NATIONAL ACTION PLAN

FOR WARNING AND MITIGATION EFFECTS OF SAND AND DUST STORM (SDS) IN THE REPUBLIC OF KAZAKHSTAN FOR 2021-2024

Almaty, 2020

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Content

ABBREVIATIONS

ADB	Asian Development Bank
AF	Adaptation fund
AIC	Ago- Industrial Complex
AAS	Academy of Agricultural Sciences
GDP	Gross domestic product
GRP	Gross regional product
GACCC	Global Alliance to Combat Climate Change
GEF	Global Environment Facility
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EU	European Union
GCF	Green Climate Fund
LULUCF	Land use, land use change and forestry
IFAD	International Fund for Agricultural Finance
CA	Central Asia
CAREC	Regional Environmental Centre for Central Asian
CIS	Commonwealth of Independent States
CIF	Climate Investment Fund
MEGNR	Ministry of ecology, geology and natural resources
MA	Ministry of Agriculture
MF	Ministry of Finance
MNE	Ministry of National Economy
ME	Ministry of Energy
ICF	International Climate Fund
SD-2050	Strategy of development of Kazakhstan 2050
RK	Republic of Kazakhstan
RAP	Regional Action Plan
RDW	Research Development Works
NSACC	National Strategy for Adaptation to Climate Change
NSAPCSUB	National strategy and action plan for the conservation and sustainable use of biodiversity
NAPEP	National Action Plan for Environmental Protection
SDS	Sand dust storms
NAP	National Action Plan
PPACC	Pilot Program for Adaptation to Climate Change
GHG	Greenhouse gas
PFBGHGR	Preparation of the First Biennial Greenhouse Gas Inventory Report
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
SFCCC	Special Fund to Combat Climate Change
SEA	Strategic environmental assessment
EG	Emergencies

ABOUT THE PROJECT

The project “Regional approaches to combating sand, dust storms and drought” is funded by the Secretariat of the United Nations Convention to Combat Desertification (UNCCD) and implemented by the Regional Environmental Center for Central Asia (CAREC).

Considering that the countries of Central Asia (CA) are significantly affected by drought and sand and dust storms (SDS), especially in areas outside the highlands, where a semi-arid and arid climate prevails. Recognizing the growing risk of droughts and SDSs, the UNCCD parties have taken decisions to counter the negative impacts of droughts and SDSs.

In order to assist the participating countries in improving their preparedness and resilience to droughts and SDSs, and creating conditions for the implementation of coordinated actions and exchange of data at the national and regional levels, the UNCCD Secretariat developed mechanisms for promoting policies in the field of drought and SDS management, provided support to states in the development of national drought management plans, methodologies and tools, including a drought management package, and a comprehensive list and global overview map of SDS sources has been developed.

The initiative of the UNCCD Secretariat for Central Asia aims to support the countries of the region in the development and implementation of strategies to reduce the risks of SDS and droughts at the national and regional levels, and facilitates coordination among government agencies working in the climate and environmental profile, the academic community, practitioners and local communities.

Through a comprehensive drought risk mitigation and SDS strategy, including monitoring and early warning systems, CA countries can strengthen regional integration and capacity to effectively improve their preparedness and resilience to relevant environmental and natural disasters, focusing on proactive management in line with national mitigation plans. disaster risks and mitigation; and national plans for the management of land, water and other natural resources.

It is also worth noting that the UNCCD Secretariat and CAREC recognize the importance of women in the implementation of the Convention and other environmental initiatives and therefore identifies the following critical areas for their involvement: (i) raising awareness and participation in the development and implementation of programs; (ii) decision-making processes that men and women implement at the local level in the management, development, implementation and evaluation of regional and national action plans (RAPs and NAPs); and (iii) capacity building, training and public awareness, especially at the local level with the support of local organizations.

1. INTRODUCTION

1.1 Natural and climatic conditions and the influence of weather phenomena on the processes of SDS in Kazakhstan

A dust (sand) storm is an atmospheric phenomenon in the form of the transfer of large amounts of dust (soil particles, grains of sand) by the wind from the earth's surface in a layer several meters high with a significant deterioration in horizontal visibility. At the same time, dust (sand) rises into the air and at the same time dust settles over a large area. Depending on the color of the soil in a given region, distant objects acquire a grayish, yellowish or reddish tint. It usually occurs with a dry soil surface and a wind speed of 10 m / s or more.

Often occurs during the warm season in desert and semi-desert regions. In addition to the "proper" dust storm, in some cases dust from deserts and semi-deserts can be retained in the atmosphere for a long time and reach almost anywhere in the world in the form of dusty haze.

Less often, dust storms occur in steppe regions, very rarely - in forest-steppe and even forest regions (in the last two zones, a dust storm occurs more often in summer with severe drought). In steppe and (less often) forest-steppe regions, dust storms usually occur in early spring, after a winter with little snow and dry autumn, but sometimes even in winter, in combination with blizzards [1].

SDS are natural phenomena that affect all groups in society and the environment. An estimated 2,000 million tonnes of dust are released into the atmosphere annually. Most of the sand and dust is emitted due to natural conditions, but human activities make a significant contribution to the SDS due to unsustainable land and water use [2].

The geographic location of Kazakhstan makes the country highly susceptible to various natural disasters, such as earthquakes, floods, droughts and mud-stone flows, which impede livelihoods of the population and limit their livelihood opportunities, including access to adequate food and drinking water. About 75% of the country's territory falls into this category.

Most of the territory of Kazakhstan is located in the arid zone, represented by steppes (a vast territory in the north of the country), semi-deserts (dry steppes that occupy the central part of the country) and deserts (occupying most of the flat territory of the country).

In Kazakhstan, there are vast territories that are the source of dust and sand storms. Natural factors play a role in the formation of dust and sand storms. Such natural factors as climate aridity, frequent strong winds, scarcity of vegetation, insufficient soil moisture, low relative air humidity, frequent repetitions of soil and atmospheric drought, soils with a light texture contribute to the active development of deflationary processes (in the form of dust storms) in Kazakhstan [3]. Desertification caused by deflation in Kazakhstan covers dry steppe, semi-desert and desert landscapes (including 205 km^2 of arable land) [4].

On average in Kazakhstan, the rate of increase in the average annual air temperature is 0.28 ° C every 10 years, the largest increase in temperatures occurs in spring and autumn - by 0.30 and 0.31 ° C / 10 years, in winter - by 0.28 ° C / 10 years, in summer the lowest rate of temperature increase is observed - by 0.19 / 10 years. In accordance with the linear trend of air temperature anomalies (relative to the base period 1961 ... 1990) for the year, all trends in the series of average annual and seasonal values of the surface air temperature are positive and statistically significant, which indicates a steady increase in air temperature in Kazakhstan from 1941 to 2015 year.

On average in Kazakhstan for the period 1940 ... 2015 annual precipitation decreased slightly - by 0.2 mm / 10 years. On average, in Kazakhstan in all seasons there is a weak tendency (statistically insignificant) to decrease the amount of precipitation by about 0.7 mm / 10 years, except for the winter season, when the tendency to increase precipitation is 1.5 mm / 10 years. Thus, in the changes in the precipitation regime for the period under study, a significant tendency towards an increase in precipitation in winter and a decrease in precipitation in other seasons remains.

Agrometeorological phenomena that are dangerous for vegetation cover (including agricultural crops) include frosts, droughts, dry winds, heavy rainfall and hail, strong winds and dust storms. The most common and dangerous in Kazakhstan are droughts and dry winds. Analysis of unfavorable agrometeorological phenomena that caused a significant and complete destruction of agricultural crops in Kazakhstan showed that the share of atmospheric and soil drought is about 80%, heavy rain and hail - 14%, frost - 2%, waterlogging - 2%, severe frosts, strong winds and SDS - 1% each [5].

At the latitudes in which Kazakhstan is located, constant westerly winds dominate. The territory of Kazakhstan from east to west along a parallel of 50 ° of Northern latitude crosses the high-pressure strip due to the Voeikov axis. It is the southwestern spur of the Siberian anticyclone. This high-pressure belt in winter becomes an important wind section on the flat part of the republic: south and south-west winds prevail to the north of this belt, and north and north-east winds to the south. As you move away from this high-pressure band, the wind speed decreases. In Central Kazakhstan in January, the average monthly wind speed is 4-6 m / s, and in Southern Kazakhstan it decreases to 2-4 m / s. In summer, the wind speed decreases: in July in the north, it reaches 2-3 m / s, in the south - 1-2 m / s. In the highlands of Kazakhstan in winter and summer, the wind moves quite quickly. Mountain-valley winds are observed in mountainous areas and the coastal zone of large reservoirs. In summer, twice during the day (in the morning - from the plain, in the evening and at night - from the mountains), they change their direction. The Ebi wind blows when high pressure is established over the basin of Lake Ebi-Nur, located in China, in the southeast of Zhungar Ala-tau. With this arrangement of the anticyclone, east winds are formed, which blow towards Lake Alakol, where at this time an area of low pressure is formed. The Zhungar gates is a tectonic depression. Its width reaches 40 km, and the narrowest point is 10 km. In summer, the strength of the wind increases, and its speed reaches 60-80 m / s. In winter, compressed air has a temperature 8-10 ° C higher than in the surrounding areas. Therefore, the wind is considered warm. It blows on average 70-100 days a year. The Saikan wind blows from the Saikan ridge through the Zhungar gate to Central Asia and in the opposite direction. When high pressure is established over Lake Alakol, the Saikan wind blows from northwest to southeast towards Lake Ebi-Nur. The wind speed reaches 50-60 m / s. In the Alakol depression, the temperature drops to –30–37 ° C. The winds are especially strong in September and April, and they subside at other times of the year. The Chilik mountain-valley wind is formed from the movement of cold air from the glacier area at the source of the Chilik River to the Ili Valley. The wind blows along the river valley from north-west to south-east during the day, and in the opposite direction at night. The wind speed during the year is 8-10 m / s. The Arystandy-Karabass mountain-valley wind blows continuously along the valley of the Arystandy River, located on the southwestern slope of the Karatau ridge. When passing over the sandy desert Moyynkum forms a sandstorm. The Kurdai wind blows over the Kurdai pass, located in the southeast of the Zhambyl region, between the Kindiktas mountains and the Zhetyzhol ridge. Its speed reaches 40 m / s (144 km / h), when the Siberian anticyclone is established on the territory of Kazakhstan in winter. On average, strong winds blow 55 days a year. The Mugalzhar wind blows in the region of the Mugalzhar mountains. Air masses coming from the west or north-west cannot completely pass through the Ural Mountains with their entire volume, and some of them go around the Mugalzhary from the south. The emergence of this wind is associated with relief and atmospheric circulation. The speed of the Mugalzhar wind reaches 50 m / s, and then it turns into a strong storm. This wind is observed in Aktobe, Atyrau, Mangystau regions. When analyzing the geographical distribution of wind speed in Kazakhstan, special attention is paid to winds with a speed of more than 4 m / s. causing SDS. Dry winds of moderate and strong intensity, which have a negative impact on the growth and development of agricultural crops, are observed in the North Kazakhstan region on average for about 5 days a year. In Kostanay region from north to south the number of dry wind days increases from 5 to 70 days a year. In Akmola region, it also grows from north to south from 5 to 25 days, and in Pavlodar region - from 5 to 20 days [6].

