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THE DYNAMICS OF THE FLOW OF THE RIVER URAL IN THE CONDITIONS OF MODERN CLOBAL CLIMATE CHANGE

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ABSTRACT

On the basis of data on the temporal dynamics of cross-border flow of the Ural River and the dynamics of the climate in the region during the twentieth century, as well as information about changes in land use and economic activity of surface runoff estimated sensitivity to climate change. Changing of a climatic temperature within 0.50C and rainfall of 10 mm results in a change of water flow rate of 110 m^3 / s flow and 20 m^3 / s accordingly. Clearly, therefore, the is a high sensitivity of runoff from even weak climate variations in temperature and precipitation.

From the analysis of the time water flow row it follows that, despite the increase in temperature in the region in recent decades, not only the runoff has not decreased, but even slightly increased, which we attribute to a slight increase in rainfall in the catchment area amid rising temperature. In the second half of the twentieth century in the Ural River, it was built several large reservoirs. As a result, the interannual variability of the spring and autumn runoff decreased significantly, which we view as a positive factor. Water withdrawals for irrigation and evaporation and infiltration across the bed of the river are mainly determined by the loss of a drain on the Kazakhstan site.

Keywords: transboundary Ural River, arid zone, climate change, sensitivity of runoff to climate change, impact of climate change on runoff.

INTRODUCTION

The second half of the XX century was characterized by global warming, which was accompanied by a slight increase in rainfall. However, in arid zones, which include the Kazakh part of the basin of the Ural River, the increase in evaporation caused by rising temperature, offset by a little increase in rainfall. Changes in the region occurred and are occurring in the global warming that contributed to the deterioration of the environment. It seemed therefore important to assess the sensitivity of the Ural River runoff to climate change. Because of this assessment, it seems possible to construct scenarios of flow of the Ural River, the next 20-30 years. The construction of such scenarios is quite a challenge, as evidenced by a variety and diversity of the approaches described in the literature. Without asking to describe these approaches, we note only that we would have preferred an approach based on the physically understandable thesis that climate

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change in a specific region (but not in the hemisphere) determined by changes in the general circulation of the atmosphere.

The region of studying. The field of research is the Kazakh part of the basin of the Ural River (Zhaiyk), one of the four largest rivers in Kazakhstan and in fact the only one in Western Kazakhstan (figure 1).

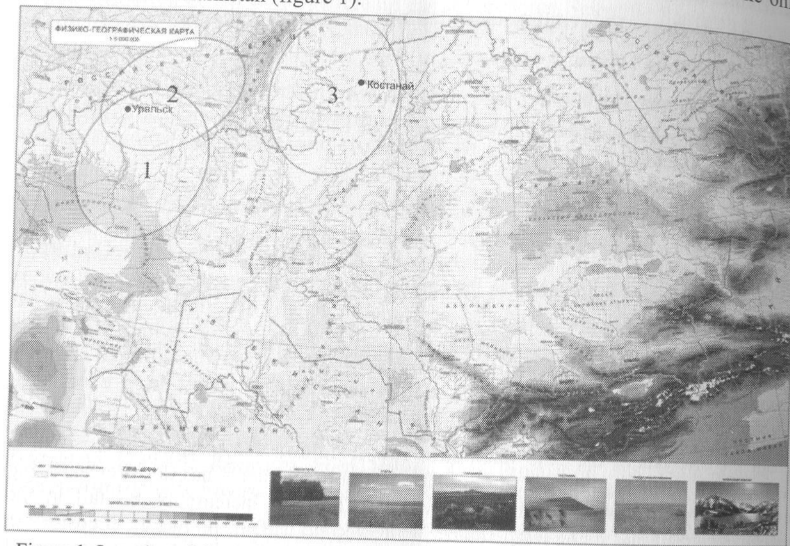

Figure 1. Location of the region studies (1) on the territory of Kazakhstan and the Ural River watersheds (2 and 3)

The Ural River has two catchment areas that are located on the territory of Russia. One, the main catchment area, situated to the east, and the second - to the west of the Southern Ural Mountains. The main catchment area is situated of the east of the Southern Ural and the second a little inferior is situated to the west, but the conditions of runoff formation in these watersheds, separated by mountains of the Southern Ural, substantially different.

The site of the Ural River in Kazakhstan is a transit area where there is only the loss of flow.

In the second half of the twentieth century on the territory of Russia in the Ural River basin it was built several reservoirs, the largest of them Irikla reservoir, interannual regulation. As a result, the interannual variability of the spring and autumn runoff became smoother significantly.

In the fifties of the last century on the territory of Kazakhstan, it was built Kushmurun channel for irrigation of farmland. Through this channel is taken annually on average 600 million m3 of water.

Materials and methods

In the work official figures of the National Hydro meteorological Service of Kazakhstan on average monthly temperatures and precipitation for stations in Western Kazakhstan during the twentieth century to the present time were used. We also used data from several research expeditions, kindly provided to us.

