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ANALYSIS OF ATMOSPHERIC ARIDITY IN THE TERRITORY OF ALMATY REGION IN THE CONDITIONS OF MODERN CLIMATE CHANGE

This paper presents an analysis of the atmospheric aridity on the Almaty region based on the calculation of the Ped' S aridity index according to air temperature and precipitation on seven stations, relatively evenly located in the study area over the summer period from 1986 to 2016. Droughts are dangerous natural phenomena, as they lead to the death of crops in vast areas, the massive loss of livestock due to grass burning, extreme heat, dehydration and reduction of water reserves. All these actions reduce electricity generation disrupt industry, transport, trade and the lack of drinking water causes hunger and death in some areas. During droughts, oil and forest fires occur which reduce the soil-protective role of forests, their water conservation value as well as reduce timber for industry and construction. Droughts intensify the melting of glaciers and create conditions for the formation of glacial mudflows. They also contribute to the drying and grinding of the soil, which in turn leads to its wind erosion. During the period of drought, the upper horizons of permafrost thaw, the groundwater level drops, rivers shallow and lakes, ponds and marshes dry out. Nowadays, droughts do not have such terrible consequences, but require large monetary costs to protect and preserve the crop. In the course of this study, some interesting indicators to characterize droughts obtained the number of cases with droughts of varying intensity, the extreme values of the S index and the catalog of atmospheric droughts S.

Key words: atmospheric drought, aridity index, anomalies of temperature and precipitation, number of cases with droughts, air temperature, amount of precipitation.

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Қазіргі климаттың өзгеруі жағдайында Алматы облысының аумағындағы атмосфералық қуаңшылықты талдау

Мақалада Алматы облысының аймағы үшін 1986-2016 жылдар аралығында жаз мезгіліне атмосфералық қуаңшылықтың талдауы келтірілген, яғни ауа температурасы мен жауын-шашынның мәліметтері негізінде қарастырылып отырған аумақтағы салыстырмалы түрде біркелкі орналасқан 7 станцияға Педтың қуаңшылық индексі S есептелген. Құрғақшылық қауіпті табиғи құбылыстарға жатады, себебі олар: ауыл шаруашылығы дақылдарының үлкен алаңдарда қырылуына, шөптердің жануына, қатты ыстығы және сусыздануы салдарынан малдың жаппай қырылуына, су қорының азаюына әкеледі, бұл өз кезегінде электр энергиясының өндірілуін төмендетеді, өнеркәсіп, көлік, сауда жұмысын бұзады, ал кейбір аудандарда ауыз судың болмауы аштық пен өлімді тудырады. Құрғақшылық кезінде ормандардың топырақ қорғау рөлін, олардың су қорғау мәнін төмендететін, сондай-ақ өнеркәсіп пен құрылыс үшін ағаш қорын қысқартатын мұнай және орман өрттері пайда болады. Құрғақшылық мұздықтардың еруін күшейтеді және гляциалды селдерді қалыптастыру үшін жағдай жасайды. Олар топырақтың құрғауына және ұсақтануына ықпал етеді, бұл өз кезегінде оның жел эрозиясына әкеледі. Құрғақшылық кезеңінде көп жылдық қатпарлықтың жоғарғы қабаттары ериді, жер асты суларының, өзендердің деңгейі төмендейді, көлдер, су айдындары мен батпақтарда кебу процестері жүреді. Қазіргі уақытта құрғақшылық мұндай қорқынышты зардаптарға ие емес, бірақ өнімді қорғау және сақтау үшін үлкен ақшалай шығындарды талап етеді. Осы зерттеуді орындау барысында келесі нәтижелер алынды: әртүрлі қарқындылықтағы қуаңшылық жағдайларының саны, S индексінің экстремалды мәндері, атмосфералық қуаңшылық каталогы құрастырылды.

Түйін сөздер: атмосфералық құрғақшылық, құрғақшылық индексі, температура мен жауын-шашынның ауытқулары, құрғақшылық жағдайларының саны, ауа температурасы, жауын-шашын сомасы.