In the 21st century, according to forecasters' calculations, warming should be expected throughout Kazakhstan, while the greatest increase in temperature on average across the territory of Kazakhstan is expected in the winter and summer seasons (by 2-4 degrees until the end of the century), while experts do not significantly increase precipitation predict that it increases the likelihood of drought and the movement of desert lands to the north [7], which will lead to the risk of SDS. This fact cannot be ignored when planning the development of industries directly related to climatic conditions. According to experts, climate change affects the state of forests, water resources, rangelands (degradation, desertification) and, of course, the threat of the risk of natural disasters, including the SDS. Understanding the risk associated with a SDS is a major step in managing the risk of potential disasters from an SDS. It requires both short-term and long-term interventions, as well as increased awareness of the population at risk of SDS as a hazard and risk of natural disasters. The need for risk assessment of SDS, based on a systematic analysis, serve as the basis for preventing and reducing the risk of SDS, preparation and prevention, response and recovery, and is not questioned both at the level of decisions of the competent authorities and at the level of international projects.

1.2 Water supply in the Republic of Kazakhstan

Over the past 30 years, the issue of scarcity of water resources has been topical and one of the main throughout the world, along with issues related to climate change and other global challenges. According to a special 2019 United Nations World Water Report, water consumption worldwide has steadily increased by about one percent annually since the 1980s. Growth is driven by a combination of global population growth, socio-economic development, and changing patterns of water consumption [8].

In terms of water supply, Kazakhstan ranks last among the CIS countries, yielding even to Turkmenistan. The total water resources of rivers in an average water content year are 100.5 km^3, of which only 56.5 km^3 are formed on the territory of the republic, the rest of 44.0 km^3 comes from neighboring states. The reasons for the instability of river flow are considered to be global and regional climate changes, as well as economic activities in catchments and river valleys, including in the territories of neighboring states [9]. Surface water resources in Kazakhstan are almost completely depleted. Groundwater is mainly used for household and drinking needs and constitutes an insignificant part of the total water consumption (3-5% of the total water intake). Water management challenges of the republic can be solved only through the economical use of surface waters and the development of groundwater resources. The main groundwater resources (about 50%) are concentrated within South Kazakhstan. A significantly smaller amount of these resources (up to 20%) is formed within Western Kazakhstan. The regions of Central, Northern and Eastern Kazakhstan account for about 30% of all groundwater resources [9].

Irrigated agriculture is widespread in the southern regions of Kazakhstan. The main crops are rice, cotton, wheat, potatoes, sugar beets and vegetables. In the late Soviet period, irrigated land for cultivation reached its maximum, however, during the transition period, it fell sharply. In the period 2010-2014 alone, the area of irrigated land decreased by 18%. There are many reasons for this significant decline. On the one hand, the reorganization of collective farms led to the formation of smaller structures of rural commodity producers, most of which turned out to be financially insolvent. As a result, the organizational and economic mechanism for the use of irrigated lands was disrupted, the issues of ensuring soil fertility and payment for electricity for water supply were significantly aggravated. On the other hand, the irrigation and drainage system collapsed due to insufficiently defined responsibilities of new users and a lack of investment in their operation and maintenance. The deterioration of irrigation and drainage has led to salinization and waterlogging of these areas, a decrease in soil fertility and crop yields. So, since 1990, the yield of cereals fell by almost 48%, sugar beet - by 52%, cotton - by 39%, potatoes - by 26% and vegetables - by 34% 12. The efficiency of water use is low. Only 50-70% of the water allocated for irrigation ultimately reaches crops due to losses in between-farm (10-25%) and in-farm (20-30%) irrigation networks.

[ten]. In recent years, at the expense of UNDP funds, projects have been implemented to restore and improve reclamation of irrigated lands in South Kazakhstan, Almaty, Mangistau, Kyzylorda and some other regions of the republic. The main challenges of land degradation in irrigated croplands are: 1) re-salinization caused by high levels of soluble salts in irrigation water and thin soil layer, and 2) waterlogging. Both of these problems are caused by the poor condition of the irrigation and drainage systems. Abandoned lands are especially vulnerable to salinization, since salts continue to flow with groundwater to the soil surface through capillaries and accumulate due to the lack of irrigation and drainage. Thus, salinization is more often not a cause, but a result of abandonment. Excessive expansion of the area of irrigated land during the period of the centralized planned economy led to the development of marginal lands, less suitable for sustainable irrigated agriculture. Now these lands are mostly abandoned, and pose the risk of SDS. Anthropogenically saline lands are found mainly in the Turkestan, Almaty, Mangistau, Kyzylorda regions. Now these lands are mostly abandoned, and this is the risk of SDS. To combat salinization, how to introduce PPB in the republic, the introduction of new technologies for growing crops. Additional funding should be provided for research and development.

To date, there are several ways to combat soil salinization:

- phytomelioration - sowing of perennial grasses on secondary saline soils;

- the use of irrigation installations with a metered water supply mode;

- demineralization of water used in irrigation;

- subsurface irrigation;

- use of vertical drainage;

- plastering;

- fertilization;

- washing of soil covers with fresh waters.

Drip irrigation is applicable where other irrigation methods cannot be used or are ineffective:

- on soils prone to salinity;

- when using for irrigation water with a high content of water-soluble salts;

- in areas with prolonged droughts and constant strong winds;

- with difficult terrain and a large slope of the site (up to 45 degrees or more);

- in the presence of sources with a limited amount of water;

- on soils with low capacity and very low or high hygroscopicity.

In addition to anthropogenic soil salinization, there are large centers of natural salinization in the republic. According to our estimates, this is 799.8 thousand hectares. In the republic, unfavorable socio-economic and soil-reclamation situations are taking shape, caused by the harsh climatic, soil-geochemical and hydrothermal features. Thus, the increase in the areas of technogenic salinization largely depends on arid conditions.

Another challenge is transboundary waters. Seven out of eight water basins in Kazakhstan are transboundary. Our country is very much dependent on the water management policy of its neighbors - China, Kyrgyzstan, Uzbekistan and Russia. The main problem with China is the lack of an agreement on the water resources of transboundary rivers. Today, Kazakhstan is the first and only country, that is still negotiating with China. Kazakhstan insists on concluding an agreement on the conservation of the ecosystem of transboundary rivers, but the Chinese side is not interested in this. Work on the agreement began back in 2015 and continues to this day. For example, on the

Ili River on the border with China, the issue of an acute shortage of water resources arises. Currently, the water withdrawal from China to Xinjiang Uygur Autonomous Region is about 3.5 km^3 / year, in the coming years it will increase to 5 km^3 / year, which will lead to shallowing and salinization of the largest lake in Kazakhstan - Balkhash. At the same time, in the last 20 years, the flow of the Ili River has decreased from 17.8 to 12.7 km^3 / year. According to expert estimates, the implementation of these projects will lead to the fact that by 2050 the flow of the Ili River in Kazakhstan will decrease by 40%, and as a result of the commissioning of industrial (mainly oil production and oil refining) enterprises in the river basin in China, pollution of the river water will increase. This will aggravate environmental challenges in the Kazakh part of the river, which is considered unfavorable even without this, since the tributaries of the Ili in Kazakhstan are polluted by household, agricultural, industrial wastewater, and degraded and saline territories are increasing. In general, water withdrawal from neighboring countries negatively affects the water availability in Kazakhstan. As the population of neighboring countries increases, water withdrawal will increase, which will negatively affect the situation in Kazakhstan [11].

Thus, there are several reasons for the reduction of water resources in Kazakhstan: uneven distribution of fresh water sources throughout the country, outdated water supply infrastructure, geographic features, irrational management of water resources, insufficient priority level in the formation of water policy, raw materials direction of the economy in relation to oil production and gas. The processes of the occurrence of SDS are directly related to the processes of water supply in the republic.

The processes of the occurrence of SDS are directly related to the processes of water supply in the republic. Urgent measures are required to reduce the foci of SDSs arising as a result of reduced water resources. Kazakhstan needs to take a comprehensive approach in the formation of water policy, which includes the creation of profiling institutional foundations for resolving issues related to water resources in the form of specialized departments (ministries, agencies). In the region, water resources issues are dealt with by non-core departments, such as the Ministry of Agriculture or the Ministry of Energy, but it is necessary to understand that for integrated water supply it is necessary to have a separate institutional body dealing with water policy. The state programs that were adopted by Kazakhstan did not solve the main issues of drinking water supply in all settlements and auls of Kazakhstan. Before the adoption and design of state water supply programs, it was necessary to conduct research and involve scientific specialists, prepare technical justifications and conduct public monitoring in the planning and implementation of programs. For example, when planning state programs, Kazakhstan did not conduct research, technical diagnostics and a low level of preparation of design estimates. According to experts, states need to take measures to effectively shape their water policies.

The following measures are required:

- improvement of interstate water relations.

- development of explored groundwater reserves.

- desalination of saline and brackish waters.

-Prevention of the harmful effects of water.

- regulation of river flow by reservoirs.

- modernization of the hydrological monitoring system

-development of the recycling water supply system.

- development of hydropower resources.

- development of the water-transit potential of the republic.

Improvement of the administrative and organizational system of water resources management:

-creation of a separate institutional body dealing with water policy.

-assessment and forecast of water resource potential.

-development of the state system of water resources management.

-implementation of an integrated water resources management system.

-improvement of water legislation.

-creation of a system of information and analytical support for water resources management.