Methods. We abandoned the linear approximation of the time series because the linear trends have great inertia time. So to go from pronounced positive temperature trend, characteristic of the last decades, the negative takes more than 10 years since at the expressed lowering of the temperature trend is a long time to reduce gradually the angle of inclination to zero. Therefore, we approximated our rows by sixth degree polynomial, which on the one hand a well smoothes the time series, retaining, however, climatic extremes, and other polynomial of sufficiently sensitive to the dynamics of change in the sign just a few years. The disadvantage of this method of approximation is that we do not know how long it will remain the sign (direction) of the changes of the studied parameters. Therefore, together with the approximation of the time series by a polynomial of sixth degree, we made extensive use of harmonic analysis of the series. Harmonic analysis, as is known, involves decomposition of the original time series to trigonometric functions. In addition, each of the harmonic chooses its dispersion. The faster the series, converge the fewer harmonics it can be submitted. In our study, at 95% of the dispersion in temperature time series was replaced by three harmonics, and four of precipitation, i.e. rainfall time series converge slower. In the text, however, we appreciate the contribution of harmonics not shares of variance, but through amplitudes. This allows us to use to measure the scattering in degrees and millimeters, respectively, which is very convenient.

If a polynomial of sixth degree smoothes the time series, quickly responding to the trend in its dynamics, then harmonics characterize us the internal structure of the series. Each of harmonics is accepted interpreted as feedback certain groups of factors. There is no reason to believe that the factors that existed in the formation of the climate in earlier times suddenly disappear. This statement makes it possible to build a time-series change scenarios for the future 20-30 years as the sum of its basic harmonics at each point of the series, extended for the same period in advance.

Match directions approximating line and the dynamics of the main sum of the amplitudes of harmonics indicates whether approximated accidental changes or they are due course fundamental.

The paper used for typing macro processes by G.Y. Vangengeim, which is widespread in Russia and in countries of the former Soviet Union [1]. This typology is based on the localization of the Rossby waves, that is, on the location of troughs and ridges of the geopotential field in the middle troposphere over the region from the middle of the Atlantic and to the longitude 100 ° E. If over the European part of Russia, i.e. west of the Ural Mountains, is trough, it is located to the east of the mountain ridge crest and such a situation is of type C (Mixed). In the reverse arrangement of troughs and ridges is situation of the type E (East). The axis of the mountain ridge in such a situation can mix markedly to the east, to coincide with the axis of the mountain ridge.

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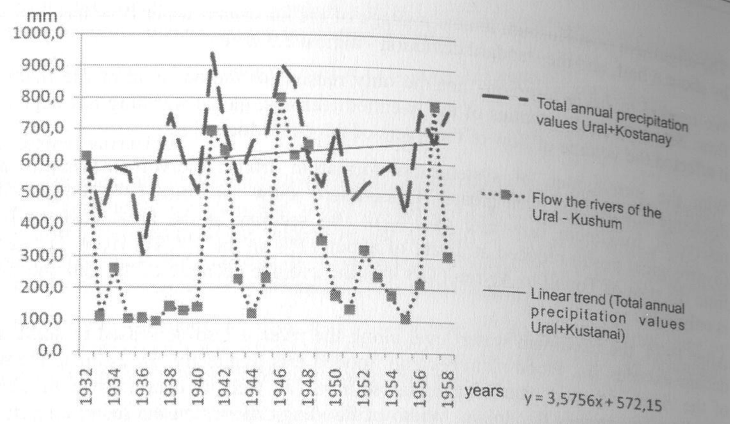

Figure 2. Comparison of total annual precipitation values on meteorological stations Uralsk and Kostanay and water consumption r. Ural (post Kushum)

From Figure 2 we can see that between the curves of the total amount of precipitation and runoff r. Ural has a good coordination, especially during peak flow. The greatest runoff occurs when both stations falls maximum rainfall. It was also noted in [5] law, after a small amount of precipitation in the basin the sharp increase does not lead them to the same increase in runoff since the precipitation leaves on soil moisture, filling lakes, valleys etc.

It was also noted that the sharp decline in rainfall after the maximum did not lead to a similar reduction in runoff since previously accumulated runoff water content is maintained.

The linear trend of the total amount of precipitation at stations Uralsk and Kostanay indicates that there has been a marked increase in their (the regression equation shown in Fig. 2). This is consistent with studies [3, 4], according to which the flow is also increased.

Next, we investigated the relationship between the time series of precipitation and temperature in western Kazakhstan, on the one hand, and the flow fluctuations in the r. Ural - on the other.

The time course of water flow at the station Kushum located on the north of territory, Ural River at the entrance to the territory of Kazakhstan shows that in the period 1921-2007 annual water consumption values ranged from 89.1 to 800.0 m³ / s (Figure 3).

