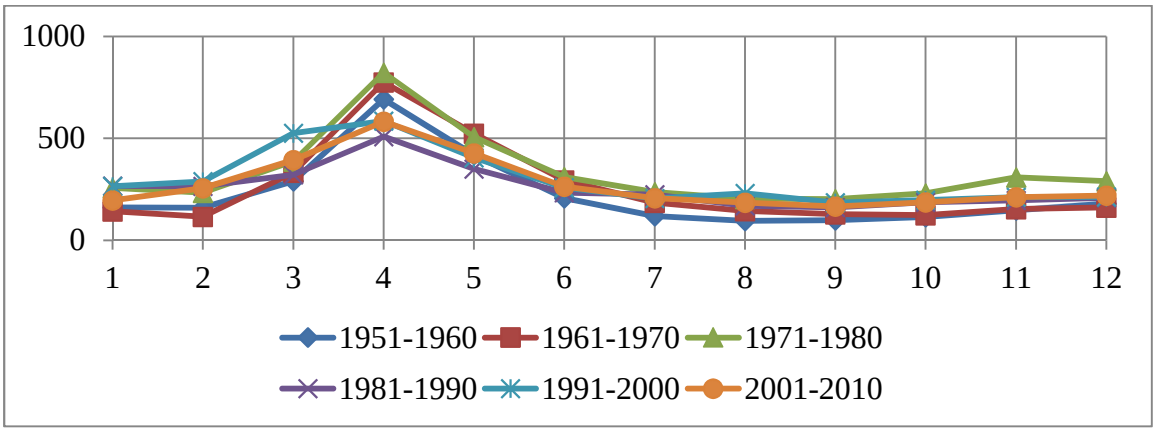

Fig. 2: Averaged hydrographs of monthly water runoff of the Pripyat River, m^3/s

The following results of the current changes in runoff of the rivers of Belarusian Polesye in the period from 1951 to 2010 were obtained:

– The average annual runoff of major rivers of Belarusian Polesye virtually did not change. The increase of runoff of some rivers is caused by the transfer of the runoff from other rivers;

– The changes of maximal runoff are beyond the accuracy of the calculation and for all the rivers its reduction is characterized;

– The minimum runoff of the rivers of Belarusian Polesye significantly increased;
– The transformation of the intra-annual runoff distribution on the rivers of Belarusian Polesye was found out.

For the period from 1966 compared to the previous period for the small rivers the following changes were obtained:
– Annual runoff for the rivers of southern and south-western part of Belarusian Polesye was increased. In the north-western part the runoff slightly decreased, while in the northern and central parts the changes have not occurred;
– The maximal spring runoff of the rivers has decreased. This is due to climate changes, which influenced the formation of the maximal runoff. Increase of the number of thaws and significant decrease of the snow water in winter causes an increase of winter runoff and sometimes leads to winter floods;
– The minimal summer-autumn runoff has increased in the territory of Belarusian Polesye. Increase of the minimum summer-autumn runoff is associated with land reclamation drainage. The thickening of the hydrological network has reduced the filtration of runoff and as a result the increasing of minimum summer-autumn runoff and the reducing of evaporation.

The runoff of the major rivers of Belarusian Polesye changes under the influence of climatic factors, and the leading of these factors is precipitation. The mechanism of long-term fluctuations of the annual runoff is determined by the asynchrony of the fluctuations of the water-balance processes.

The anthropogenic impact on river runoff mainly due to irretrievable water decreasing does not exceed 3% compared to its absolute value. The influence of anthropogenic factors on small rivers is more important, especially the large-scale land reclamation in Polesye.

Thus, the regularities of water regime formation of the rivers on the territory of Belarusian Polesye in general repeat the patterns of formation of water regime of the rivers of Belarus. Therefore, fluctuations of the river runoff on the territory of Belarusian Polesye are caused mostly by climatic factors, and the anthropogenic factors do not have a significant impact on the runoff in the modern conditions.