1.3 Analysis of the state and measures to preserve land resources in Kazakhstan

On the territory of Kazakhstan, there are many varieties of soils that differ in physical and chemical properties and the level of fertility. With a total area of more than 272 million hectares of Kazakhstan, soils occupy 235 million hectares, the remaining 37.5 million hectares are in the waters of seas, lakes, reservoirs and glaciers. The soils of the plains of Kazakhstan occupy 201 million hectares (73.8% of the country's territory), the soils of the foothill plains and mountains - 34 million hectares (12.4%). The share of chernozems (humus content 5-7% with a small layer thickness of up to 45 cm) accounts for 27.5 million hectares, chestnut soils (humus 2-3%) - 90.5 million hectares, brown (humus 1-2%) and gray-brown soils (typical dark soils contain 0.6–0.8% humus on top) occupy 119.4 million hectares (Figure 1). Unsuitable for agriculture soils are widely developed on the territory of the republic. For example, sandy massifs occupy 27 million hectares,

saline soils - salt licks and salt marshes - 20 million hectares [12].

Figure 1- Soils of Kazakhstan

A distinctive ecological property of the soil cover of Kazakhstan is its complexity, which is expressed in a variegated alternation of different types of soils and soil varieties on a small area. The complexity of soils is a consequence of the aridity of the climate, the diversity of the relief, the variegated geological structure and parent rocks. It largely determines the characteristics of the vegetation cover of the landscapes of Kazakhstan, as well as the agricultural use of land. Here 61 million hectares of arable soils have been identified (of which 21 million hectares have already been plowed up). Unfavorable ecological properties of soils in Kazakhstan are: frequent exposure to erosion processes, salinity, low natural fertility. The reason for this is both natural factors (natural processes of desertification), the prevailing sandy loamy-loamy texture of soil, and irrational economic activity. This kind of farming is manifested in non-observance of agrotechnical rules for soil cultivation, which led to an active manifestation of water and wind erosion, soil depletion and loss of fertility and, as a consequence, to dehumification of arable soils. Wind erosion of soil (deflation) is developed on an area of 45 million hectares, it affected 18 million hectares of farmland, and 18.9 million hectares are subject to water erosion. Loss of soil fertility as a result of dehumification and deflation is observed on an area of 11.2 million hectares

of non-irrigated land and 0.7 million hectares of irrigated arable land. (Figure 2) [12].

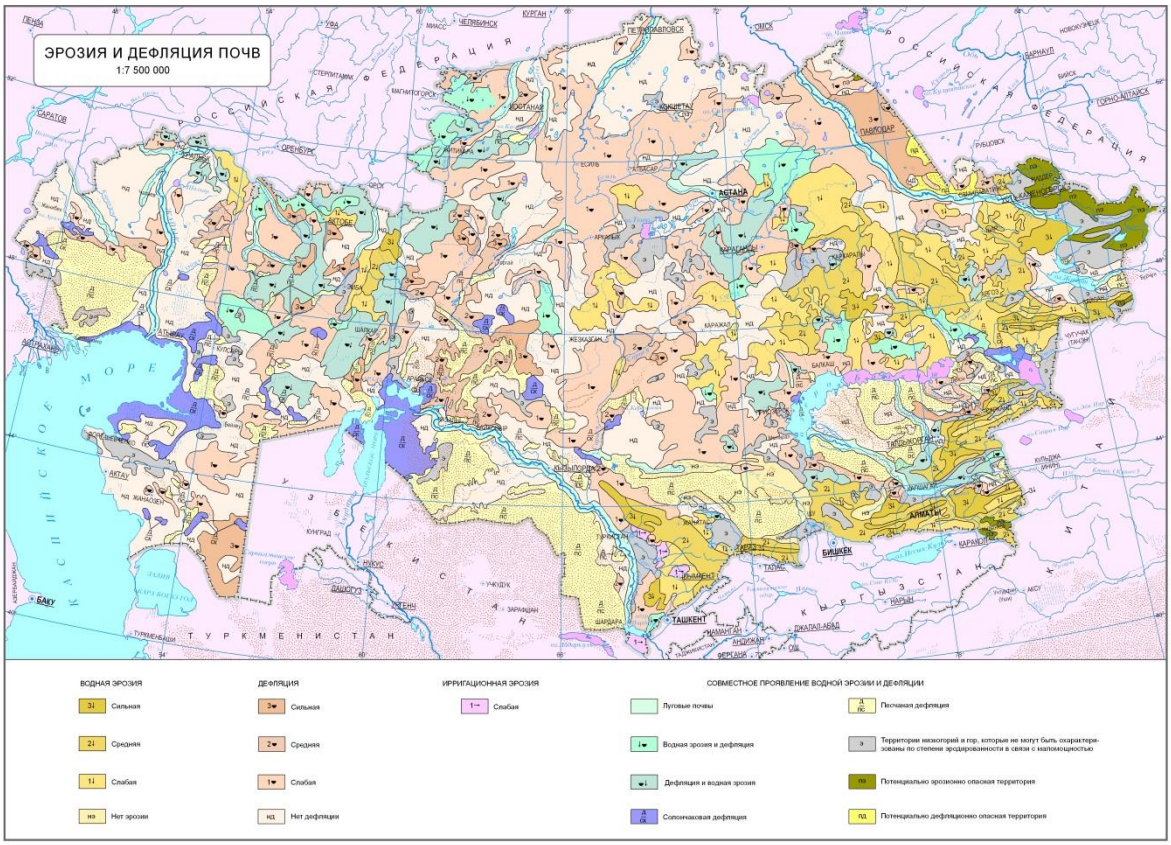

Figure 2- Erosion and deflation of soils in Kazakhstan

All these factors are the sources of SDS in the republic. A number of measures must be taken to reduce the anthropogenic occurrence of PBB sources.

On arable land:

- conducting intensive grain farming on more fertile soils (area 16-18 million hectares) with the optimal use of chemical and biological methods;
- transformation of a part of low-productivity arable land (area 6-8 million hectares) into fodder lands and the creation of sown hayfields and pastures on them (tinning);
- reconstruction of the irrigation system and elimination of secondary salinization of irrigated lands;
- development of reclamation projects suitable for various forms of management (peasant, farm, collective, etc.), providing for the rational use of irrigation water and prevention of desertification of the soils of the irrigated zone;
- for effective protection of soils from water erosion, a complex of soil protection measures is recommended with a contour-strip organization of the territory on the slopes, taking into account their steepness and exposure and including soil-protective crop rotations, techniques
- soil treatment and fertilization system, depending on the degree of soil erodibility;

- increasing the humus balance of soils in Kazakhstan by saturating crop rotations with perennial grasses, maximizing the use of straw, stubble crops, intermediate crops, green fertilizers

A large area of the country is occupied by arid or semi-arid ecosystems that are prone or already affected by land degradation. In particular, this applies to irrigated and rainfed arable lands affected by salinization, soil erosion or loss of humus, as well as grazing lands, which have been severely affected by concentrated grazing in relatively small areas in the last decade, and wooded areas degraded as a result of illegal logging and fires. In Kazakhstan, about 14% of all pastures have reached an extreme degree of degradation. Most of these processes are observed in the regions of the Aral and Caspian Seas and around Lake Balkhash. The North Caspian Sea (Ryn-sands), the Aral Sea region, the delta of the Syrdarya river (Kyzylkum), the southern Pre-Balkhash deserts refer to a significant and high degree of land degradation under the influence of cattle grazing. Degradation of pastures occurs mainly in the desert and semi-desert landscapes of Kazakhstan (Figure 3).

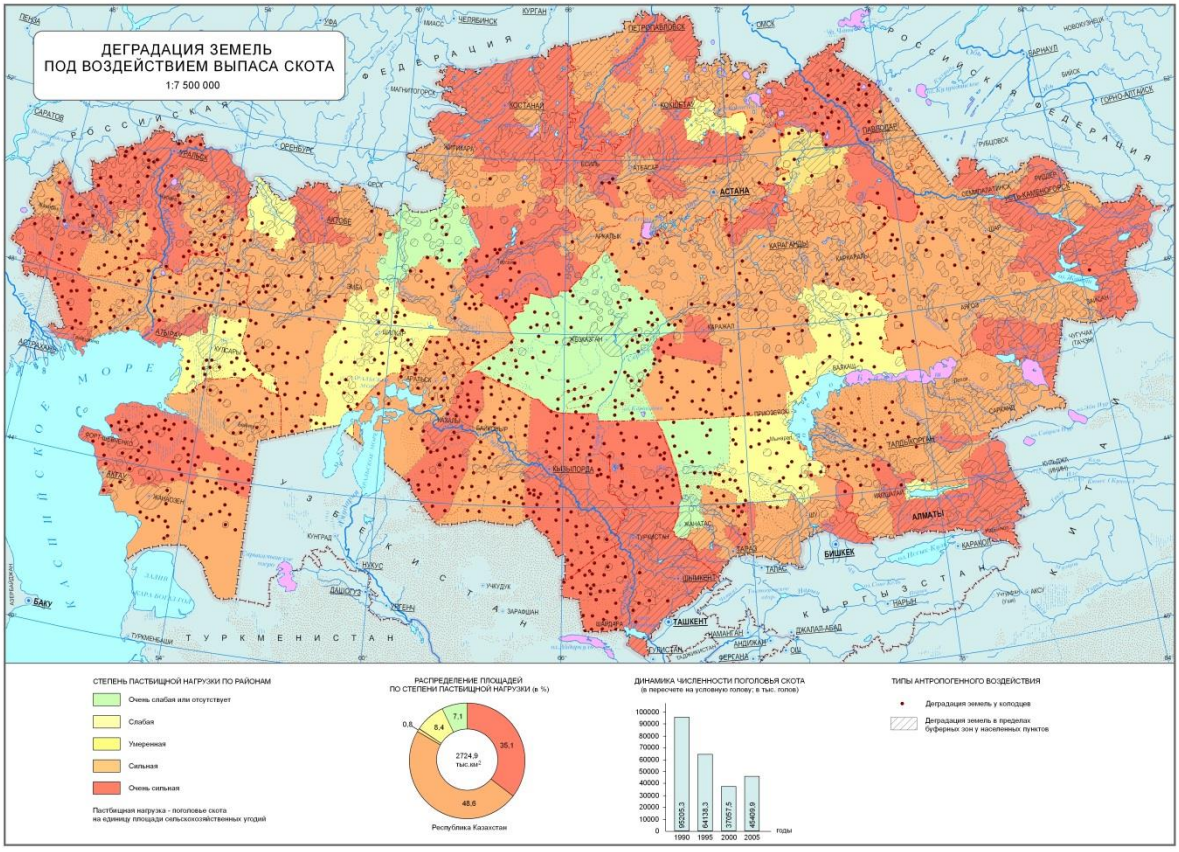

Figure 3- Land degradation in Kazakhstan

To better understand the processes of soil / land degradation and deflation, it is necessary to know the regional divisions of Kazakhstan, which are mainly prone to dust storms. To reduce the anthropogenic impact on pastures, the following measures are required:

- restoration of seasonal use of pastures on the basis of distant pasture breeding;
- watering of pastures;
- land reclamation of degraded lands, including sand consolidation;
- reconstruction of old mine wells;
- monitoring the state of the seasonal use of pastures, the introduction of standards for the use of pastures.