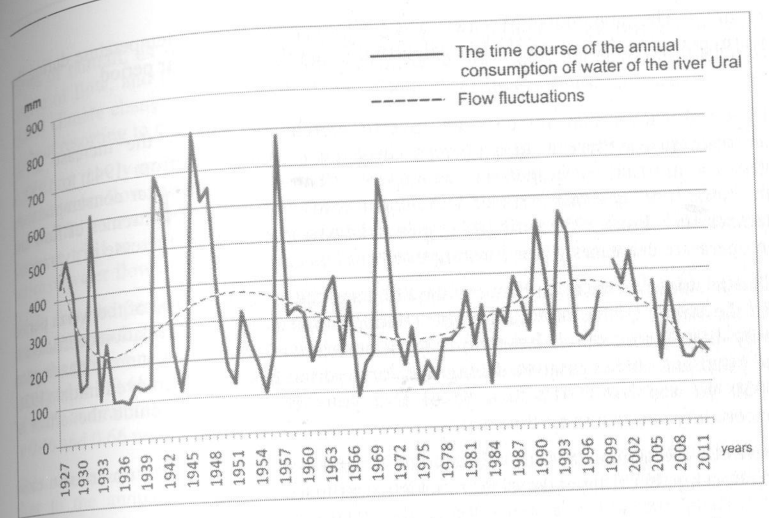

Figure 3. The time course of the annual consumption of water of the river Ural (station Kushum).

We may notice a large variability from year to year, especially until 1973. This polynomial trend shows that around 1930, and climate 1977 occurred lows precipitation and around 1950 and 1997 - climatic maximums. In the period from 2003 to 2007, it noted a decrease in water consumption.

Figure 4 shows the time course of water flow r. Ural and the average temperature during the warm period to the station Uralsk, calculated for a rolling five-year period.

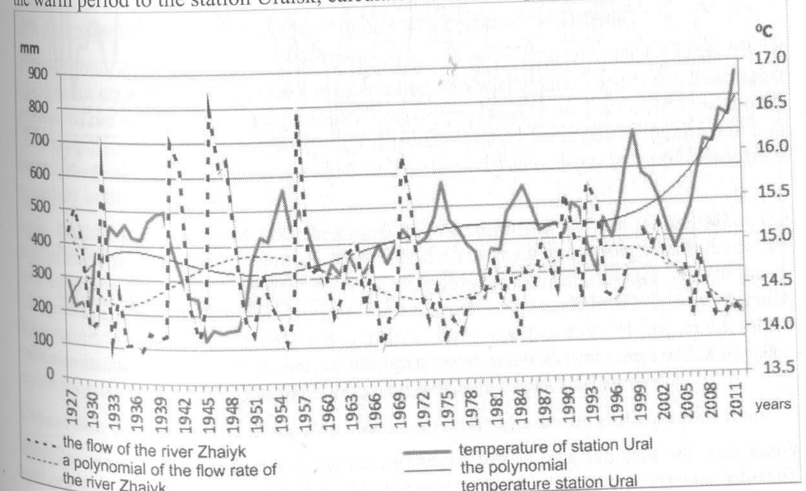

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Figure 4. The time course of water flow r. Ural and the average temperature during the warm period to the station Uralsk, calculated for a rolling five-year period.

Figure 4 shows that there is an inverse correlation, namely the increase in air temperature corresponds to a decrease in water consumption, from 1941 to 1957, a decrease in mean air temperature corresponds to an increase in water consumption. At the same time, you may notice a certain asynchrony between the extremes of flow and temperature. From 1958 until 1977 against the background of an increase in average air temperature decreases water consumption.

The calculated correlation between the drain and the air temperature of the warm period for the station Uralsk showed that this relationship is weak; the correlation coefficient is only -0.30. Note that when determining the correlation between the annual consumption of water and air temperature during the warm period have been removed initial (1926-1930 y.) and last (2012-2014 y) of five years in order to exclude the effect of uncertainty inherent in all time series.

Between the annual amount of precipitation and water flow r. Ural observed a close relationship, but a direct correlation, which is quite natural.

The time course of the annual amount of precipitation in the course of the station Uralsk repeats the flow of water, even when the amount of rainfall, calculated over a rolling five-year period (Figure 5).

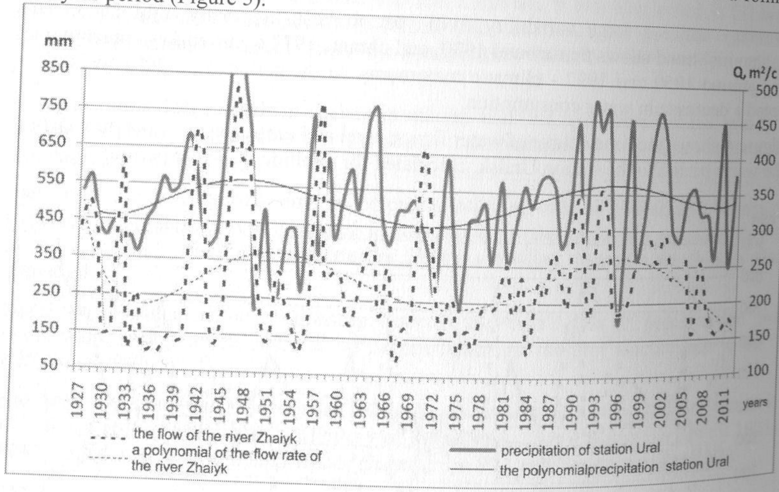

Figure 5. The time course of water flow r. Ural and the annual amount of precipitation in the station Uralsk calculated over a rolling five-year period.

Excluding the start and end of the series, we can say that all through a series of water flow follows the time course of precipitation. Therefore, we can conclude that the time

series of rainfall, as well as the time course of the temperature well reflects the time course of flow, and the task of assessing changes in the flows under the influence of global climate change, at least at the level of overall estimates, these data can be used, without resorting to other information.