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Анализ атмосферной засушливости на территории Алматинской области в условиях современного изменения климата

В статье приведен анализ атмосферной засушливости для региона Алматинской области на основе расчета индекса засушливости Педя S по данным температуры воздуха и осадков для 7 станций, относительно равномерно расположенных на исследуемой территории за летний период с 1986 по 2016 год. Засухи относятся к опасным природным явлениям, так как они приводят к гибели сельскохозяйственных культур на громадных площадях, массовому падежу скота из-за выгорания травостоя, сильной жары и обезвоживания, уменьшению запасов воды, что в свою очередь снижает выработку электроэнергии, нарушает работу промышленности, транспорта, торговли, а в некоторых районах отсутствие питьевой воды вызывает голод и смерть. Во время засух возникают нефтяные и лесные пожары, которые снижают почвозащитную роль лесов, их водоохранное значение, а также сокращают запасы древесины для промышленности и строительства. Засухи усиливают таяние ледников и создают условия для формирования гляциальных селей. Они способствуют иссушению и измельчению почвы, что в свою очередь приводит к ее ветровой эрозии. В период засухи оттаивают верхние горизонты многолетней мерзлоты, понижается уровень грунтовых вод, мелеют реки, высыхают озера, водоемы и болота. В наше время засухи не имеют таких страшных последствий, но требуют больших денежных затрат для защиты и сохранения урожая. В ходе выполнения данного исследования были получены следующие результаты: число случаев с засухами различной интенсивности, экстремальные значения индекса S, каталог атмосферных засух S.

Ключевые слова: атмосферная засуха, индекс засушливости, аномалии температуры и осадков, число случаев с засухами, температура воздуха, сумма осадков.

Introduction

The concept of "drought" has become so organically incorporated into geographical and agronomic practice that one could unwittingly get the impression that there is a clear, unambiguous understanding of its nature. Meanwhile, it is not yet possible to talk about the presence of a generalized model of drought set at the level of its most significant features.

The concepts of "drought" and "aridity" commonly used linked together. Drought defined as an abnormal weather condition that can manifest itself in any region, while aridity is a characteristic of the climate of certain areas. A different understanding of the essence of the phenomenon led to the emergence of many definitions and approaches (Buchinsky, Rauner, Uteshev, Ped', Drozdov). For example, WMO identifies six types of droughts: meteorological, climatological, atmospheric, agricultural, hydrological and public (Abisheva, 1995).

In Kazakhstan, as well as it has been seen around the world, there are sharp climate fluctuations caused by both natural and anthropogenic factors. Thus, over the past 15 years, air temperature extreme values beaten in Kazakhstan where there has been a tendency to increase in average annual air temperatures and a decrease in precipitation in the warm half-year.

Most of the territory of Kazakhstan represented by semi-arid and arid flat landscapes characterized by low biological productivity and a weak ability to restore disturbed vegetation, in which the processes of desertification are most clearly and diversely manifested. Therefore, in Kazakhstan a particular importance should be given to the effective and rational use of natural resources environment in dry years. When solving these problems, complex ecological and geographical studies of specific territories and analyses of the development and dynamics of their landscapes under the influence of droughts are necessary (Chernysh, 2012).

Atmospheric droughts in Kazakhstan create a special environmental stress of soil conditions, since the evaporation rate of soil moisture is directly dependent on the lack of air humidity. The reaction of different soil types is not uniform, however, lowering of moisture is common to all, which significantly reduces the wind resistance of the soil and enhances desertification and deflationary processes. Therefore, dust storms are usually destructive companions of droughts and they cause great damage to all sectors of the economy (Salnikov et al., 2015).

Among all the regions of Kazakhstan that are relatively homogeneous in climatic characteristics, the Almaty region is notable for its lush diversity.

The area stretching between the Balkhash Lake and the mountains of the Ile Alatau, combines five climatic zones. Here it is equally well possible to develop agriculture and cattle breeding. This region includes five climatic zones, which cause a large variety of ecosystems, and has two reserves and five natural parks. However, such picturesque paintings risk becoming outdated if climate risk management methods are not applied at the state level as soon as possible.

The territory of the region belongs to the Balkhash and Alakol watershed. A characteristic feature of the basin hydrography is a dense river network in the mountainous part and rare in the plain. The bulk of surface water formed within the high mountain ranges flowing to the north-west of the region.

Physical and geographical conditions of the Almaty region are favorable for the cultivation of grain and vegetable crops as well as for the development of animal husbandry. The territory occupied by agricultural production (plant growing and animal husbandry) is 16,423.3 thousand hectares. In the total structure of agricultural land in the Almaty region, pastures account for 89.5%, arable land – 6.6%, hayfields – 3.9%. Sown area of crops is 861.6 thousand hectares. The soil-climatic conditions of the Almaty region are favorable for growing wheat, barley, corn, sunflower, oats, sugar beets, tobacco, potatoes and rice. For this purpose, snow retention, the creation of forest shelterbelts, ponds and reservoirs in ravines and beams, harrowing of soil and other agro-measures are carried out (Sekenova et al., 2016).