In recent years, the economic situation in the republic has improved significantly and this has made it possible to invest significant funds in supporting the agro-industrial complex and strengthening the natural resource management system. However, the restoration of degraded ecosystems requires time, an appropriate science-based approach and a clear action plan, targeted financing of these activities.

Rational use of land resources is of great importance in the economy of agriculture and the country as a whole. Accounting and assessment of the state of land resources is of great importance, since land is the basis of agricultural production. In recent years, the growth of arable land has stopped, convenient and suitable lands have been developed, uncomfortable salt licks, salt marshes and sands have remained. Despite this, the allotment of agricultural land for non-agricultural needs continues: for the construction of roads, industrial enterprises, housing and other facilities. As a result of the activities of industrial enterprises, land is disturbed and degraded. Degradation of pastures and arable lands is one of the priority national environmental problems. The extensive development of agricultural production in Kazakhstan has left its mark in the form of land degradation and depletion of landscapes. A significant part of the country's territory is subject to desertification, which leads to a decrease in the productivity of livestock and crop production. Over 40 years of exploitation of plowed virgin and fallow lands as a result of wind and water erosion, up to 1.2 billion tons of humus have been lost (Figure 4).

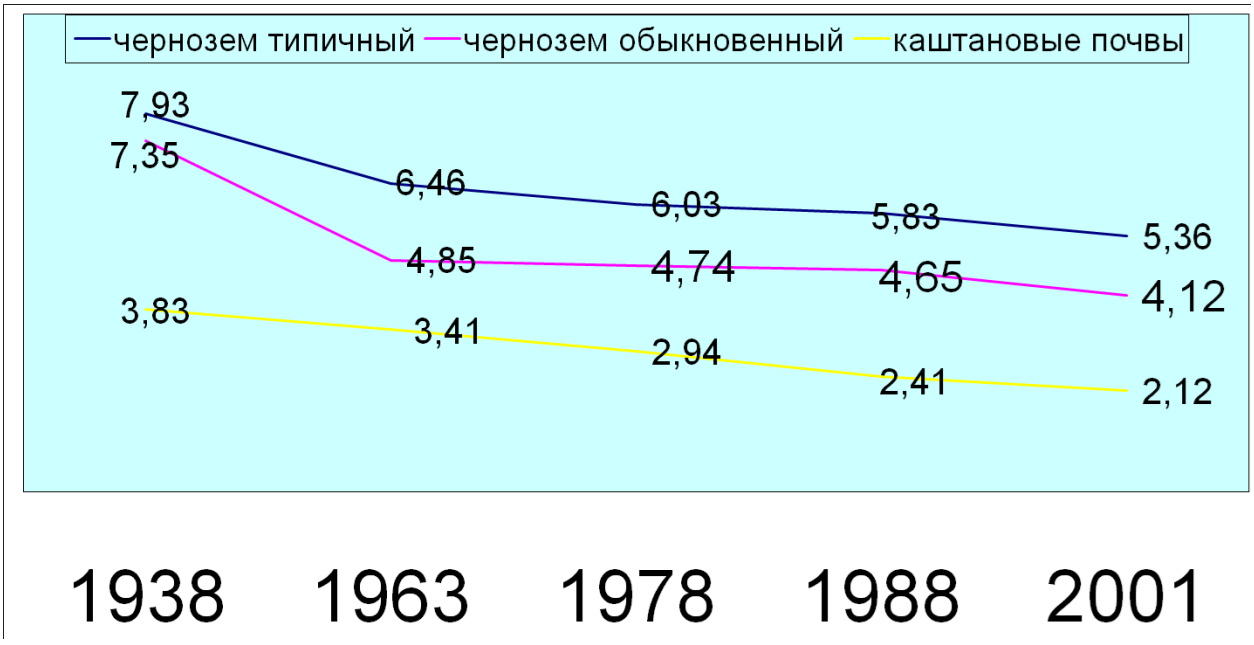

Figure 4- Changes in humus content in the main types of soils in Kazakhstan

Measures are being taken in the republic to remedy the situation, but their implementation is hampered by the large capital intensity of the work. At the same time, failure to make decisions today will lead tomorrow to even greater economic losses, worsening food supply for millions of

people, and may slow down the country's economic development. In recent decades, the role of human activity in increasing desertification has noticeably prevailed over the influence of climate fluctuations. The main results of anthropogenic impact are associated with the deterioration of the state of soils and crop production. All these processes directly cause the risk of SDS.
Land users are obliged to take effective measures to improve soil fertility, to carry out a set of organizational and economic, agrotechnical, forest reclamation and hydraulic engineering measures to prevent wind and water erosion of soils, to prevent salinization, waterlogging, soil pollution, overgrowing with weeds, as well as other processes that worsen the condition soil. Measures for land reclamation and protection, field protective afforestation, for combating soil erosion and other measures aimed at radically improving land are provided for in state development plans and are carried out by the relevant ministries, departments and land users. In Kazakhstan, land monitoring is carried out - a system for monitoring the state of the land fund for the timely identification and assessment of changes, prevention and elimination of the consequences of negative processes. The country is closely monitoring soil pollution in agricultural areas, in the immediate vicinity of cities and industrial facilities, as well as at the background level. Control over the background pollution of the soil cover is of great importance. It reflects the total global pollution of the atmosphere and - as a consequence - of the soil. Objects of the soil pollution observation network are agricultural lands (fields), separate forests, recreation areas (parks, sanatoriums, rest houses) and coastal zones. In general, the land resources of the Republic of Kazakhstan are characterized by constant variability, i.e., change in the dynamics of different types of land (both agricultural and non-agricultural land). The main goal of the environmental policy in combating the risks of SDS is to ensure environmentally safe living conditions for people, rational use and protection of natural resources, development of legal and economic foundations for environmental protection in the interests of present and future generations. To achieve this goal, it is necessary, first of all, to consistently carry out the structural restructuring of the production sphere, to implement a technical policy based on resource conservation, resource substitution, and the use of low-waste and non-waste technologies.
The main goal of reducing anthropogenic impact in the fight against the risks of SDS is to ensure environmentally safe living conditions for people, rational use and protection of natural resources, development of legal and economic foundations for environmental protection in the interests of present and future generations. To achieve this goal, it is necessary, first of all, to consistently carry out the restructuring of the production sector, to implement a technical policy based on resource conservation, resource substitution, and the use of low-waste and non-waste technologies.

1.4 The ecological state of the lands of the Republic of Kazakhstan

Globally, shallow and dry lakes are major sources of dust, but local sources can be found wherever the soil can be blown away by the wind, including glacial floodplains, volcanic ash zones, newly plowed agricultural fields, mining, degraded and desertified areas.

The potential for sand or dust to enter the atmosphere depends on soil moisture, soil texture, surface crust, roughness, vegetation, wind speed, turbulence and thermal convection. Conditions conducive to the release of dust in one location can vary throughout the year and can vary significantly between years.

The main zones of environmental stress and land degradation in Kazakhstan are the Aral Sea regions, the Caspian Sea region, the Balkhash region, abandoned lands in the northern regions of the country. The Aral Sea was once the world's fourth largest inland body of water, but in recent years it has shrunk to less than one third of its former size. The rise in the Caspian Sea level has led to the inundation of coastal areas, including areas of active oil production, agricultural land and pastures in western Kazakhstan. A special threat is posed by radioactive contamination of soils at the former nuclear test site in Semipalatinsk [13].

The main economic consequences of desertification / land degradation are reduced crop yields and production, reduced livestock productivity, dust and sand storms. The total volume of economic

losses due to desertification in Kazakhstan is estimated at 93 billion tenge. Land degradation is especially affecting poor peasant farms. The consequence of aridization is desertification and the deepening of the degree of dryness of desert areas.