Analyzing purely qualitatively the time courses of water flow and temperature (Fig. 4), and the water flow and precipitation (Fig. 5),we may note that in the first case we have not bad an inverse correlation, and the second - a positive relationship. In this regard, we have tried to assess the closeness of the relationship between the smoothed time series of water flow and temperature and flow of water and precipitation.

To do this, the parameters of the corresponding values were taken by us with smooth curves, eliminating the beginning and end of the series of approximately 5 years. In this case, the ratio of negative correlation between water flow and air temperature in Uralsk increased to - 0.68, and the coefficient of positive correlation between the consumption of water and rainfall in Uralsk increased to 0.87. Coefficient of determination was equal to 0.46 and 0.66 respectively.

Thus, we can see that, despite the relatively low correlation annual quantities of water flow to the annual quantities of air temperature and rainfall correlation smoothed (climatic) running water flow with a temperature, and especially with precipitation in Uralsk high.

It is important to include climate change in the temperature within 0.50C of climate and rainfall of 10 mm results in a change of climate in the water flow rate of 110 m^3 / s flow and 20 m^3 / s accordingly. Clearly, therefore, the high sensitivity of runoff from even weak climate variations in temperature and precipitation.

A similar analysis of the relationship between air temperature and runoff, precipitation and runoff we performed for the station Atyrau, situated in the delta r. Ural, but water consumption data were taken us Makhambet station (near Atyrau).

It turned out that in Atyrau time series of temperature and precipitation do not correlate with the magnitude of runoff. It was of interest to determine the cause.

In [6-8] one of the co-authors of this paper made typing the entire territory of Kazakhstan on the specifics of the time evolution of the climate temperature. Northwest referred to the second type, and the south-west, where the Atyrau is situated - the fourth. Consequently, there were fundamentally different climate changes of temperature in these areas, which ware a consequence of the difference macro meteorological processes in these regions.

From the theory of the general circulation of the atmosphere [1.9] follows that the precipitation regime north and south of 50 ° N differs greatly, as along this latitude the axle of climate ridge pressure is situated. Accordingly, north of 50 ° N maximum precipitation occurs in the summer and to the south (Atyrau) - in the spring. Secular fluctuations position axes troughs and ridges form the position of the temperature extreme in the time course, but these extremes in different regions not occur simultaneously, which are fixed in the division of the territory into types [7].

Connection between Ural River flow and macro circulation of atmosphere forms.

It is of interest not only to the amount of precipitation during the year, but to macro synoptic conditions under which these precipitation fell as we have separated aim in any

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research in this field how to predict such conditions. The average annual characteristics of macro circulation conditions are of little use for this purpose. So we took the monthly precipitation data, which we united in cold and warm periods. In the cold period, it included seven months from October to April inclusive. In the northern regions of Kazakhstan, which carries out the analysis, the snow that fell from October to April, it coming out in the last decade of April, providing a spring flood [10].

Based on the previously discussed the dynamics of flow, depending on the temperature and precipitation seems appropriate to consider the Ural River flow fluctuations in connection with the frequency as the macro-types of the general circulation, cause loss of greater or lesser amount of rainfall in the catchment area. Of the large number of works devoted to the study of precipitation in the area of the mountain range and the surrounding area, highlight the work [5] as the most complete, contains the maximum amount of information about a connection to the rivers of Central and North Urals. Since then, the problem of communication between the forms of atmospheric circulation and the values of river flow Urals almost no one did.

We have carried out search for links between the monthly precipitation for stations Uralsk and Kostanay and types of atmospheric circulation by G.Y. Vangengeim. It was shown, though at qualitative level that such communication exists.

To do this, we calculated the average rainfall during of cold and warm periods. It is close to 22-32 mm / month cold and 37-46 mm / month for the warm period for both stations. Next month's rainfall was divided into gradation of 10 mm in the larger and smaller directions from the "norm." For each of the gradation repeatability was calculated average of each of three types including macro processes days, i.e. twenty-four hours at [1].

We got that, and for the warm and cold seasons, rainfall was weakly correlated with changes in the frequency of occurrence of circulation types, if the rainfall changes within a small range. We explain that it does not take into account the intensity of the types of processes.

Due to these features of the problem, we decided to change our analises, reducing the number of gradations of precipitation to two. Next, we considered the average repeatability for macro-types when rainfall "above normal" and when they are "below normal". The gradation, which gets "the norm", we excluded from the calculation of anomalies at all. Data normally only used in the assay for comparison. It seems that this will provide a large difference in the frequency of these types of grades. Results are presented in table 1 for the Uralsk station and in table 2 for Kostanay station.

Table 1. Types of circulation at the precipitation "below norm" and "above the norm", Uralsk.

