ҚАЗАҚСТАН РЕСПУБЛИКАСЫ ҒЫЛЫМ ЖӘНЕ ЖОҒАРЫ БІЛІМ МИНИСТРЛІГІ Л.Н. ГУМИЛЕВ АТЫНДАҒЫ ЕУРАЗИЯ ҰЛТТЫҚ УНИВЕРСИТЕТІ

МИНИСТЕРСТВО НАУКИ И ВЫСШЕГО ОБРАЗОВАНИЯ РЕСПУБЛИКИ КАЗАХСТАН ЕВРАЗИЙСКИЙ НАЦИОНАЛЬНЫЙ УНИВЕРСИТЕТ ИМЕНИ Л.Н. ГУМИЛЕВА

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE REPUBLIC OF KAZAKHSTAN L.N. GUMILYOV EURASIAN NATIONAL UNIVERSITY



"ЖАСЫЛ ЭКОНОМИКАҒА" КӨШУ ЖАҒДАЙЫНДА ҚАЗАҚСТАН РЕСПУБЛИКАСЫНЫҢ ТҰРАҚТЫ ДАМУЫ: ЕУРОПАЛЫҚ ОДАҚ ЕЛДЕРІНІҢ ТӘЖІРИБЕСІН ҚОЛДАНУ" ХАЛЫҚАРАЛЫҚ ҒЫЛЫМИ-ТӘЖІРИБЕЛІК КОНФЕРЕНЦИЯСЫНЫҢ ЕҢБЕКТЕР ЖИНАҒЫ

СБОРНИК ТРУДОВ

МЕЖДУНАРОДНОЙ НАУЧНО-ПРАКТИЧЕСКОЙ КОНФЕРЕНЦИИ «УСТОЙЧИВОЕ РАЗВИТИЕ РЕСПУБЛИКИ КАЗАХСТАН В УСЛОВИЯХ ПЕРЕХОДА К «ЗЕЛЕНОЙ ЭКОНОМИКЕ»: ПРИМЕНЕНИЕ ОПЫТА СТРАН ЕВРОПЕЙСКОГО СОЮЗА»

WORKS

OF THE INTERNATIONAL SCIENTIFIC AND PRACTICAL CONFERENCE "SUSTAINABLE DEVELOPMENT OF THE REPUBLIC OF KAZAKHSTAN IN THE CONDITIONS OF TRANSITION TO A "GREEN ECONOMY": APPLICATION OF THE EXPERIENCE OF THE COUNTRIES OF THE EUROPEAN UNION"

> ACTAHA, 2022 ASTANA, 2022

## Л.Н. ГУМИЛЕВ АТЫНДАҒЫ ЕУРАЗИЯ ҰЛТТЫҚ УНИВЕРСИТЕТІ ЕВРАЗИЙСКИЙ НАЦИОНАЛЬНЫЙ УНИВЕРСИТЕТ ИМ. Л.Н. ГУМИЛЕВА L.N. GUMILYOV EURASIAN NATIONAL UNIVERSITY

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# СБОРНИК ТРУДОВ

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### ISBN 978-601-337-777-3

#### Ж 33

«Жасыл экономикаға" көшу жағдайында Қазақстан Республикасының тұрақты дамуы: еуропалық одақ елдерінің тәжірибесін қолдану» халықаралық ғылыми-тәжірибелік конференциясының еңбектер жинағы. – Астана: "Л.Н. Гумилев атындағы Еуразия ұлттық университеті"КЕАҚ, 2022. – 484

Сборник трудов международной научно-практической конференции «Устойчивое развитие Республики Казахстан в условиях перехода к «зеленой экономике»: применение опыта стран европейского союза». – Астана: НАО «Евразийский национальный университет имени Л.Н. Гумилева», 2022. – 484

Works of the International scientific and practical conference «Sustainable development of the Republic of Kazakhstan in the conditions of transition to a "green economy": application of the experience of the countries of the European Union». – Astana: NAO "L.N. Gumilyov Eurasian National University", 2022. – 484

### ISBN 978-601-337-777-3

УДК 338 (574) ББК 65.9 (5Каз)

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# CLIMATIC FEATURES OF KAZAKHSTAN AS A CAUSE OF DESERTIFICATION PROCESSES