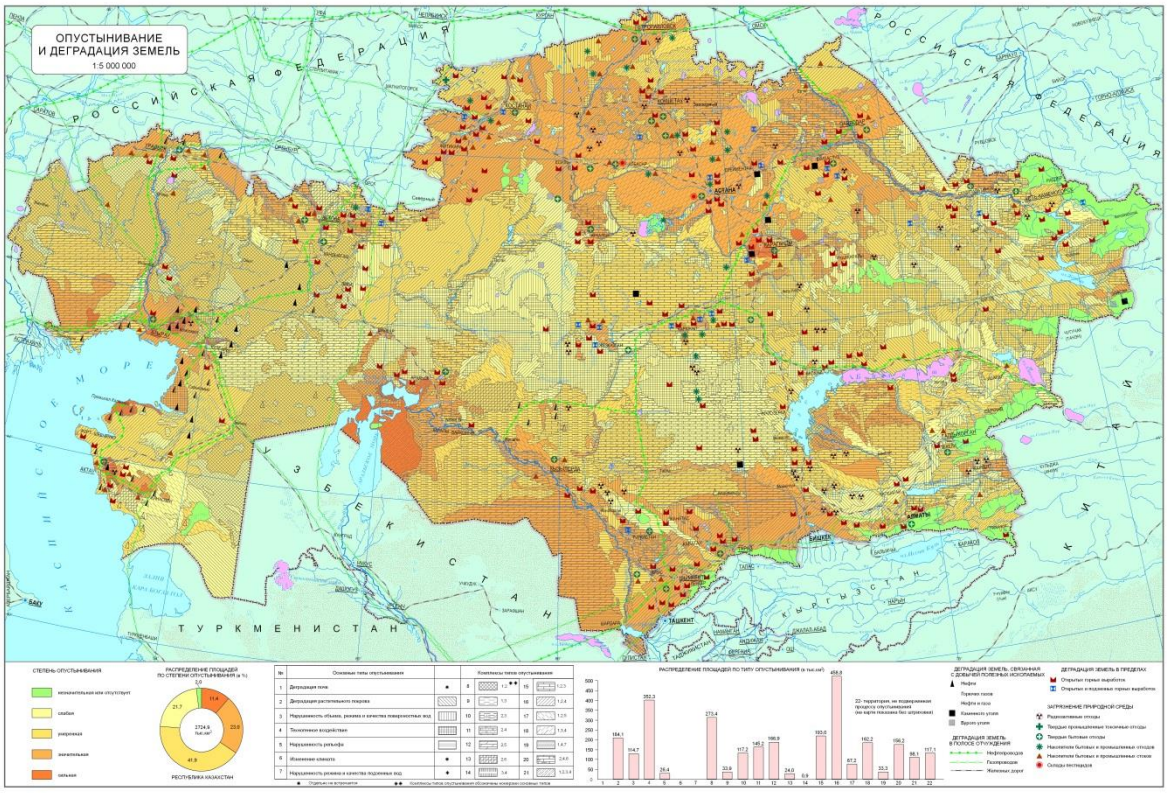

Figure 5- Desertification and land degradation in Kazakhstan

A number of regions of the country may turn out to be or have become zones of ecological disaster, that is, in terms of sanitary, hygienic and ecological conditions, such regions are unsuitable for population and agricultural use. According to preliminary calculations, damage from pasture degradation in Kazakhstan is 963.2 million US dollars per year. Lost income from erosion of arable land - 779 million US dollars per year. Secondary salinization, waterlogging and other causes are losing revenue of US $ 375 million. The annual damage from the loss of humus is 2.5 billion US dollars. At present, the area of degraded lands in the republic is 179.9 million hectares, or 66% of its territory [13].

Kazakhstan is one of the most ecologically unfavorable regions of the Eurasian continent. The arid climate and the flat nature of the surface predetermine the development of a strong wind regime and associated deflationary processes. Under such conditions, they form with low thickness, mainly saline with low biological productivity. Such landscapes are fragile, easily injured and are subject to rapid destruction under the unreasonable influence of human civilization and have the ability to self-heal.

It is against such landscape backgrounds that the long-term industrial, agricultural and military-industrial development of the territory of Kazakhstan without taking into account their environmental sustainability threshold. The republic was a storehouse of many minerals: out of 105 elements of the periodic table, 99 were found in the depths, 70 reserves were explored, more than 60 elements were involved in the production. At the same time, the share of Kazakhstan in the former Union passed reserves of chromite - 98.2, barite - 81.7, phosphorite - 64.7, tungsten - 53, lead - 38.5, molybdenum - 29.3, copper - 38.4, bauxite - 22.1%, asbestos - 20.1% / 8 /.

Oil and gas, manganese and coal, iron and uranium ores had a significant share. When mining minerals, Kazakhstan was mainly a raw material base. All waste was left in the places of extraction,

primary processing and enrichment, and the enriched clean "cream" ready for industry was sent to the centers. Ekibastuz polished ash coals were burned and burned on site, polluting the environment, and clean energy was transferred to the places of consumption, mainly for technological progress and intensive extraction of natural resources from the bowels of the earth were one of the reasons for the degradation of the soil cover of the republic. Society, developing different sectors of the national economy, performs the function of a great geological and geochemical force. About 25-30 tons of various minerals and rocks. But the trouble is that only 1.5-2.0% of what is mined turns into useful products, and the rest turns into nature, often in such a way that natural forces are not able to include these waste products in their circulation. Abandoned quarries, overburden dumps, tailing dumps of concentration plants, ash dumps, slags from thermal power plants, dumps of household and industrial waste, etc. The area of such disturbed lands in Kazakhstan, according to incomplete data, not counting the sanitary zones, is 200 thousand hectares. It should be noted that there are still many lands in the republic that have not yet been classified as disturbed. The enterprises of the military-industrial complex caused great damage to the soil cover of the republic. Until recently, the areas of such territories were secret, only now it became known that the land allotted for "defense" purposes amounted to more than 20 million hectares / 8 /. We have to state that Kazakhstan is the only place on the planet where nuclear-strategic programs have been fully implemented: from the extraction of raw materials, the manufacture and testing of nuclear warheads to the testing and destruction of rocket-space complexes. In addition, in many regions of the republic, not to mention the Semipalatinsk test site, nuclear tests were carried out, the consequences of which posed a particular danger to the soil cover. More than 20 nuclear and more than 500 air and underground explosions were carried out / 9 /. All these territories are potential sources of SDS.

Unfavorable environmental conditions have also developed on the agricultural lands of the republic. As mentioned above, the soil and climatic conditions of Kazakhstan are highly arid. Therefore, the area of bagar farming in such a territory should be small. This was the case until 1954. In 1953, the area of arable land in Kazakhstan, together with irrigated arable land, amounted to 11 million hectares. After the approval of the program for the development of virgin lands, in a short period of 1954-1960. in the northern regions of the republic, 25 million hectares were developed, which occurred without sufficient scientific substantiation. As a result of the pursuit of the "plan", along with suitable lands, soils that were obviously unsuitable for agriculture (light sandy loam, solonetz, light chestnut and chestnut soils of semi-deserts and dry steppes) were plowed up. The arable land area reached 36 million hectares. As a result, SDS have become more

frequent in the northern regions of Kazakhstan (Figure 6).

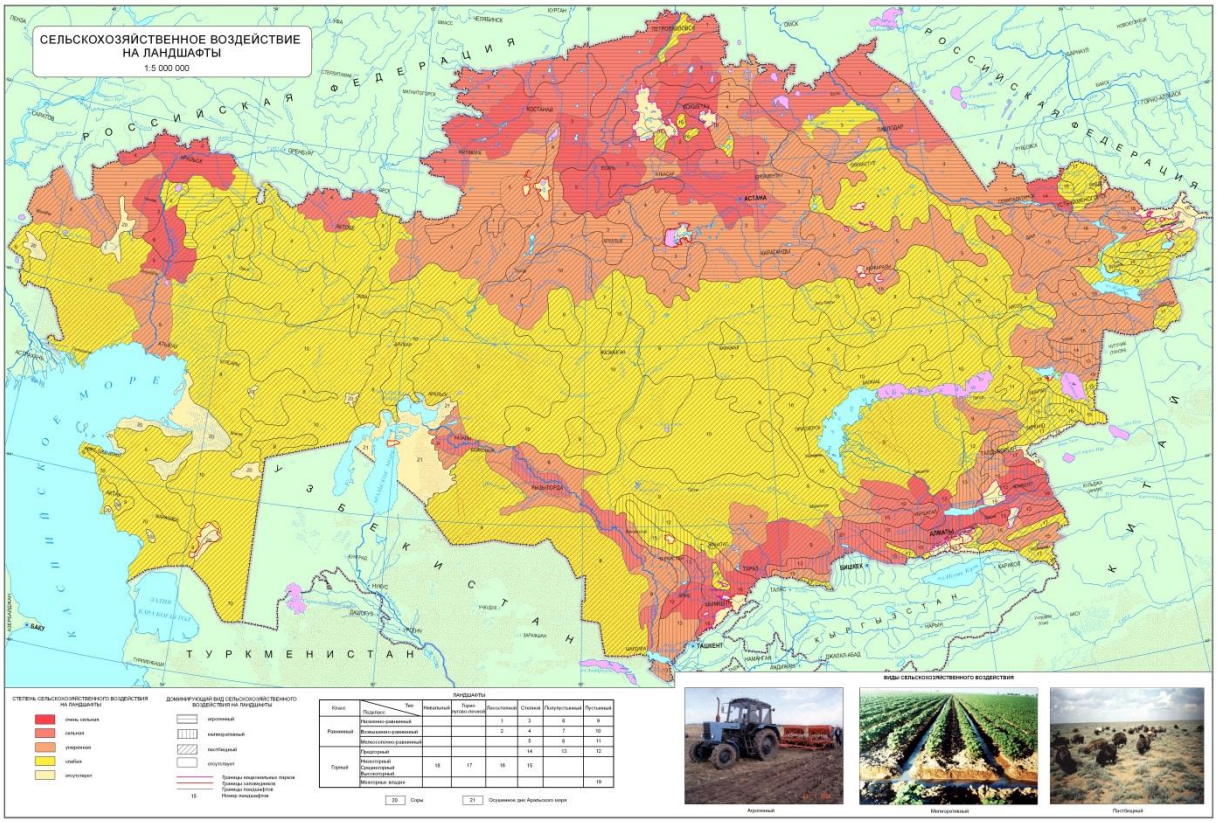

Figure 6- Agricultural impact on landscapes

In modern conditions of the transition to a world market economy, according to scientists' calculations, in order to sell grain at world prices, its yield per hectare should be at least 10 centners / ha, and lower than its production is not justified. Therefore, in Kazakhstan, the process of reducing the area of cereals, giving yields below 10 c / ha, has begun. It is planned to concentrate them mainly in the chernozem zone [13].

A critical ecological situation has developed in the Aral Sea region - a zone of intense desertification, salinization and deflation. At present, the level of the Aral Sea has dropped by 18 m, the salinity of the water has reached 70 g / l, the sea area has dried up and began to desertification on the territory of 3.5 million hectares, including 2 million hectares in the Kazakh part. Aeolian erosion has brought white dust storms from the dried-up bottom of the Aral Sea, which is one of the strongest centers of dust / sand / salt storms in Central Asia [14].

Speaking about the ecological state of the soil cover of the republic, one should not forget about the highly degraded pasture lands from overgrazing and their irrational use, which should also be attributed to disturbed lands. The area of degraded pastures reaches 60 million hectares, including 15 million hectares that have left agricultural use. There are many lands disturbed and contaminated from man-made transport load, as well as oil-bitumen wastes and oil and gas emissions in the Caspian regions, the area of such a territory is 5 million hectares.

Thus, the total area of anthropogenically disturbed and contaminated lands in the republic is 100 million hectares, which are the main focus of the occurrence of SDS [15] To determine the occurrence of SDS, the project developed a map of the foci of SDS occurrence (Figure 7), according to long-term data.