Type Circulation	Seasons					
	Cold			Warm		
	Precipitation,mm			Precipitation,mm		
	<20	norm	>30	<20	norm	>30
W	9.2	8.8	10.5	7.9	9.0	7.2
E	12.4	10.1	7.7	13.9	11.7	9.8
C	10.8	10.2	12.3	8.6	9.7	13.9

Compare the data precipitation and frequency types for the "norm «containing in table 1 for Uralsk. We can see that the amount of rainfall "above the norm" observed at significantly different types of circulation than the "norm" during the cold period. In addition, in the cold and into the warm periods of the year rain "above norm" observed a marked increase in the frequency of occurrence of type C (2.1 and 4.2 days, respectively) and a decrease in the frequency of occurrence of type E (up to 2.4 and 1.9 days, respectively). Repeatability of W type increased by 1.7 and 1.8 days, respectively.

When rainfall was "below norm", then in the cold and in the warm parts of the year especially noticeable increasing of repeatability type E, 2.3 and 2.2 days, respectively. In the cold part of the year, reducing the recurrence of type C and W in the precipitation "below the norm" there, and in summer a decrease recurrence types C and W is 1.1 days.

Consider the data for Kostanay (table 2). In the cold period of rainfall "above the norm" occur in the W, E and C, equal to 11.0, 8.2 and 12.1 days, respectively. It marked a notable increase in C for 1.9 days, W - 2.2 days and reduced the frequency of occurrence of E 1.9 days. When precipitation "below norm" circulation types of 8.6, 12.0 and 9.6 days, respectively. Repeatability types C and W very little decreased to 9.6, such as W – 8.2 days respectively, while type E increased by 12.0 days.

Table 2. Types of circulation at the precipitation "below norm" and "above the norm", Kostanai.

Type Circulation	Seasons					
	Cold			Warm		
	Precipitation, mm			Precipitation, mm		
	<20	norm	>30	<20	norm	>30
W	8.6	8.8	11.0	11.9	9.0	7.9
E	12.0	10.1	8.2	12.3	11.7	12.5
C	9.6	10.2	12.1	6.2	9.7	10.0

The Kostanai rainfall "above the norm" in the warm season takes place at essentially constant repetition of type C, but below the "norm" - with its significant decline. In the cold period of the opposite: rainfall above the "norm" in the marked increase in type C and decreasing typeE, and below the "norm" - with almost constant repetition of type C and a marked increase in type E.

As we saw above, in Uralsk above "norm" precipitation during the warm period occurs only when a marked increase in C and at the same time fall type E. Precipitation type "below norm" –have place with a marked increase of E and decrease C and W. In the cold period between trends in the type of E is the same as in a warm and repeatability types C and W in the precipitation "below normal" increases even more.

It was interesting to consider further the conditions under which there is an extreme flow of Ural River, i.e. what combinations of types give extremely high and extremely low runoff in the catchment area of both parts simultaneously. Since the epochs - the concept is very commonly, we specified the repeatability of each type of macro-processes in the number of days of deviation from the normal type of recurrence only

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for periods of extremes. From table 3 below, we can see that the extreme is determined more by macro processes combination, not only the types of epochs.

Analysis of extreme water flow r. Ural presented in figure 3 and table 3 shows that a minimum flow in the thirties took place under the prevailing macro processes E + W (-9), the maximum in the fifties under the prevailing process W (9) + E (15). The type C (-26) had the lowest recurrence.

The second minimum flow in the 70 - 80 years took place in an epoch when the dominant E recurrence of this type E (64) at about the same frequency of occurrence of type C (-25). Type W (-37) was expressed too weakly. Consequently, occurred two minimum flow observed in the r. Ural are quite different combinations of types. A minimum of 30-ies took place at a very low frequency of occurrence of type C and with a low prevalence of type W with a slight excess of the norm type E. Minimum of eighties took place at a high excess rate of type E and a very low recurrence types W and C (Table 3).

Table 3. Relationship of runoff r. Ural with the forms of circulation *

View extreme	Years	Type Circulation	
		Types for periods Extreme runoff	By Vangengeim (epochs)
min	1928-30	W (9), C(-26), E (15)	E
max	1949-58	W (-19), C(+9), E(18)	E+C
min	1970-1984	W(-37), C(-25), E(64)	E
max	1998-2002	W(41), C(-14), E(-26)	W
*Note: In brackets is given the average (annualized) deviation from the normal type of recurrence in those days			

Maximum flow in the fifties, there was above the threshold for a certain type C (9) and type E (18) with repeatability below normal type W (-19). A maximum of two-thousand years has taken place with the prevalence of type W (41), a low recurrence type C (-14) and E (-26). Consequently, the maximum runoff of r. Ural can take place at a rather diverse mix of types of circulation.

It can be seen therefore that the findings of [5] and we are generally in good agreement. Since there are essentially two watersheds, one east and the other west of the Southern Urals, the combination of the two types of macro-circulation is the normal situation. Runoff minima occur at maximum repeatability of type E with a low recurrence type C and W, or high repeatability types W and C. The maximum flow occurs in type C or W and the fairly repeatable types of W or C. However, the relationship between the annual fluctuations in flow and number of days per year of a certain type of circulation was often weak, that we have noted in the course of analysis. The years of highest and lowest water content are prepared for a long period and occur usually at the end of the period, which determines the most favorable or unfavorable conditions of runoff formation in the area. These conditions are formed including and repeatability type macro-circulation of the atmosphere, and combinations thereof. Perhaps the use of repeatability micro types it makes sense to apply only to predict situations "rainfall above normal" and "below normal" rainfall.