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## Introduction

The atmospheric circulation, the annual precipitation and their treatment, the average long-term temperature. Kazakhstan, located in the center of the large continent of Eurasia, has a sharply continental climate. Since the country is located at a considerable distance (thousands of kilometers) from the oceans and seas, their mitigating effect on the climate is insignificant. Kazakhstan is located in the southern part of the temperate climate zone. The Republic has four distinct seasons (summer, autumn, winter, and spring). Winter is dominated by severe Siberian frosts. In summer, tropical air masses dominate, forming over Kazakhstan and Central Asia. The amplitude of summer and winter temperatures increases the continentality of the climate. The entire Republic is characterized by a large variation in temperature, both daily and annual. In the low-mountain part of the plains, the average annual and monthly temperatures change from North to South, and in the high-mountain areas with the elevation of the terrain above sea level.



Figure 1. Precipitation map in Kazakhstan 1:5 000 000 (Source: National Atlas of Kazakhstan)

As shown on the climate map, the amount of precipitation falling on the territory of Kazakhstan is insignificant and they are distributed unevenly. This is due to the remoteness of the Republic from the Atlantic ocean and its location in the Central part of the continent of Eurasia. The average annual precipitation on the territory of Kazakhstan ranges from 130 mm to 1600 mm. Thus, in the areas located in the North-East of the Aral sea and in the Western part of lake Balkhash, only 130 mm of precipitation falls, in some years even less. The largest amount of precipitation falls in the Western Altai. In the low-mountainous part of the Republic, the amount of precipitation decreases from North to South. In the North, precipitation falls a little more than 400 mm (in Petropavlovsk-425 mm), in the Central band – up to 275 mm, in the South-up to 130 mm. The amount of precipitation decreases from West to East. In the West, near Uralsk, 374 mm falls, and in the East, near the Zaisan basin 200 mm. High-altitude areas receive more precipitation than low-altitude areas.

High-altitude areas in the East and South-East of the Republic are more humid. On the windward slopes of the mountains precipitation is 500 mm or more, and in the upper reaches of the

Malaya Ulba river in the Altai – 1600 mm. The annual distribution of precipitation on the territory of Kazakhstan is uneven and by season. In the Northern part, 70-80% of annual precipitation falls during the warm season, most of them in July. In the southern desert zone and at the foot of the mountains in the East and South-East, there is a minimum of summer precipitation. In the southern regions of the Republic, there is no precipitation during the summer for 2 to 3 months in some years. At this time, there are so-called "dry" rains, when raindrops do not reach the earth's surface, evaporate.

The amount of precipitation on the territory of Kazakhstan does not yet indicate that it is sufficiently humidified. Humidification also depends on the amount of evaporation. If the value of evaporation is less than annual precipitation, there is excess humidity, and conversely, if the value of evaporation exceeds the annual rainfall, the shortage of moisture. For example, a moisture coefficient close to one is observed in the Northern forest-steppe zone of the Republic. In Kazakhstan, everywhere, except in the highlands, the annual amount of evaporation is several times higher than the annual amount of precipitation. For example, in Turkestan (southern Kazakhstan), the evaporation rate is 1250 mm, and the annual precipitation is 238 mm. The moisture coefficient is 0.19, which indicates a very dry climate.

A peculiar atmospheric phenomenon observed on the territory of Kazakhstan is a dust storm. The occurrence of a storm is directly dependent on the wind speed and the nature of the soil cover. Dust storms and winds that blow during dry weather in areas with easily deflated soil. Blowing away the grains of soil, dust storms expose the roots of plants and this causes great harm to agriculture. The number of days with a dust storm in the desert zone of Kazakhstan is on average 20-38, in the deserts of the South of the Republic and in the area of lake Balkhash, dust storms are 55-60 days. In the South-East and in the Eastern mountains of the Republic, dust storms are mostly not observed, because the surface of these places is story clay.

Atmospheric circulation over the territory of Kazakhstan is influenced by planetary circulation. For example, an increase in zonal air circulation in the Northern hemisphere leads to an increase in the flow of oceanic air masses from West to East, and in 2 to 2.5 days they reach Kazakhstan without significant changes. At this time, i.e. during the zonal circulation, despite the location of the Republic in the center of Eurasia, the continentality of the climate weakens. Thus, atmospheric circulation over the territory of Kazakhstan is part of the General circulation of the atmosphere.