The climate of Almaty region characterized by high air temperature during the growing season, insignificant precipitation, and low relative humidity, evaporation of moisture by the soil and water surface, which contributes to the development of drought and wind erosion.

Drought is one of the most dangerous natural phenomena in the warm half-year, causing enormous material damage to agriculture and reducing the yield of grain crops and pastures. Drought in spring and summer is especially destructive. The purpose of this study is to calculate and analyze the aridity parameter on the territory of Almaty region, since most of it used for the cultivation of crops, which in turn is important for the economy and agriculture of our republic.

Great attention is paid to drought forecasting. Moreover, developed countries are trying to predict it not only on their own territory but also on the territory of other states, which, depending on the aridity of the year, can either import or export grain, livestock and other agricultural products (Radzka, 2015).

Baseline data and research methods

A different number of scientific works are devoted to the problems of climatic and circulation conditions of occurrence and preservation of droughts. One of the widely used drought characteristics (1) in practice is the hydrothermal coefficient of G. Selyaninov (HTC):

$$HTC = 10\ \Sigma R / \Sigma t, \quad (1)$$

where,

ΣR – the amount of precipitation in mm during the growing season with air temperature above 10ºC;

Σt is the sum of air temperatures in ° C for the same period.

Following Selyaninov G.T., moistening of the vegetation period is excessive when HTC is> 2.0, dry when HTC is <1.0 and dry when HTC is <0.5. Long periods without rain, high temperatures and low relative humidity of the air lead to the fact that the plant has absorbed moisture reserves in the soil are exhausted and soil drought occurs. While atmospheric drought occurs rapidly and develops intensively, the soil moisture reserves are depleted gradually. The transition from sufficient soil moisture to the state of soil drought is relatively slow (Uteshev, 1959).

Recently, many researchers have used the parameter Si, proposed by D.A. Ped' (2):

$$Si = \frac{\Delta T}{\sigma T} = \frac{\sigma R}{\Delta R} \quad (2)$$

Si is the intensity of atmospheric-soil drought at the i-th station, ΔT, ΔR is the deviation from the normal values of air temperature and precipitation, σT, σR are the standard deviations of the indicated meteorological values. Then the following criteria are used:

Si > 0 – atmospheric drought

Si < 0 – excessive moisture.

According to the degree of intensity, droughts are divided into weak (0.0 < Si < 1.0), medium (1.0 < Si < 2.0), strong (2.0 < Si < 3.0) and catastrophic (Si > 3,0) (Sadokov et al., 2001).

According to the data of air temperature T and precipitation R for 30 years from 1986 to 2016, and D.A. Ped's formulation, the aridity index S for 3 summer months was calculated for 7 stations of Almaty region, relatively evenly located throughout its territory (Fig. 1).