Expected change in temperature, precipitation and runoff of r. Ural on the future.

We carried out a harmonic analysis of time series of temperature, precipitation in the basin and of the runoff r. Ural. Figure 6-7 presents the row of temperature station Uralsk polynomial approximation by six degree and harmonics in it accordingly.

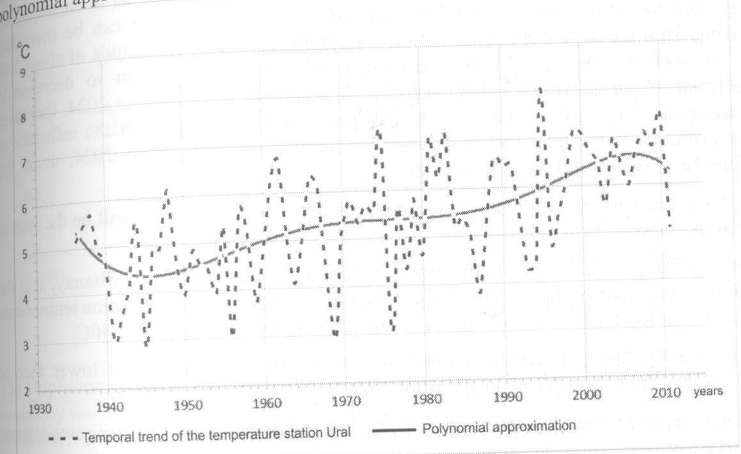

Figure 6. Uralsk. Temporal trend of the temperature. A polynomial approximation of sixth degree.

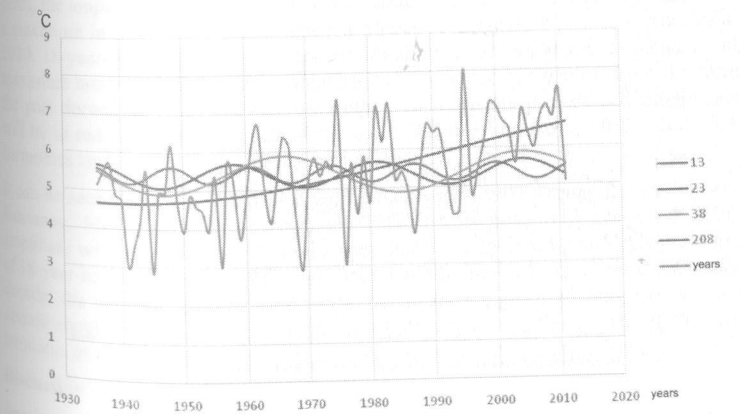

Figure 7. Uralsk. Harmonics in the row of temperature.

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Approximation line is in reality the result of summarizing the main harmonics in the row of temperature. It is obviously they formed climatic minimums and maximums of temperature in the past. Additionally the fundamental harmonics, the allocation and accounting trend on the future decades where implemented by the method of Babkin A.V. [11]. There are harmonics in length 208, 38, 23 and 13 years, with the amplitudes of 2.6, 1.2-1.4, 0.8-1.2 and 0.50 C respectively.

The same harmonics isolated in Kostanay, however, instead of a harmonic13 years here there is a harmonic of 8 years with the same amplitude. The amplitudes of the fundamental harmonics of 208, 38 and 23y are in Uralsk, the same as in Kostanai. By analyzing the time dependence of the harmonics of temperature, it can be seen that, starting from the 2005-2006, two centuries harmonics (with an amplitude of about 2.00 C), as well as 38- and 23-year-harmonics after maximum began to decrease in amplitude. Their minimum expected in 11-19 years, i.e. from 2016 to 2024, therefore, up to about 2016 drop in temperature will occur fairly quickly under the influence of two centuries harmonics and two other harmonics, and then, until 2024, under the influence of only one 38-year-harmonic.

The total decrease in temperature is approximately 2.1- 2.60C, i.e. it will be the sum of the amplitudes of harmonics.

Since the amplitude of the fundamental harmonics Uralsk same as Kostanay, and the time of occurrence of the maxima (2005) match, we should expect the same temperature variation as Kostanay, i.e. decrease in the next one to two decades 1.2-1.40C.

Consequently, the temperature pattern in the catchment area will be lower than at present, and moisture loss by evaporation will also be lower than today.

We next consider the time series of precipitation and its harmonics for the same stations (Figure 8-9).

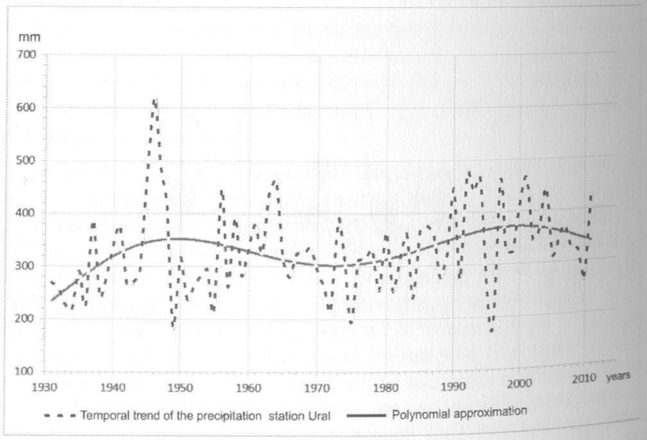

Figure 8. Uralsk. Temporal trend of precipitation. A polynomial approximation of sixth degree.