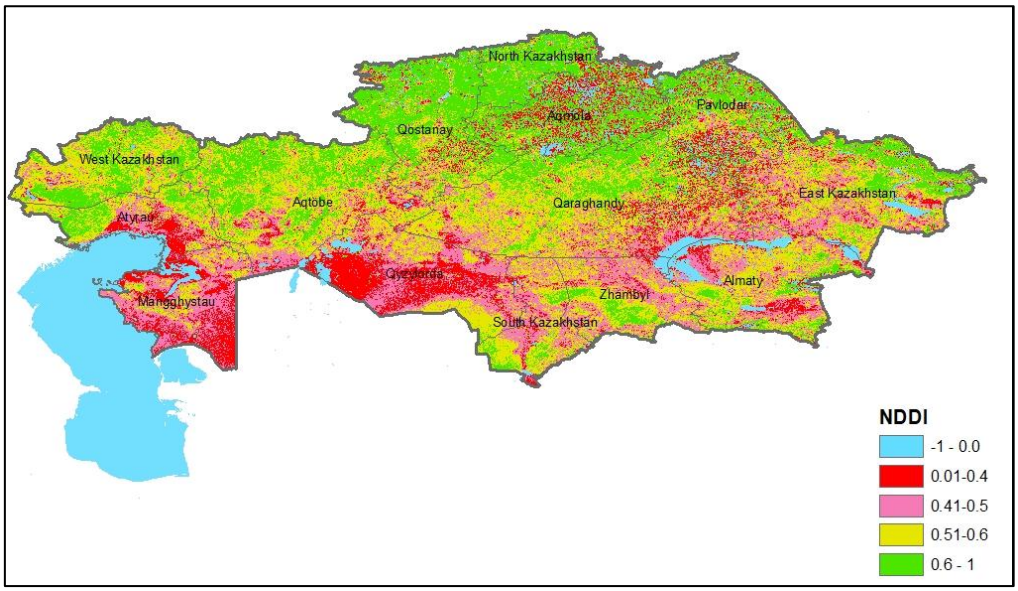

Figure 7- Foci of SDS

The map shows the main sources of SDS and an attempt was made to separate them into sources of anthropogenic origin and natural origin. It is almost impossible to visually make such a division. Therefore, we made a division based on literature data. The main foci of anthropogenic occurrence of SDS are: the territory of the Caspian Sea region, the Aral Sea zone, the Balkhash region, the territory of the Akmola and Kustanai regions.

Based on the above, we can say that the soil and ecological state of the territory of Kazakhstan is extremely tense. The destabilization of the ecological situation has reached such a degree that the processes of soil self-restoration have become impossible. The National Action Plan for the Prevention and Mitigation of the Consequences of SDS involves the development of a comprehensive program for the rational use, protection and restoration of the fertility of disturbed soils, measures to prevent further degradation, deflation and salinization of soils, restore the fertility of eroded, dehumified and technogenically disturbed soils, improve pastures, etc. questions directly or indirectly related to the risk of SDS.

2. **The negative impact of the development of SDS processes on the health of the country's population.**

The “Concept of environmental safety of the Republic of Kazakhstan” notes that the country has developed an unfavorable, and in a number of regions, a crisis environmental situation, requiring the introduction of a system of restrictions and norms of environmental management, which would serve as the basis for environmental safety. A dangerous manifestation of the ecological crisis is the factor of atmospheric pollution, including dust and sand storms. Atmospheric air is a vital component of the natural environment and an integral part of the human, plant and animal habitat. The problem of air pollution is one of the most exciting problems of our time: the open nature of the atmosphere, its close interaction with the lithosphere, hydrosphere and space contribute to the spread of anthropogenic pollution on a global scale. Air pollution issues have crossed the borders of individual states, becoming common to almost all countries of the world.

With the accession of Kazakhstan to the “Convention on Long-Range Transboundary Air Pollution”, the republic had the opportunity to participate in planning measures to reduce emissions of harmful substances, solve problems of air protection at the international level and exchange current information on a number of scientific and technical issues.

The main ecologically most problematic regions of Kazakhstan, both from the point of view of natural and anthropogenic conditions, are the Aral Sea region, the Caspian Sea region and the Ili Balkhash region. The extreme natural conditions characteristic of these arid zones have a negative effect on the human body, increasing the likelihood of disease among the local population. Against this background, significant anthropogenic changes, including SDS, significantly worsen the quality of the environment, which is an additional reason for the decline in the level of health of the population, as well as the basis for classifying these territories as regions of ecological crisis and ecological disaster.

As you know, the deterioration of the ecological situation in the Aral region is caused by a catastrophic decrease in the level of the Aral Sea, which led to the emergence of toxic bottom sediments to the surface. Due to dust and salt storms, agricultural lands and sources of drinking water are polluted over vast areas. The environmental problems of the Caspian region are caused by other reasons - pollution of the components of the natural environment, mainly by the oil and gas industry. Note that dust / salt storms from the Aral Sea region also make a certain contribution

to environmental pollution in the Caspian region (Figure 7).

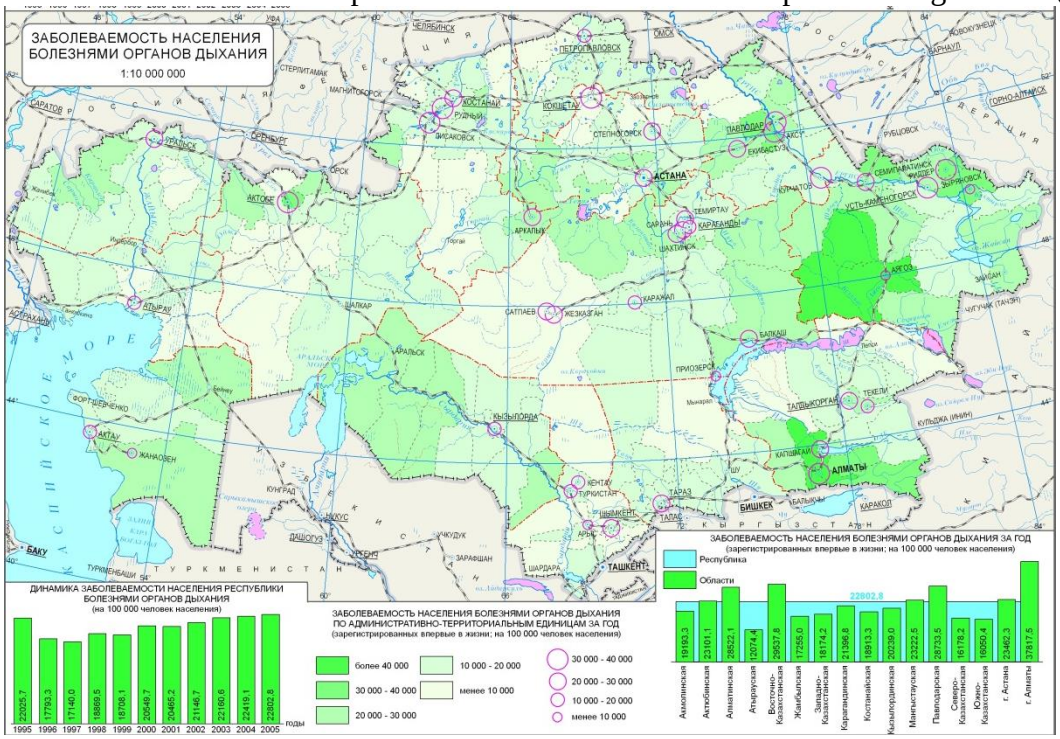

Figure 7 - The incidence of respiratory diseases in the population

The specific problems of the Ili-Balkhash region are related to the management of the Ili river water resources. The filling of the Kapchagai reservoir led in the 1970s to a dramatic drop in the water level in the lake, causing fear of a second disaster after the Aral Sea. In recent decades, Lake Balkhash has regained its former size. The operation of the Kapchagai hydroelectric power station changed the seasonality of the Ili River, increasing the outflow of water in the winter. The withdrawal by China of a significant amount of water in the upper reaches of the river. Or for irrigation has led to a reduction in the water balance of the entire basin. To prevent these problems, the Government of Kazakhstan has reached an agreement with the Chinese side to take measures to prevent such a development of events. The SDS challenges in this region are predominantly of a medium scale, they are similar to the nature of the SDS in other regions and are mainly related to grazing and cutting down of trees and shrubs.

The ecological situation in the Aral and Caspian regions has attracted the attention of researchers for several decades. Based on the analysis of literature data [16], as well as information from the IFAS Agency (International Fund for Saving the Aral Sea), we can talk about a significant increase in the overall incidence of the population of the territories under consideration. There is a high level of congenital anomalies and neoplasms, an increase in the number of diseases of the endocrine, nervous, digestive, genitourinary systems, as well as diseases of the respiratory and circulatory systems. In children from ecologically unfavorable areas, a significant decrease in anthropometric indicators was found. Against the background of a significant increase in the overall incidence of the population of the Aral Sea and the Caspian region, caused by the deterioration of the ecological situation and socio-economic conditions, regional features in the structure of diseases were revealed.

In the Aral Sea region, the first ranking place in the structure of population diseases is occupied by diseases of the digestive system, the second place - by diseases of the respiratory system, the third - by diseases of the circulatory system [17]. In the oil and gas regions of the Caspian region, the first rank in the structure of diseases is occupied by diseases of the respiratory system. Further,

the structure of diseases of the population of the considered regions of the Caspian region has territorial features. In the Atyrau region, diseases of the blood and hematopoietic organs take the second rank, and in the Mangistau region - diseases of the digestive system. The third ranking place in the Atyrau region is occupied by diseases of the digestive system, and in the Mangistau region - diseases of the eye or its appendages [17].

In the scientific literature, when discussing the environmental problems of the considered territories of Kazakhstan, especially the Aral Sea region, much attention is paid to assessing the impact on the health of the population of natural water pollution. This is due to the low quality, and often the shortage, of drinking water in many localities [18]. In particular, based on the example of a number of districts of the Kyzylorda region, it was established that the closer the territory is to the Aral Sea, the worse the quality of drinking water and the higher the morbidity and mortality of the population living there. In areas close to the Aral Sea with increased mineralization of drinking water (Aral, Kazal, Karmakchinsky), in contrast to the Zhanakorgan region (located at a distance of more than 400 km from the Aral Sea, where water mineralization is much lower), a progressive increase in the incidence of diseases of the genitourinary system and oncological diseases has been revealed (primarily of the digestive system). It has been proven that an increase in the mineralization of drinking water leads to a significant increase in the incidence of urolithiasis, cholelithiasis and hypertension, as well as bronchial asthma and ischemic heart disease [18].