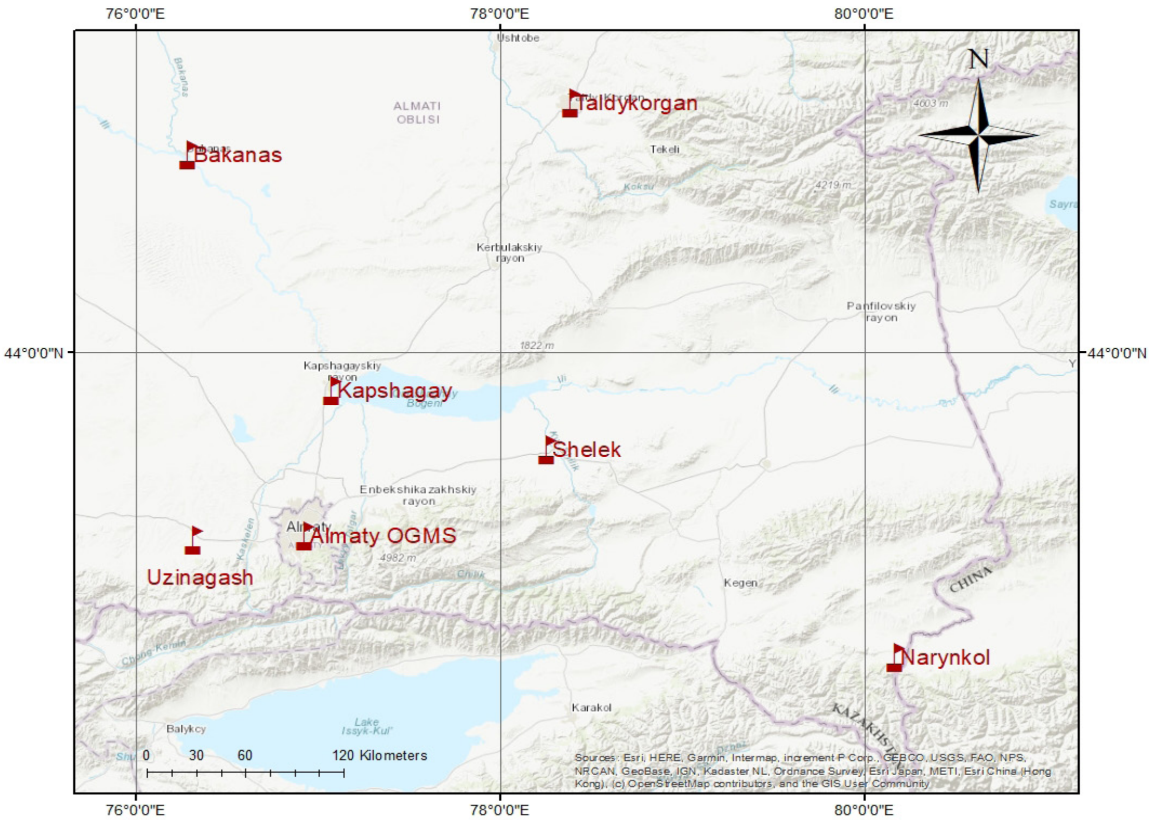

Figure 1 – Location of meteorological stations in Almaty region

The average monthly data on precipitation and air temperature from tables TM-1 were used as the starting material.

Results and discussion

Table 1 shows the standard deviations of temperature (σT) and precipitation (σR) for the period of 1986-2016 in the summer period of the year at seven stations of the Almaty region.

Following table 1, the standard deviations of temperature σT at stations in all summer months vary slightly from 0.7 (Chilik in August) to 1.6 (Taldykorgan in June).

The standard deviations of σR precipitation vary in the range from 6.9 (Chilik, August) to 31.2 (Almaty, June).

From the calculations of the aridity index of Ped', table 2 shows the extreme values of the aridity parameter (Smax) observed in the study area from 1986-2016.

Analysis of the data in Table 2 shows that a severe drought observed throughout the study area. At the same time, Smax varies from 2.4 (at Bakanas station in August) to 4.7 (at Narynkol station in July).

In June, the average Smax value for the territory of Almaty region is 3.1. The maximum is observed in Chilik (Smax = 3.6) in 2008, the minimum in Bakanas (Smax = 2.6) in 2008.

In July, the average Smax value for the territory of Almaty region is 3.8. The maximum is observed in Narynkol (4.7) in 2015, and the minimum value is in Chilik (2.6) in 2015. At the remaining stations, the Smax values range from 3.5 to 3.9.

Table 1 – Standard deviations of temperature (σT) and precipitation (σR)

Station	June		July		August	
	σ_T	σ_R	σ_T	σ_R	σ_T	σ_R
Almaty	1,4	31,2	1,2	30,2	1,2	21,8
Bakanas	1,2	16,3	1,1	12,9	0,9	10,6
Kapchagay	1,3	26,7	1,2	28,8	0,9	11,4
Narynkol	1,0	23,6	0,8	24,7	0,8	20,2
Taldykorgan	1,6	22,3	1,2	27,5	1,2	16,4
Uzunagach	1,3	29,3	1,1	30,8	1,0	19,1
Chilik	1,0	9,6	1,7	24,6	0,7	6,9

Table 2 – Extreme values of the drought parameter during droughts Smax

Station	June	July	August
Almaty	3,5 (2008)	3,9 (2015)	3,0 (2012)
Bakanas	2,6 (2008)	3,5 (2015)	2,4 (1987)
Kapchagay	2,9 (1990)	3,8 (2015)	3,1 (1987)
Narynkol	3,4 (1990)	4,7 (2015)	3,2 (1987)
Taldykorgan	2,9 (2008)	3,9 (2015)	2,2 (2014)
Uzunagach	2,7 (2001)	3,9 (2015)	2,7 (2012)
Chilik	3,6 (2008)	2,6 (2015)	3,3 (2012)
Standart	3,1	3,8	2,8

In August, on average, for the territory the value of Smax is 2.8. The highest value is noted in Chilik (3.3) in 2012, while at other stations the Smax values range from 2.2 to 3.2.

It should be noted that in all summer months in the study area, extreme values are observed in the last decade, and it can also be noted that at all stations under consideration in July, the extreme values decrease in 2015.