It is obviously there where climatic minimums and maximums of precipitation in the past (figure 9).

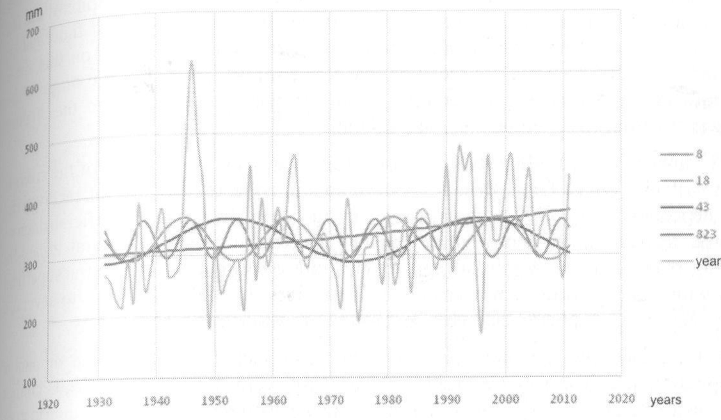

Figure 9. Uralsk. Harmonics in the row of precipitation.

The amplitude of the 8-year-harmonic increases in 2013, partially compensated a fall, caused by the first two harmonics. Comparing the amplitude of the harmonics and time of occurrence of extreme, not difficult to find the decline in rainfall in the current and the next decade will be about 25 mm. After 2030 the amount of precipitation will begin to increase.

In the time series of precipitation occur station Uralsk harmonic length 43, 18 and 8 years, the amplitude of which 70, 70 and 55 mm, respectively. 8-year-old harmonic had a maximum in 2001 and currently has a tendency to decrease with a minimum of about 2020. 18-year-old harmonic had a maximum about 2001, and tends to increase with a maximum around 2018. Since the amplitude of these two harmonics about the same, in the past decade, they compensate each other. In Kostanay present and future decades will be in reducing the amplitude of the main, 38-year, and since 2012 - and 23-year-harmonics amplitudes 55, 50, and 25 mm respectively.

It can be seen that the amplitude of the fundamental Uralsk harmonics are higher than Kostanay. Maximum 43-year harmonic occurred around 1998 and until 2020, its amplitude will decrease. The decline since 2008 is largely compensated by the growth of 18-year-harmonic, and in 2013 - and 8-year-old harmonica. As a result, the end of the decade, the amount of precipitation may fall in the range of 10 mm, and in the next decade should be expected to increase up to 50 mm due to the growth of the primary harmonic of 43-year-old, who will start at the beginning of the third decade.

Discussion

Sensitivity of the rivers in the droughty region to climate change is very high. The drain sensitively reacts to very insignificant climatic fluctuations of temperature and rainfall

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on border of a zone of formation of a drain. Anthropogenic impacts on environment components in a river basin can make on it the most adverse effect.

In [12] methods of modeling influence of global climate change on hydrological system of the Aral Sea located, in fact, in the center of Eurasia was studied. In spite of the fact that the area of formation of a drain is at distance about one and a half thousand km from the sea, and the system of the accounting of the consumed water on this site is unreliable, authors nevertheless received that influence of climate change on processes in Aral's pool significantly. Reservoirs of an arid zone are sensitive to the slightest climatic fluctuations of temperature and rainfall.

In [13] authors studied influence of climate change on underground food of the rivers in Great Britain. Though Great Britain is out of an arid zone, by authors was received that such dependence exists. It indicates quite strong dependence of a superficial drain on climatic fluctuations of temperature and rainfall irrespective of a natural zone. The existing balance between rainfall and temperature on the one hand and a superficial drain with another, being rather steady on a temporary interval of one year to several, it is very sensitive to climatic changes, i.e. changes on a time span till 10 years.

In [14] are analyzed not only temporary, but also spatial changes of an amount of precipitation at a river Yangtze drain size during 40 years. The received results confirm that sensitivity of water systems to climatic changes is high even outside an arid zone. There is a number of other works devoted to this problem, but with similar regularities.

Our results for a river basin the Urals in general confirm the general conclusions received for other river basins. However, we can see a number of features except aridity of climate. They are such as of essentially different conditions of formation of extreme runoff, the expected scenarios of change of a drain on prospect gave existence of two regions of formation of a drain divided by mountains.

The search of communications executed by us between a seasonal amount of precipitation and types of macro circulation appeared less successful, than it was expected. We consider that the reason consists in lack of quantitative estimates of intensity of types of circulation and, perhaps, in insufficiently clear split of types. At the same time, the forecast on such basis of a seasonal amount of precipitation is "above norm" and "below norm" it was quite successful.

