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Perennial Dynamic of Changes Runoff Formation Factors in the Left-Bank Plains Parts of Ertis River Basin

M. M. Moldakhmetov*, L. K. Makhmudova*, Zh. A. Zhanabayeva* and Zh. T. Raymbekova**

* Department of Meteorology and Hydrology, Al-Farabi Kazakh National University, 71 Al-Farabi Ave., Almaty, Kazakhstan
(E-mail: *mmoldahmetov64@mail.ru; Mlk2002@mail.ru; Zhanusik.9@mail.ru)*
** Department of Hydrology and mudflow problems, State Institution "Kazselezaschita MES RK", 70 Sh. Kaldayakov St., Almaty, Kazakhstan
(E-mail: *raimbek_zhanara@mail.ru*)

Abstract
In the article was produced analysis series of hydrometeorological elements - air temperature, amount precipitation for the cold period, maximum altitude of snow cover. The spatial and temporal patterns of distribution of hydrometeorological elements were identified.

Keywords
Tendencies of changes; runoff formation factors; air temperature; maximum altitude of snow cover; precipitation.

INTRODUCTION

The climate of East Kazakhstan is well lit as in climatological literatures and as studies of hydrometeorological type (A.C. Uteshev, 1959; R.I. Galperin, 1965; I.S. Sosedov, 1963; U.N. Murzabekova, 1990). In recent years were published detailed generalizations of climate in whole of territory of CIS and Kazakhstan (Consolidated annual report…, 2012), but in these works didn't take into account regional peculiarities of specific areas. Climatic conditions are decisive for the formation of the general water content of the territory. Distribution of river runoff on the territory conditioned by climatic factors. It is subjected to the laws of geographical zoning. The article is considered the perennial dynamics of climatic factors of runoff formation by separately (the characteristics of the snow cover, rainfall and temperature) for the period from 1961 to 2008 years.
According to the recommendations of the WMO norms of climatic variables are calculated as the average value for the base period from 1961 to 1990 years.

Global climate warming have been noted since the mid 70s of the last century, so to characterize the intensity changes in climatic variables were used the slope of the linear trend for the period 1974 to 2008 years.

Snow cover - not only an important element of the climate, but also a powerful climatic formation factor, which influence impact on the mode of weather, hydrological and soil processes. Information about the distribution of snow cover on the Kazakhstan territory is needed to solve many national economic problems, because it is the power source of the rivers and soil moisture.
The snow cover plays exclusively major role in the formation of hydrological regime and water resources, operation mode of the most important life support systems predetermines exclusively high relevance of researches snow cover by a wide range of tasks - from the search of spatial and temporal distribution characteristics of snowfall to assess the possibilities of using the properties of the snow cover for the engineering purposes.

Research methods

Researches of snow cover are occupying an important place in scientific and applied researches. The main objective it is to study dependencies, determining meteorological and hydrological regime of the various physical-geographical regions, and obtaining practical results that are used to meet the queries of economic activities. The main sources of the snow cover study are serving as direct observations materials of hydrometeorological network stations and posts.

Headwater of Ertis River is located in the Altai Mountains in territory of China and Kazakhstan. In the upper reaches of river before the confluence of Lake Zaysan it is called Black Ertis (or Kara-Ertis). The river crosses several zoned areas: from mountain and steppe - in the headwaters to lowland and taiga - in the downstream (after Omsk city). In the Altai Mountains Ertis takes several abounding in water tributaries, then almost 1000 km flows through non inflow territory of Eastern Kazakhstan, and in the taiga into the river flows main tributaries - Yesil and Tobyl (A.M. Chernyaev, 2001).

The left bank of the Ertis River by the nature of the water regime of the river plains, hilly-hummocky and lowland areas belong to the rivers with the spring flood. The rivers of left bank area of Ertis River feed mainly meltwater, maximum runoff are an objective quantitative measure of the magnitude of snow storage at the end of the winter period.

Climatic conditions are decisive for the formation of the total water content of the territory. Precipitations contribute increase water storage in the snow. In the excess moisture area due to high amount of rainfall and small evaporation of even small rivers have enough high runoff. Climatic factors, in particular, the precipitations are determining the distribution of runoff territory in accordance with the laws of geographical zoning (V.G. Ushakov, 2010).

The starting material for the analysis of perennial dynamics of changes of runoff formation factor in the left bank plain part of the Irtysh River Basin are observational data (precipitation data for the cold period, the air temperature in the cold period and the maximum altitude of snow cover) on a meteorological stations network of RSE "Kazhydromet".