G.K. Turulina and G.T. Suleimenova studied droughts in various regions of Kazakhstan also showed that droughts of low intensity most often observed, moderate droughts are less common, and severe droughts are very rare. Extreme values of the aridity parameter Smax can also be observed throughout the study area and reach 2.4–4.1. (Turulina et al., 2001)

According to the results of research by the authors (Sal'nikov et al., 2015; Sal'nikov et al., 2016), over the most part of Kazakhstan 5 dry years were also observed (1991, 1995, 1991, 2010, 2012 and 2014), droughts occurring for two and three months in a row.

Table 3 shows the number of cases with droughts of varying intensity, observed in the territory of Almaty region from 1986-2016 in the summer period at 7 stations.

As can be seen from table 3, for the period under review, the total number of cases with droughts of varying intensity was 348.

Droughts of weak intensity S = 0 – 1 are most often repeated. They account for 50.9% or 177 cases.

The greatest number of cases with droughts of low intensity is observed at Bakanas station (29 cases) and the least number of cases at Almaty station (24 cases).

The recurrence of droughts with an intensity of S = 1 – 2. is equal to 30.5% or 106 cases of the total number of cases with droughts. The highest frequency of occurrence is also observed at Bakanas station (19 cases), and the least frequency at Almaty station (11 cases).

The recurrence of severe droughts S = 2-3 is even less and amounts to 13.2% or 46 cases. The highest frequency of occurrence is observed at the Almaty station (9 cases), and the lowest frequency at the Bakanas and Chilik stations (5 cases).

Table 3 – The number of cases with droughts of varying intensity for the study period

Station Almaty	Drought				Total number cases
	S (0-1)	S (1-2)	S (2-3)	S (3-4)	
Almaty	24	11	9	3	47
Bakanas	29	19	5	1	54
Kapchagay	27	15	8	2	52
Narynkol	20	13	6	5	44
Taldykorgan	26	18	6	1	51
Uzunagach	26	14	7	2	49
Chilik	25	16	5	5	51
Amount	177	106	46	19	348
%	50,9	30,5	13,2	5,4	100

Catastrophic droughts with S = 3-4 are much less common. Their repeatability is only 5.4% or 19 cases of the total.

Table 4 shows the catalog of dry years from S = 0-1 by months of the summer period in the territory of Almaty region from 1986 to 2016.

Table 4 – Catalog of dry years with S> 0 over the summer period in the territory of Almaty region (1986-2016)

Months	Years
June	1990, 1991, 1994, 1995, 1996, 1997, 2000, 2001, 2004, 2005, 2007, 2008, 2010, 2011, 2012, 2014
July	1986, 1991, 1994, 1996, 1997, 2000, 2005, 2007, 2008, 2009, 2011, 2012, 2013, 2014, 2015
August	1987, 1989, 1994, 1998, 1999, 2001, 2002, 2006, 2008, 2010, 2012, 2014

According to the data of table 4 it can be seen that, during the period under review, 4 dry years (1994, 2008, 2012 and 2014) were observed in the Almaty region, during which a weak drought was observed throughout the summer period.

There are droughts observed for 2 consecutive months in 1991, 1996, 1997, 2000, 2005, 2007, 2011. It can also be noted that at the same time in June and August, droughts were observed in 2001 and 2010.

For agricultural production, droughts are dangerous when S> 1. Such droughts were observed in the following years and months and are given in table 5.

Table 5 – Catalog of dry years with S> 1 over the summer period in the territory of Almaty region (1986-2016)

Months	Years
June	1990, 1995, 2001, 2005, 2008, 2012, 2014
July	1991, 1997, 2005, 2008, 2012, 2014, 2015
August	1987, 1999, 2002, 2006, 2008, 2012, 2014

Following data shoen in Table 5, a drought with S>1 was observed for 3 consecutive months in 2008, 2012 and 2014. Also, at the same time in June and July a drought was noted in 2005.

Droughts with the index S>2 are the most dangerous for the life of people and for the economy of the republic, since they cause catastrophic damage to the local economy (Table 6).

Table 6 – Catalog of dry years with S> 2 for the summer period in the territory of Almaty region (1986-2016)

Months	Years
June	2001, 2008
July	2015
August	1987, 2006, 2008, 2012

Data analysis of table 6 showed that drought with S>2 in Almaty region was observed in June and August in 2008. Mostly severe droughts with an index greater than 2 are observed after the 2000s.

Table 7 shows the deviations from the norm of the average monthly air temperature (ΔT ºC) and the amount of precipitation (ΔR, mm) in droughts at stations of the Almaty region.

Also, here, the total for ΔT and ΔR is given the number of cases for which they were averaged.

Analysis of the data in table 7 shows that for droughts with intensity S (0-1) there are small air temperature anomalies from 0.1 to 0.3°C and precipitation anomalies from -9.8 to -4.6 mm.