The climate of the Republic is mainly influenced by three types of air masses: Arctic, temperate and tropical latitudes. Kazakhstan is located at a very long distance from the oceans. Air masses formed over the Pacific and Indian oceans do not enter Kazakhstan. The climate of Kazakhstan is influenced only by the Atlantic and Arctic oceans and their seas. The absence of mountain barriers allows air masses to move freely from North to South, and from West to East. Arctic air masses are formed over the Arctic ocean in the Arctic and on coastal land and Islands. The Arctic continental air that forms over the Arctic ocean is characterized by low temperatures in both winter and summer with little moisture content. The air is very clear and dry. With its invasion from the North, anti-cyclonic weather is established on the territory of Kazakhstan (mainly in winter). Arctic continental air often penetrates to the South of the Republic during the off-season, and spring and autumn frosts are associated with it. Air masses of moderate latitudes are formed in the midlatitudes of the continent. Kazakhstan is completely located in the southern part of the temperate climate zone, so the air of moderate latitudes prevails here. Coming from the West, from the Atlantic ocean, moderate air is called marine moderate. After passing huge distances, it loses a lot of moisture and gets to Kazakhstan already significantly dried up. Nevertheless, it brings from the West the main part of precipitation that falls in the Republic. The moisture in the lower part of the air is lost along the way, and little rain falls on the plains. Moisture contained in the upper layers falls in large quantities on the Western, North-Western slopes of mountain areas.

In that way, the climate situation: atmospheric circulation, insufficient precipitation, as well as sharp temperature amplitudes that cause droughts, dust storms in summer, and severe dry frosts in winter, becomes a fundamental cause of land degradation in Kazakhstan.

Main part

**1.** Changes of the climate parameters in the period 1941-2022 years. Modern desertification has been developing in recent decades in the context of global warming, characterized by an increase in the average annual surface air temperature on land, especially in arid inland regions.

This section is devoted to the study of the dynamics of climate characteristics from 1941 to 2022 and their impact on the processes of desertification in Kazakhstan.

According to the RSE Kazhydromet, the last 80 years (for the period of 1941...2022) on the territory of Kazakhstan, there was a widespread increase in surface air temperature, both in General for the year and in all seasons. Average annual air temperatures in Kazakhstan increased at a rate of  $0.27 \degree C$  every 10 years, the greatest warming occurred in the autumn period-by  $0.32 \degree C/10$  years, slightly less in winter and spring-by  $0.29 \degree C/10$  years, respectively, and in summer the lowest rate of temperature increase was observed – by  $0.20 \degree C/10$  years. On the territory of Kazakhstan at the present time there are positive trends in extremes of temperature. The number of hot days (above  $35 \degree C$ ) increases in the Western and southern regions of Kazakhstan – from 1 to 5 days every 10 years. The total duration of heat waves on the entire territory of the Republic increases by 1 ... 3 days/10 years.

Over the period of 1941-2022, the average annual precipitation in Kazakhstan decreased slightly – by 1.0 mm/10 years or about 0.5 % of the norm/10 years. On average, there is a slight tendency for precipitation to decrease by about 0.8 mm/10 years in Kazakhstan in all seasons, except for the winter season, when the tendency for precipitation to increase is 1.3 mm/10 years (1.7% of the norm/10 years).

If we consider in more detail, by regions, the highest rates of average annual air temperatures increased in the West Kazakhstan region-by 0.38 ° C/10 years, the lowest in the South Kazakhstan region, East Kazakhstan region, Almaty and Mangystau regions – by 0.23...0.25 ° C/10 years. In other regions, the average annual temperature growth is within the range of 0.27 ... 0.31 ° C/10 years.

Changes in precipitation by region are characterized by a slight increase in annual precipitation (by 0.4...4.0 mm/10 years). It was observed in Karaganda, Aktobe, Mangystau, North Kazakhstan and Almaty regions, and a slight decrease (by 0.1...5.2 mm/10 years) was observed in Pavlodar, Akmola, Kyzylorda, Zhambyl, Kostanay, South Kazakhstan, West Kazakhstan, Atyrau and East Kazakhstan regions.