As for assessing the impact on the health of the population of the territories under consideration, pollution of another component of the natural environment - atmospheric air, in our opinion, insufficient attention has been paid to this issue. Most often, it is said about the possible negative impact on the health of the population of dust storms, which significantly intensified and became more frequent after the shallowing of the Aral Sea. In this regard, it is indicated that dust storms annually carry up to 75 million tons of dust from the drained bottom of the Aral Sea, including salts, pesticides, herbicides and heavy metals dangerous for humans / 58 /. There are frequent catastrophic situations, when, during dust storms, the dust content in the atmospheric air of cities exceeded the MPC by 10–14 times. However, based on the data of Kazhydromet, we can say that these extreme natural phenomena do not significantly affect the average annual indicators of atmospheric air quality. So, on the territory of the Kyzylorda region in 2011 in five out of seven districts the average daily dust (suspended matter) content did not exceed 2 MPC. In 2014, in five districts, the dust content was less than 1 MPC, in the other two - less than 2 MPC. A more serious situation was observed in the Caspian region. According to Kazhydromet data, in 2011 the average daily dust content in the atmospheric air of the regions under consideration exceeded the MPC value by 3-4 times, and in 2014 - by 4-7 times [18].

Calculations made by Movchan V.N. and Amonulloev O.Kh in 2011 and 2014 [19] show that the risk of developing non-carcinogenic effects from inhalation of pollutants into the human body, judging by the values of the hazard index, in the Caspian Sea region is 2–3 times higher than in the Aral Sea region. This fact indicates that air pollution in the Caspian region can lead to more significant negative changes in public health than in the Aral region. In the settlements of Zhanbai, Zaburunye, Dossor and Makat (Atyrau region of the Caspian Sea region), the hazard index in 2011 was 11.7, respectively are 12.2, 13.5 and 11.7; which is significantly higher than the permissible (less than one) level. In 2014, its values became even higher and amounted to 20.9, respectively; 15.4; 16.7; 19.3. In the settlements of Dunga and Zhetybai (Mangistau region of the Caspian Sea region), the hazard index in 2011 was close to the hazard index for settlements in the Atyrau region and amounted to 13.2 and 13.6, respectively. In 2014, its values did not change significantly (13.0 and 12.6, respectively) and were significantly less than the hazard indices for this year in other settlements of the Atyrau region.

Hazard indices in the Aral Sea region in most cases did not differ significantly both for the estimated years and for the studied areas. Districts of the Kyzylorda region, different in distance from the Aral Sea, were analyzed. In the most unfavorable regions in terms of the general morbidity of the population - the Aral and Kazalinsky, the hazard index of the development of non-carcinogenic effects in 2011 was 7.4 and 7.3, respectively. In 2014, its values slightly decreased to 6.8 and 6.7, respectively. In the most distant from the Aral region - Zhanakorgan (which from the ecological point of view was considered as relatively safe), the hazard index turned out to be higher than in the disadvantaged Aral and Kazaly regions (7.7 - in 2011 and 8.1 - in 2014 [19]).

The calculation of the hazard index for the "mortality" indicator confirmed the above statement that air pollution in the Caspian region can lead to more significant negative changes in public health than in the Aral Sea region. So, for example, the values of this index for the Atyrau region are in the range of 6.9-15.0, and for the Mangistau region - in the range of 7.3-9.3. It is noted that even in the ecologically most problematic areas of the Aral Sea region (Aral and Kazaly regions), the values of this index are significantly lower than in the Caspian region and varies within 4.1–4.4 [19].

Based on the results of the studies carried out, one can come to the conclusion that in different types of anthropogenic impacts on the natural environment in the regions of Kazakhstan, the ecological situation differs significantly both in the structure of the population's morbidity and in the degree of risk to its health. The most dangerous situation for the health of the population is developing in the Caspian region - in areas where the oil and gas industry of the national economy is actively developing. Here, in the structure of morbidity among the population, respiratory diseases occupy the first place, and the risk of developing non-carcinogenic health effects associated with atmospheric air pollution is 2–3 times higher than in the Aral Sea region. In the Caspian region, the risks of death caused by atmospheric air pollution are 2 times higher than in the Aral Sea region. In the considered areas of the Aral Sea region, where environmental pollution is associated with dust and salt storms from the territory of the drying Aral Sea, diseases of the digestive system occupy the first place in terms of population appeal. Respiratory diseases are in second place, although the risk indicators for the development of non-carcinogenic effects on public health and the risks of death from air pollution are much higher than the permissible level. The positive influence of the remoteness of the territory from the Aral Sea on the considered indicator of risk to public health was not found either. Assessment and forecast of negative changes in public health give reason to believe that in the considered regions of Kazakhstan, the priority tasks for solving environmental problems should include the implementation of measures to improve the quality of atmospheric air in the regions of the Caspian oil and gas industry [19].

Another challenge that the regions of Kazakhstan face individually is achieving the required level of health and access to health care. Access to health services in a developed country must be universal and balanced. However, in some southern regions of the country, in particular in Mangistau, South Kazakhstan and Almaty regions, access to hospital beds is more limited than in the rest of the country. In all regions, with the exception of large cities, there is a shortage of doctors: the density of therapists is at least two times lower than in the cities of Astana or Almaty.

Significant differences in health services are also reflected in "output" indicators such as infant mortality under 5 years of age per 1000 live births. Despite significant progress in a short period

from 2010 to 2014, the differences between the most lagging and most advanced regions are still almost 2 times: 16.45 in Kyzylorda oblast compared to 8.08 in Nur-Sultan.

To ensure better access to health care, regions need to provide an adequate level of infrastructure and incentives for doctors to work in more remote areas. In Mangistau oblast, the option of investing part of the income from export of goods in ensuring access to healthcare could be considered. Awareness campaigns and financial incentives need to be organized and carried out to attract more doctors to the most remote areas. Moreover, it makes sense for the government to consider providing loans to poorer regions such as South Kazakhstan and Almaty region to help increase investment in health infrastructure.

The National Action Plan for Mitigating the Consequences of SDS includes the following measures to preserve public health:

- Involvement of experts, including healthcare workers, to develop a method for assessing the impact of SDS on the health of the population living in ecologically unfavorable regions of the Republic.
- Monitoring the impact of SDS on various groups of the population by gender and age.
- Development of measures to reduce the impact of SDS on public health.

Vulnerable population groups in Kazakhstan

One of the main principles of the 2030 Agenda for Sustainable Development is the inclusiveness of all groups of people and their equal consideration. At the same time, issues of vulnerable groups of the population, in general, are poorly considered in assessments of climate change. According to the 2019 UN Human Development Report, apart from women, the most vulnerable populations in Central Asia are young workers, migrants, the long-term unemployed, the disabled, historically marginalized communities and residents of rural and geographically isolated areas (UN, 2019) [20].

Among the countries of Central Asia, Kazakhstan has moved forward on gender equality issues. The country was the first in the region to adopt the Gender Equality Strategy (2006-2016), and in 2017 continued to work on its updating, which demonstrates the commitment of the country's leadership to further advance this issue.

For a more detailed consideration and assessment of gender (inequality) in practice, three main indices are widely used: the Gender Inequality Index (GII), the Gender Development Index (GDI), and the Social Institutions and Gender Index (SIGI). Among the countries in the region, Kazakhstan, with a GI of 0.20, has the lowest level of gender inequality and ranks 42nd among the countries of the world (UNESCAP, 2019). [21] Nevertheless, there are still many challenges to be solved to fulfill the main obligations of the Beijing platform and the latest 2030 Agenda for Sustainable Development.

According to the forecasts of the World Bank, it is irrigated agriculture that will suffer the most from climate change. Floods and mudflows resulting from heavy rainfall threaten field damage and washout and reduce productivity. However, it is droughts that are considered one of the most serious destructive events that directly affect the development of agriculture [22]. In this regard,

the rural population of southern Kazakhstan is also vulnerable to the risks of natural disasters, since irrigated agriculture is actively developing in the region. In 2019, the share of agriculture in Kazakhstan's GDP was only 4.4% (“Atameken”, 2020) [23], and the government is taking measures to increase this indicator - a program “Agribusiness 2020” has been developed, as well as a program for the development of the agro-industrial complex (AIC) for 2017-2021. Despite the efforts of state bodies in this area, the programs do not contain adaptation measures to climate change, and also do not provide for measures to manage the risks of natural disasters arising as a result.

Rural poverty is usually associated with a lack of jobs and low wages. Social and technical infrastructure in rural areas suffers from a lack of funds for maintenance and services, as it used to be the responsibility of large state-owned agricultural enterprises. This infrastructure is often abandoned today. Under these circumstances, villagers rely more on the use of natural resources. A private family plot of land or a small herd of livestock is often the only and significant source of income. Unable to buy coal, gas and electricity, the rural population survives on wood fuel. Taken together, the commercial use of resources by the urban and rural population, as well as their use for the purpose of survival, has led to a sharp deterioration in the state of these resources, which are especially important for the rural population. The rural poor use poorly arable, depleted and poorly irrigated land and lack the ability to invest in agrochemicals and irrigation and drainage activities. A significant part of the rural population is also unable to maintain a large number of livestock in order to use distant pasture grazing. They use pastures around villages, which are degraded as a result of significant overgrazing. The highest poverty level was registered in Mangistau, Atyrau, Kyzylorda, Zhambyl and Almaty (except for the city of Almaty) regions, which have vast territories that are considered to be affected by desertification. In many villages, people use unsafe open sources of drinking water or bring water from elsewhere. In areas where there are problems with land degradation, as a rule, the population's standard of living is low,

which cannot be overcome without external support.