Table 7 – Deviations from the norm of the average monthly air temperature ΔT and the total precipitation ΔR for months with droughts on average for the period from 1986 to 2016

Station	Intensity of drought											
	S(0-1)			S(1-2)			S(2-3)			S(3-4)		
	ΔT	ΔR	n	ΔT	ΔR	n	ΔT	ΔR	n	ΔT	ΔR	n
Almaty	0,2	-9,8	24	1,0	-20,3	11	1,5	-28,9	9	2,7	-37,7	3
Bakanas	0,1	-4,6	29	0,9	-9,8	19	1,7	-11,5	5	2,6	-14,7	1
Kapchagay	0,2	-9,6	27	0,8	-13,2	15	1,7	-20,8	8	2,6	-20,4	2
Narynkol	0,1	-6,8	20	0,5	-19,5	13	1,1	-25,5	6	2,0	-29,7	5
Taldykorgan	0,3	-6,4	26	1,0	-15,1	18	1,9	-20,2	6	3,4	-28	1
Uzunagach	0,2	-8,5	26	0,9	-19,5	14	1,6	-23,4	7	2,5	-41,1	2
Chilik	0,2	-7,4	25	1,0	-8,7	16	1,5	-11,9	5	1,4	-10,7	5

Droughts with intensity 1<S<2 are characterized by higher temperatures and insignificant monthly precipitation. ΔT ranges from 0.5 to 1.0 °C, and ΔR precipitates from -20.3 to -8.7 mm.

Severe droughts with intensity S (2-3) are universally characterized by higher temperature anomalies and significant precipitation deficits. Temperature anomalies vary from 1.1 °C to 1.9 °C and precipitation anomalies range from -28.9 to -11.5.

Catastrophic droughts with an 3<S<4 index are characterized by even higher temperature anomalies and significant precipitation deficits. Thermal regime anomalies range from 1.4 °C in Chilik to 3.4 ºC in Taldykorgan, and precipitation anomalies range from -41.1 mm in Uzunagach to -10.7 mm in Chilik. Almaty, Narynkol and Bakanas also have large temperature anomalies and low ΔR values.

Besides, on the example of the drought in July 2014, atmospheric processes forming this dangerous phenomenon for the territory of Almaty region have been considered. The initial material was the combined-kinematic maps of natural-synoptic periods (n.s.p.) and the average maps of H500.

In July 2014, a drought of average intensity covered almost the entire territory under consideration, and this year was selected for analysis, since droughts were observed throughout the summer period and mainly with the values of the index 1<S<2 (Table 8).

Table 8 – Distribution of the parameters S, T (ºC) and R (mm) in July 2014 over the territory of Almaty region

Stations	Almaty	Bakanas	Kapchagay	Narynkol	Taldykorgan	Uzunagach	Chilik
S	1,9	0,7	1,6	1,2	1,7	1,2	1,0
T	24,9	25,2	25,9	16,6	25,4	23,0	25,6
ΔT	0,8	-0,6	0,9	0,4	0,9	0,2	0,6

Continuation of table 1

Stations	Almaty	Bakanas	Kapchagay	Narynkol	Taldykorgan	Uzunagach	Chilik
R	9,0	2,4	12,5	44,9	4,5	16,3	7,1
ΔR	-37,4	-15,9	-22,8	-15,8	-27,6	-31,3	-15,9

In accordance with table 8, droughts of medium intensity were observed at all stations of the study area, with the exception of Bakanas station. Here, the index was 0.7 which corresponds to droughts of weak intensity. Practically at all stations, rather high temperatures (16.6–25.9 ºC) and a small amount of precipitation (4.5– 44.9 mm) were noted.