The communication found us between the main harmonicas in the general circulation of the atmosphere and climatic fluctuations explain the nature of these fluctuations. The same time it allows constructing scenarios of climatic changes on prospect and, respectively, the scenario of change of a drain. Originality of our approach to creation of scenarios it is defined by use for this purpose of results of the harmonious analysis of temporary ranks of temperature and rainfall. According to our calculations in the next decades, the drain will remain within natural changes.

Now there are rather reliable data on water consumption on hydrological posts along Ural River and practically there are no data on a water intake for agricultural and economic needs. The basin accounting of the used water, and control of its quality, in fact, is absent. It complicates an assessment of anthropogenic impact on a drain. At the same time, it is obvious that the system is sensitive to such influences. The solution of such task still is necessary.

The approach to creation of scenarios of climate change and drain developed by us on prospect until 40 years probably can be effective for similar calculations of change of a drain of other rivers of an arid zone because of climatic changes.

Conclusions

Our results suggest the following conclusions:

1. Changing climatic temperature within 0.50C and rainfall of 10 mm it results in a change of climate in the water flow rate of 110 m³ / s flow and 20 m³ / s accordingly. Clearly, therefore, the high sensitivity of runoff from even weak climate variations in temperature and precipitation.

Extremes as averaging in the time series of precipitation and runoff observed simultaneously in opposition. For this reason, it was difficult to separate the effect of the temperature and rainfall on runoff in statistically significant limits.

2. Existing connection between the types of macro-processes and the amount of runoff r. Ural connection could be used as a basis for long-term forecast of runoff. This relationship next: runoff "above normal" there is at a combination type of E + C or type W, and the flow "below the norm" in the prevalence of type E.

3. The temperature increased in the last 30 years about 1.50C and rainfall in the catchment area even increased. There has been a slight increase in evaporation. Analysis of trends in the expected temperature change (gradual decrease), and some fluctuations in rainfall over the next 30 years based on harmonic analysis showed that abrupt changes in the Ural river runoff should not be expected.

By the end of this decade should expect some decrease in rainfall - in the eastern part of the catchment area of 20-25 mm / year, and in the west part 10-15 mm / year.

At the same time, due to the expected decrease in temperature, evaporation from the surface of the catchment territory will reduce, which should compensate for the decrease in precipitation, accordingly runoff of r. Ural should remain around current values.

In the following, the third decade we expect to increase rainfall in the eastern part of the catchment area of 25-30 mm in the west - 40-50 mm under reduced compared to the period of the temperature background. Because of runoff of r. Ural should increase.

4. The presence of water reservoirs on the territory of Russia is in no way impairs the flow of water to Kazakhstan. Moreover, in dry years, it supports a sufficiently high flow rate. This consumption during the existence of reservoirs never dipped to the minimum, which often took place prior to the construction of reservoirs in the 20s - 50s of the last century.

5. Completion of our analysis of the latest trends in temperature, however, showed that the climate temperature increase in the region ceased. This result will require adjustments in three to five years and, if the trend will confirm, no adaptation steps are needed. However, since this region, including its northern part, belongs to the zone of risky agriculture, the adaptation steps is not climate change, and to a large interannual variability of rainfall, still be very desirable.

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THE EFFECT OF NOISE BARRIER AT THE CONCENTRATIONS OF PM_{10} IN THE VICINITY OF ROADS

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ABSTRACT

Monitoring the status of air quality is the set of activities leading to the discovery of the environment and monitoring the evolution of air pollution in time. Knowledge of the environment is not the primary objective of monitoring, but a means of predicting its further development and designing sustainability measures. A clear statement of the objectives of monitoring is a vital precondition for the correctness of the decision about monitoring pollutants, how and where they should be monitored and the accuracy and precision required. Many factors impact air quality that determines its development and changes. Air pollution is subject to the especially primary source of pollution (road traffic) and consequently secondary influences (meteorological parameters, road surrounding segmentation) which have a different impact on current concentrations of pollutants in the air. Meteorological parameters are uncontrollable but we can change road surrounding, for example by the construction of noise barrier. This contribution deals with monitoring of air pollution from road traffic and the influence of the noise barrier on detected concentrations of selected pollutants and their dispersion. The monitoring stations were placed in the vicinity of urban road with noise barrier and there were monitored particulate matter PM_{10}.

Keywords: particulate matter, road, traffic volume, spread of pollution, noise barrier

INTRODUCTION

The dispersion of pollutants in the atmosphere is a complex process that is not only subject to different yield sources producing this pollution. Of course, the source of various pollutants is decisive for a number of substances that get into the ambient air. Physical factors influence the spread of emissions from the sources and determine the dispersion of pollutants into the environment. They are mainly meteorological parameters, the stability of the atmosphere and diversity of the surrounding terrain. Several studies have processed the dispersion of pollutants in the vicinity of roads, which to some extent confirmed different levels of concentration of pollution given the distance of the monitoring station from the intended source [7], [4], [2]. A generally acknowledged relationship is the greater the distance from the road = lower concentrations of pollutants. However, this may be different for different fragmentation of space around the road by natural or artificial barriers or specific process of dispersion of pollutants. No less important is the nature of stratification of pollution in the vertical direction, which shows a decrease with a greater height above the ground [1], [8], [5], [3], [6]. Therefore, we decided to perform measurements that would confirm or refute

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