In the conditions of arid climate of Kazakhstan the CDD index is very important, which shows the maximum duration of the period when precipitation was less than 1 mm. Let's consider the duration of the zero-day period (figure 2) on the example of 2022. At that time, the duration of the period without precipitation was about a month at almost all weather stations. Particularly long periods without precipitation, from 90 to 134 days, were observed in Mangystau, Kyzylorda, South Kazakhstan and Zhambyl regions. The duration of the rainless period from 60 to 90 days was observed at weather stations in North Kazakhstan, Mangystau regions and in the South of Kazakhstan. These climatic conditions, and to a greater extent the frequency of dry days, lead to the fact that some regions of Kazakhstan are particularly vulnerable to desertification processes.



Figure 2. Maximum duration of the rain-free period (in days) in 2022. (Source: RSE Kazhydromet, Annual Bulletin of climate change monitoring in Kazakhstan: 2022)

**2.** Zonation of the country's territory according to the climatic conditions of desertification. According to climatic conditions, Mangystau, Kyzylorda, South Kazakhstan and Zhambyl regions are potentially the most vulnerable to desertification, and the North-Kazakhstan, Akmola, East Kazakhstan, Northern parts of Kostanay, Pavlodar and North-Western parts of Karaganda regions are the least affected.

As a result of climate aridization, dust storms are common on the territory of Kazakhstan, which cause great harm to agriculture and worsen the situation in the regions as a whole.



Figure 3. Map "Zonation of the territory of Kazakhstan according to the Selyaninov SCC and the frequency of dust storms". (Compiled by the author Karymsakov.A)

## Conclusion

During of writing this article, the following conclusions were made:

It is reasonable to consider desertification as a result of interaction of both components – aridization and anthropogenic-natural degradation of dry lands. In this work, the main attention was paid to natural factors, among which the climate has the greatest impact on desertification. The study revealed that the process of desertification is dynamic, progressing every year. This is due to long-term changes in climate characteristics and the trend of global warming. In Kazakhstan, in the last decade, there has been a widespread increase in surface air temperature and a decrease in the amount of precipitation. As a result of aridization, thanks to the vegetation index, the dynamics of Kazakhstan's desertification as a consequence of vegetation degradation was demonstrated. In addition to the climate component, degradation processes are affected by a number of natural factors, such as geomorphological features of the territory, hydrological conditions and the nature of the soil and vegetation cover.

According to generalized natural prerequisites, Mangystau, Zhambyl, Almaty, Karaganda, South Kazakhstan, Kyzylorda and Aktobe regions are potentially most susceptible to desertification. The predominant cause of desertification in these areas is the climate factor.

Semi - desert areas-Atyrau, West Kazakhstan, East Kazakhstan, Kostanay and Pavlodar regions-are moderately vulnerable to desertification. The cause of desertification in these areas is represented by a combination of both climatic factors and other natural components. The Northern parts of Kostanay and Pavlodar regions are of great importance in providing food to the population, so it is very important to carry out environmental measures to combat desertification in these areas.

The least susceptible to degradation processes are the Northern regions of the Republic -Akmola and North Kazakhstan regions. Despite the insignificant degree of degradation of the territory, it is necessary to conduct a policy of rational nature management, without harming the environment.

If we assume the forecast of desertification, the main influence will be the observed increase in air temperatures and a decrease in precipitation, as well as the imposition of anthropogenic activities on this natural factor. Based on the data of RSE "Kazhydromet" on changes in CDD and temperature for 2022, it can be found that in Mangystau, Kyzylorda, South Kazakhstan and Zhambyl regions, these changes are the most unfavorable.

The government of the Republic of Kazakhstan is interested in solving the problem of desertification, so an environmental policy is being implemented to improve the living conditions of people. The main obligations to the BWC are fulfilled in the Republic. Implementation of the obligations of the UNCCD is carried out through the relevant programs: the national program to combat desertification for 2005-2030, The program for environmental protection for 2030-2050.

There are also factors that hinder the execution of these programs. More than half of the Republic's lands are not provided with good-quality planning and mapping, soil and other survey materials, and land monitoring data. In this regard, it is necessary to widely apply modern remote methods and technologies in the study and mapping of land, using materials from space surveys.

Non-governmental organizations also have a special role to play. In Kazakhstan, the political, legislative and institutional framework for the activities of non-governmental environmental organizations (NGOs) has been created and is developing dynamically in recent years. The laws "Environmental code" and "on public associations" define the basic rules for public participation, access to information and justice. The ratified Convention contributes to the growth of environmental responsibility of citizens, while Kazakhstan is able to fully participate in all the mechanisms of the Convention and receive technical and Advisory support from the European community.

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