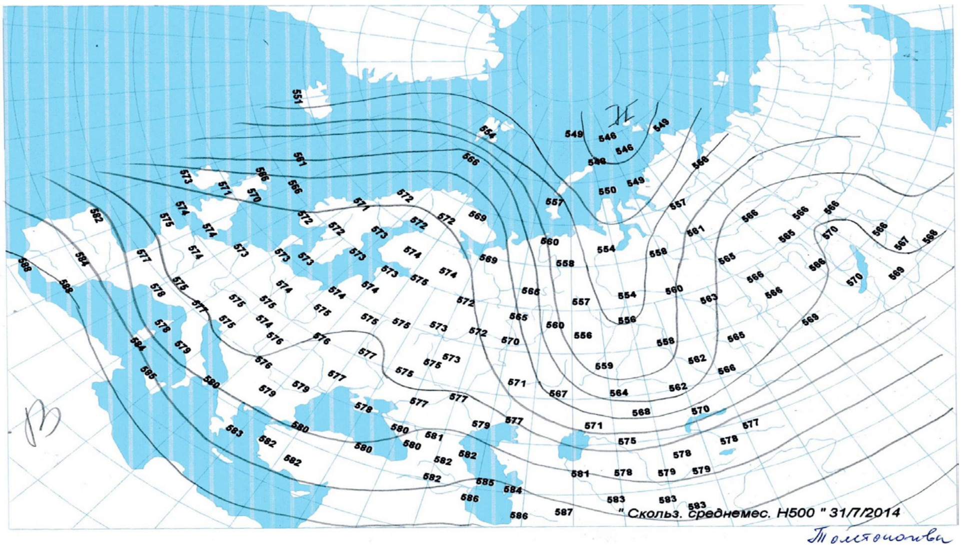

Figure 2 – Average field H500 for July 2014

Figure 2 shows the synoptic processes of July 2014. They are characterized by a vast area of high pressure, covering almost the whole of Europe, the North Atlantic, and the western part of the ETR. The axis of the high ridge is oriented from the Black Sea through Ukraine and Belarus to Finland. As a result, dry and hot weather prevails here. At the same time, to the east of this ridge, cyclonic circulation prevails, usually accompanied by abundant precipitation. The territory of Russia and Kazakhstan is located in the region of a deep altitude hollow, whose axis is directed from north to south from the Arctic Ocean through Tyumen and Astana to Tashkent. This ravine extends to greater heights and the formation of cold air at heights contributes to its formation. Central Siberia and Mongolia are influenced by the high ridge. The crest has been stationary for a long time and it has a blocking effect on the access of cold air from the north and north-west to its territory. As a result, the moisture content is reduced and dry and hot weather is maintained.

The planetary altitude-frontal zone (PAFZ) is located in such a way that dry transformed air from Turkey and Iran passes through their territory, passing through the southeastern part of Kazakhstan, and the territory of Almaty region is influenced by the western periphery of the anticyclone, which causes a dry climate considered territory. During such processes along the AFZ, high-pressure cores invade from the Black Sea regions, as well as from the northern regions of the ETR, which initially carry with them dry arctic cold air. As they move to the south and southeast, the air in these nuclei warms up, and they themselves gradually increase to anticyclones (Fig. 3-5).