Air temperature

Climate East Kazakhstan region is sharply continental with cold winters and hot dry summers. In the mountain and foothill areas of the continental somewhat mitigated. The coldest month is January; the average monthly temperature is from «minus» 14 to «minus» 20 °C, in the particular harsh winter average temperature in January reaches the «minus» 30 °C, in a very warm does not fall below the «minus» 10 °C. Absolute minimum air temperature can reach up to «minus» 50-52 °C. In the winter months throughout territory are the possible thaw, but they are rare.

Average monthly temperature of the warmest month - July is 18-22 °C. Absolute maximum air temperature reaches 40-43 °C. Midland position territory of Kazakhstan is characterized by large annual amplitude of air temperature, as well as significant changes in temperature during the day. The average annual air temperature amplitude is 34-42 °C.

Linear trend coefficient characterizing the changes in the average temperature level is for January 0,03-0,8 °C/10 years (Fig. 1). Trend component was expressing the coefficient of determination, the calculation formula and interpretation of which is shown in many research works, including (S.A. Long, 1995). In the last 10 years was dominated by significant positive deviations in surface air temperature in the cold season.

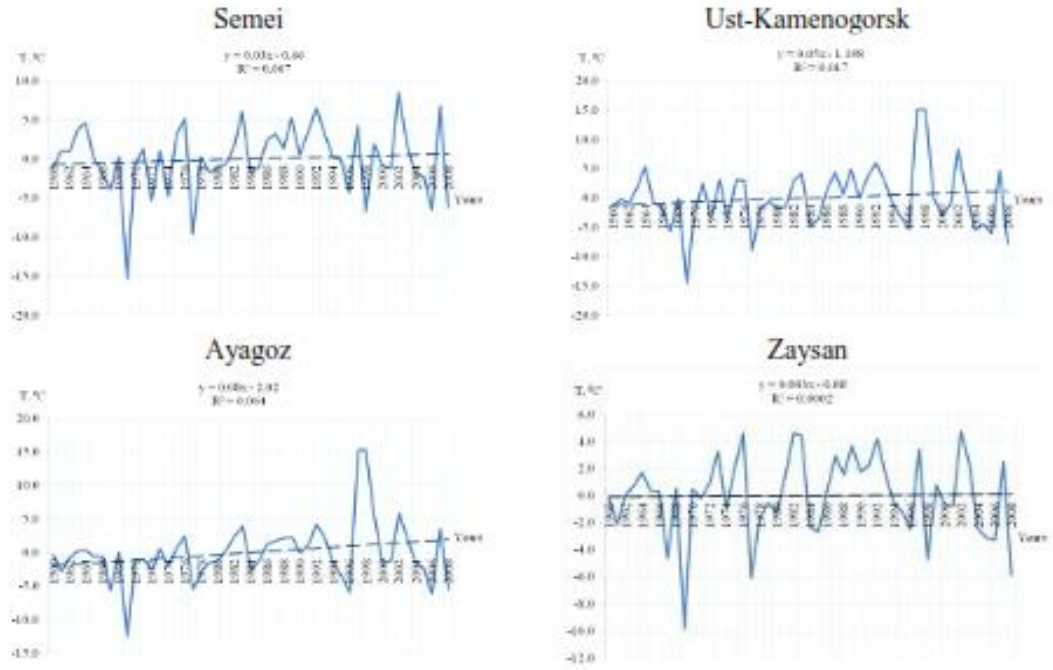

Figure 1. Time course of average monthly air temperature anomalies (January) for the period from 1960 to 2008 years.

Increase in surface air temperature of the cold period occurred at a speed of 0,8 °C for every 10 years. In East Kazakhstan territory can pick out several years with abnormally low temperatures of the cold period. This winter were 1960-1961, 1966-1967, 1968-1969, 1976-1977, 1984-1985, 1993-1994, 1995-1996, 2000-2001 and 2004-2005 years, negative anomalies were 0,5-7 °C.

In the past 20 years, the air temperature of the cold period was often higher than normal, calculated for 1974-2008 years. The highest temperature of the cold period in the consideration territory was observed in winter the 1996-1997 years, when it was above the norm by 3-4 °C (Figure 2).