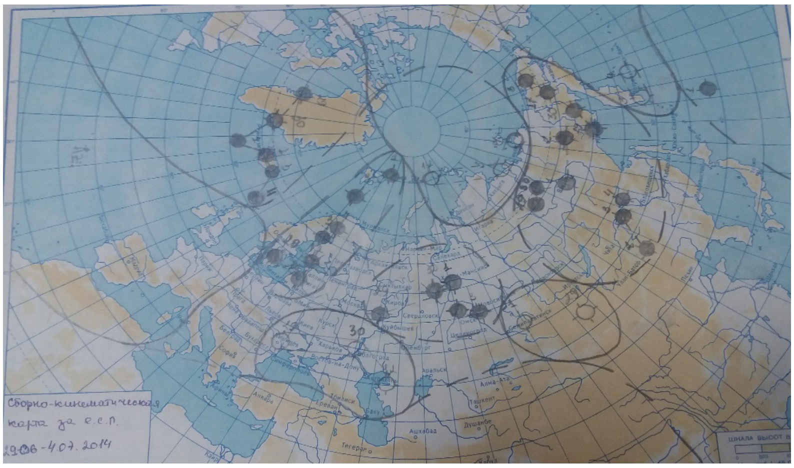

Figure 3 – CKM for 29.06-04.07.2014

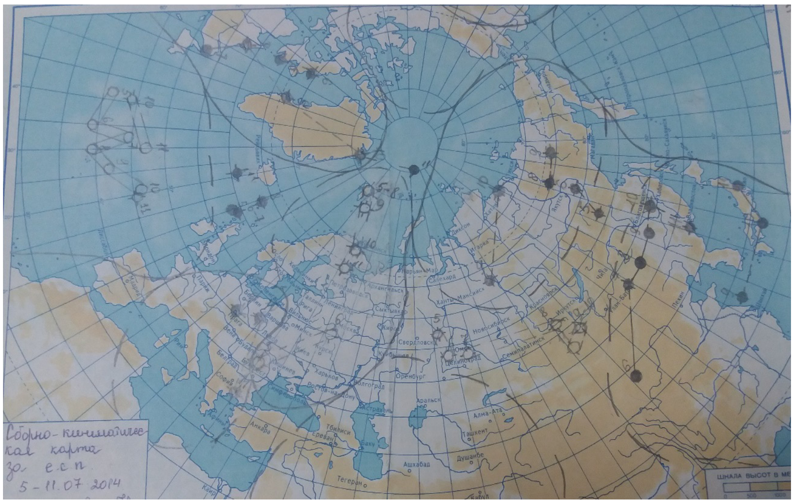

Figure 4 – CKM for July 05-11, 2014

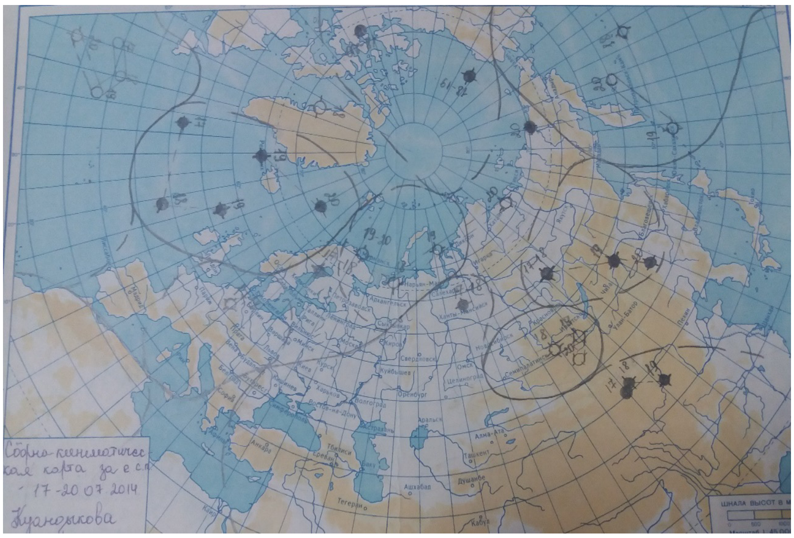

Figure 5 – CKM for July 17-20, 2014

Droughts are characterized by processes leading to stable anticyclogenesis over the study area — crests or small anticyclonic formations that have been present for a long time are formed in the surface layers.

Conclusions

The territory of the Almaty region, therefore, is a zone of risk farming, where droughts often occur. And therefore, to predict them, besides the climatic characteristics of droughts, it is necessary to take into account the peculiarities of the circulating processes of the Northern Hemisphere, leading to the occurrence of droughts.

As a result everything above the following conclusions arise:

1) extreme values of the aridity parameter during droughts Smax varies from 2.4 (at Bakanas station in August) to 4.7 (at Narynkol station in July). It should also be noted that in all summer months in the study area, extreme values have been observed in the last decade, and it can also be said that at all stations under consideration in July, the extremes fall in 2015.

2) droughts of low intensity ($0<S<1$) most often recur. They account for 50.9% or 177 cases. The recurrence of droughts with an intensity $1<S<2$ is equal to 30.5% or 106 cases of the total number of cases with droughts. The recurrence of severe droughts ($2<S<3$) is even less and amounts to 13.2% or 46 cases. Catastrophic droughts ($3<S<4$) are much less common. Their repeatability is only 5.4% or 19 cases of the total.

3) during the period under review, 4 dry years (1994, 2008, 2012 and 2014) were observed in the territory of Almaty region, during which a drought was observed throughout the summer period. Also, there are droughts, occurring 2 months in a row in the years 1991, 1996, 1997, 2000, 2005, 2007 and 2011.

4) severe droughts are almost universally characterized by high temperature anomalies and significant precipitation deficiencies.

5) droughts are observed under the anticyclonic weather regime, as shown by synoptic maps for July 2014.

6) July 2015 was the driest month for the territory under consideration.

From the data of the Annual Bulletin of Monitoring the State and Climate Change in Kazakhstan for 2015, it is known that in 2015 global warming reached record levels as a result of a prolonged rise in global temperatures caused mainly by greenhouse gas emissions from human activity, combined with El Nino phenomena. The global average near-surface temperature in 2015 was the highest, with an obvious margin from the ever-recorded values, according to data sources analyzed by WMO. The global average temperature this year was higher by almost 0.76 ± 0.09 ºC compared with the average value of the period 1961-1990. and approximately 1 ºC above the period 1850–1900. Global average temperatures above the land surface indicate that the highest temperatures in the history of observations were observed in 2015, 2005, 2007 and 2010 are comparable. The global average temperature at the sea surface in 2015 was equal to the record value for 2014. As a result of the combination of high temperatures on the land and sea surfaces, 2015 was a total record year (NITS pri RGP «Kazgidromet», 2016).

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