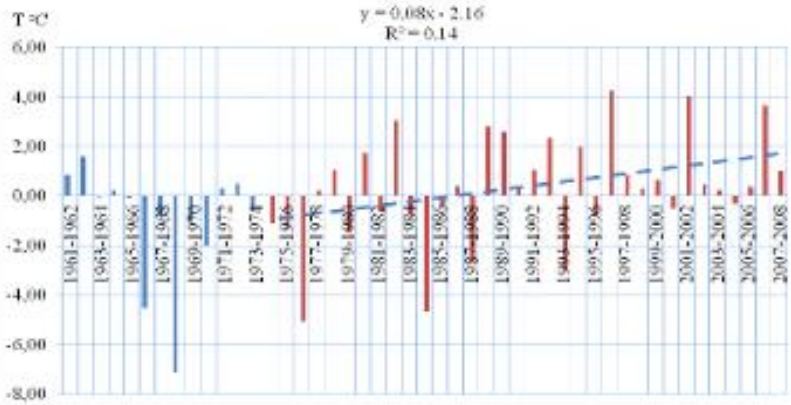

Figure 2. Temporal variations of air temperature anomalies (°C) of the cold season, averaged over the territory of East Kazakhstan

Precipitation

Uneven distribution of precipitation on the territory is characterized for East Kazakhstan. In the steppe part falls from 200 to 280 mm per year, in the foothills part from 250 to 350 mm, in the mountainous parts up to 500 mm, and in the southern part of the territory of less than 200 mm. Two-thirds of precipitation occurs in the warm season of the year (April - October).

Precipitations ubiquitously are different in significant variability from month to month and from year to year, so that their amount may significantly vary from average perennial values (Table 1).

Table 1. Maximum and minimum amount of precipitations for 1961-2008 years, mm

Station	Warm period		Cold period		Year (annual)	
	R_{min}	R_{max}	R_{min}	R_{max}	R_{min}	R_{max}
Semei	52	325	45	148	156	400
Ust-Kamenogorsk	145	430	80	327	198	614
Ayagoz	52	360	63	195	103	466
Zaisan	115	380	46	130	157	437

Variability of average and extreme precipitation values associated with physical and geographical features, the nature of the atmospheric circulation and the time of year. These factors, acting in close interconnection, are determining the features of spatial and temporal distribution of rainfall throughout the year and from year to year.

In East Kazakhstan territory warm season precipitations in the 2.5-3.0 times higher than rainfall of the cold period.

The article analyzed the time course of precipitation and set direction, speed of changes it for specific periods of time. The coefficients of the linear trends, expressed in millimeters for 10 years (Figure 3).

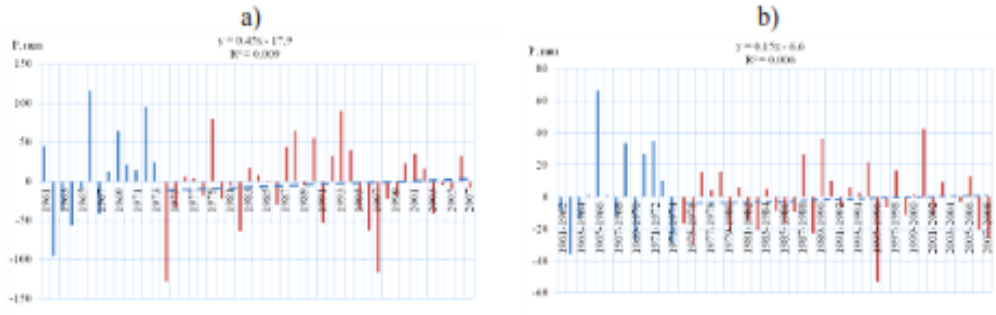

Figure 3. Temporal variations of annual amounts precipitation anomalies (a) and amounts precipitation of the cold period (b) in the territory of East Kazakhstan. Anomalies are calculated relative to the period 1961-2008 years

Analysis of the linear trend in the time course of annual amounts precipitation anomalies and amount of precipitation cold period were showed that significant changes in long-term period is not observed, the trends were not identified.

Snow cover

Snow cover of the territory of Eastern Kazakhstan (mostly) in is formed in the first half of November and the end of November and in the south part. The maximum altitude of snow cover on East Kazakhstan region is very uneven. Mostly, it does not exceed 15 cm, but can reach 80 cm and over.

The duration of period with stable snow cover is varying ranges from 105 to 180 days. The average water reserves in snow are varies from 35-45 to 130-140 mm, and in the mountains and foothills areas up to 190 mm and more.

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