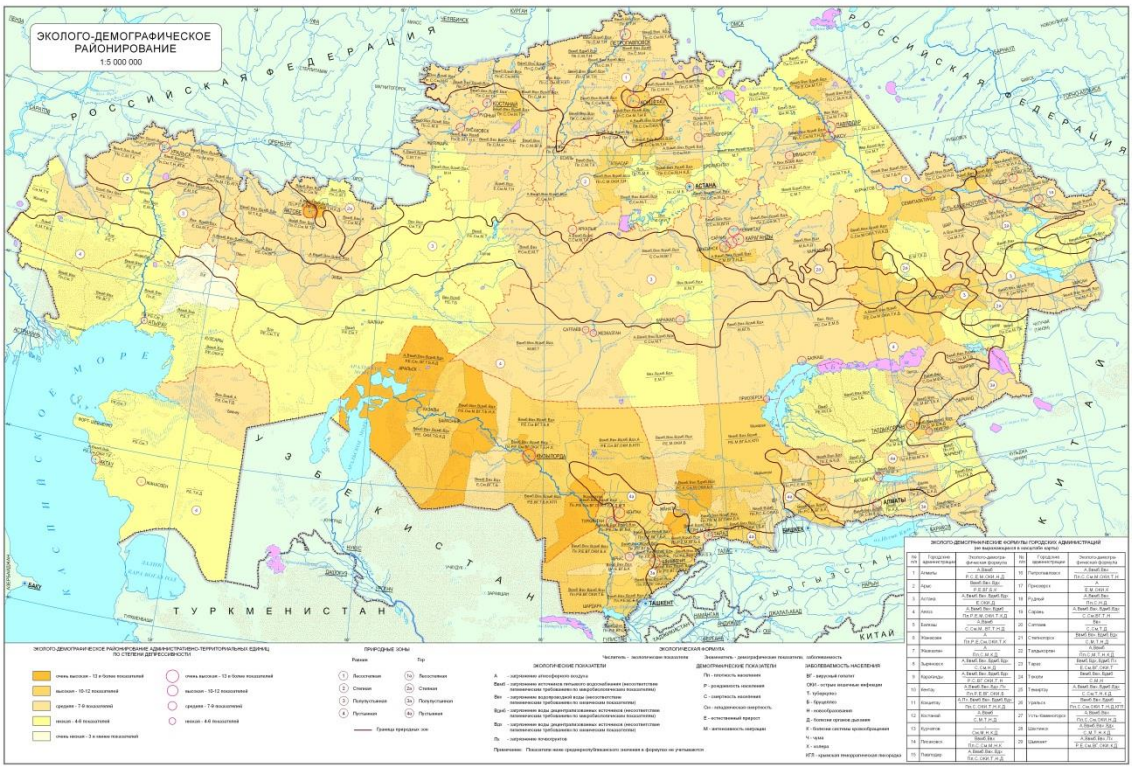

Figure 8- Ecological and demographic zoning

It should be noted that the regions of Kazakhstan with the highest level of inequality - Akmola, Karaganda and East Kazakhstan are simultaneously the regions where GDP per capita is growing at the highest rates. A fast-growing economy tends to lead to the greatest inequality in the short term, and this can be corrected by targeted policies. Since Akmola, Karaganda and East Kazakhstan are not only high in inequality, but also among the poorest regions in the country, poverty eradication measures such as income supplements for the neediest families can help them. These income bonuses can be partly funded from the republican budget until they can support themselves through rapid growth. Further analysis is needed to identify the sources of growth for these regions and to find out why economic growth is not reflected in the broader population. The lowest level of inequality in Kazakhstan is observed in Mangistau, Kyzylorda, South Kazakhstan and Pavlodar regions. The lessons learned from policy interventions in these regions can be applied to other regions with higher levels of inequality.

Another way to measure inequality is to look at the proportion of the population living below the subsistence level. In 2014, in South Kazakhstan oblast, there was 15 times more population living below the subsistence level than in the city of Astana (0.4%). In relation to South Kazakhstan, the difference was 10 times. These different ways of measuring inequality in Kazakhstan highlight significant differences between regions that could be addressed by targeted policy measures such as income premiums or more progressive tax policies. Regions with higher poverty levels, such as South Kazakhstan and North Kazakhstan, will benefit greatly from republican-level financial support.

The challenge after inequality is the significant difference between regions in the amount of investment in innovation and infrastructure. The cities of republican significance Astana and Almaty stand apart not only in terms of per capita income, but also in terms of investment in innovation, measured as investment in RDW as a% of GRP, and the number of people employed in RDW in relation to the total population.

The contrast between Almaty at one end of the scale and West Kazakhstan, Pavlodar, Kyzylorda, Almaty, Atyrau and Kostanay regions at the other end is striking. This group of regions should consider new ways of additional investment in RDW in order to close their almost 20-fold gap with Almaty. Mangystau oblast also spends quite a lot on RDW as a% of GRP, which is especially important for a region dependent on resources, but it is not entirely clear whether these costs bring results: although exports make up 75% of GRP, only 5% of exports are non-primary goods ... Moreover, Mangistau oblast in Kazakhstan is in the quadrant with the lowest level of innovation, measured as a% of total GRP. Mangystau Oblast needs to redirect RDW spending so that research turns into innovation. Most regions with a very low percentage of non-commodity exports depend on oil and gas production, which accounts for 50% of the country's total production. The oil-producing regions - Atyrau, Mangistau, West Kazakhstan, Aktobe and Kyzylorda regions - accounted for 73% of Kazakhstan's exports in 2018, and non-producing regions, for example, Pavlodar, Akmola, Almaty, North Kazakhstan region and Zhambyl regions, only 3%. Regions of Kazakhstan that account for less than 10% of non-commodity exports in total exports (non-oil regions of Kyzylorda, Atyrau, West Kazakhstan and Mangistau oblasts) need to find ways to move up the value chain and move from raw material extraction to processing and industrial production [24].

External migration for Kazakhstan is not as acute a problem as for other countries of Central Asia. Starting from the 2000s, Kazakhstan began to accept labor migrants (Sadovskaya, 2014) [25], but at the same time the emigration flow from Kazakhstan also persists, albeit to a small extent, in comparison with other countries of the region. Basically, there is internal migration in Kazakhstan - from village to city. This is also associated with problems in the development of agriculture and, as a result, unemployment in the countryside: land degradation, lack of access to limited water resources, increased risk of natural disasters, limited access to the implementation of water-saving and adaptation technologies.

Despite the existing problems, Kazakhstan significantly improved its human development rating - in the period from 1990 to 2015, this indicator improved by 15%. This once again confirms the country's efforts aimed at reducing poverty and improving the socio-economic well-being of the population (ADB, 2018) [26]. However, Kazakhstan should continue to improve these indicators, including through the use of an inclusive approach to the development of important strategic development programs, the introduction of new technologies in agriculture, ensuring the social well-being of the rural population with a special focus on vulnerable groups. This can be achieved through the involvement of a wide range of stakeholders (including vulnerable groups) in planning processes, in capacity building and awareness programs, and also in decision-making processes. A set of measures involving vulnerable groups of the population in the planning process will mitigate their vulnerability, increase their adaptability to doing business in the face of climate change and natural disaster risks, and will also contribute to sustainable development of territories. The main action plan in combating SDS should provide for an inclusive approach to the development of important strategic development programs, the introduction of new technologies in agriculture, and ensuring the social well-being of the rural population with a special focus on vulnerable groups of the population. This can be achieved through the involvement of a wide range of stakeholders (including vulnerable groups) in planning processes, in capacity-building and awareness-raising programs, and involving them in decision-making processes. A set of measures involving vulnerable groups of the population in the planning process will mitigate their vulnerability, increase their adaptability to doing business in the face of climate change and natural disaster risks, and will also contribute to the sustainable development of territories.

2.2 Methods for recognizing SDS in Kazakhstan

In Kazakhstan, there are vast territories that are the source of dust and sand storms. Natural factors play a role in the formation of dust and sand storms. Such natural factors as climate aridity, frequent strong winds, scarcity of vegetation, insufficient soil moisture, low relative air humidity, frequent repetitions of soil and atmospheric drought, soils with a light texture contribute to the active development of deflationary processes (in the form of dust storms) in Kazakhstan [3]. Desertification caused by deflation in Kazakhstan covers dry steppe, semi-desert and desert landscapes (including 205 km2 of arable land) [4]. In addition to natural factors, anthropogenic factors play a significant role in the occurrence of dust storms. Since the intensive development of irrigation in the Aral Sea basin in the early 1960s and the irrational use of water resources, significant areas of secondary saline soils and anthropogenic salt marshes have appeared. These areas are a source of salt transport, and these salts have a negative impact on the environment and living conditions of the local population.

Kazhydromet is engaged in climatic services for the economic sectors. Kazhydromet conducts round-the-clock monitoring, i.e. observes, analyzes, predicts and warns about the behavior of nature in various environments, namely in air, water, soil. Kazhydromet is the only legally responsible body that has the right to official information service of any organization with storm warnings about impending dangerous and natural phenomena on the territory of our state. Thus, together with the WMO member countries, Kazakhstan takes an active part in the fight against the natural threats that threaten humanity in the 21st century.

At present, despite the efforts being made to expand the State Observation Network, in terms of the coverage of the territory, the State Observation Network does not meet the requirements for the representativeness of stations.

The development of methods of recognition and space monitoring of dust storms in Kazakhstan has been engaged since the late 90s. The basic data of remote sensing are NOAA AVHRR and MODIS satellite images, which allow regular monitoring of territories affected by SDS. On their basis, dust storms are interpreted and their main characteristics are assessed: the direction of removal and the length of the dust plume, the area of the storm propagation, the number and area of the removal sources, etc. Previously, the main method was to analyze the difference between two images of the same territory: with a dust storm and without her. This method also takes place - to be. Currently, a special normalized differential dust index (NDDI) is used as one of the main indices used in automatic classification, which was introduced by Chinese scientists in the study of dust storms in North China and Mongolia according to MODIS data [28]:

$$\mathbf{NDDI = (\rho 2.13\ \mu m - \rho 0.469\ \mu m)/ (\rho 2.13\ \mu m + \rho 0.469\ \mu m),}$$

where ρ 2.13 μm and ρ 0.469 μm are reflectivities in 2.13 μm and 0.469 μm channels, respectively. To interpret dust storms, a two-stage classification was carried out: first, using the NDDI index, sand masses (air and ground) were separated from water bodies and clouds, and then dust storms were distinguished by temperature characteristics. As a result of such automatic classification, we obtain a vector characterizing the storm propagation zone. This vector can be superimposed on special thematic GIS cartographic layers, in particular on soil maps.

Isanova et al. 2015 analyzed the seasonal frequency of dust storms in different regions of Kazakhstan based on the average number of days with dust storms in different months for the period 1966-2003. The long-term variability of the dust storm frequencies was analyzed using the data from 1971-2010. To identify potential sources of dust storms in Kazakhstan, all information on soil texture on a dust storm frequency map was examined. The work used numerous cartographic materials (Lobova, 1946; Semenov and Tulina, 1978; Rachkovskaya et al., 2003; Dedova et al. 2006), data from meteorological stations and satellite monitoring data to detect foci of strong dust / sand / salt storms and their causes ... Space monitoring data in Kazakhstan were analyzed using the NOAA, TERRA and AQUA satellites in order to visually identify powerful dust storms. Arc Map software was used as the main tool for analyzing the regional distribution of

dust storm events, as well as for preparing a dust storm frequency map. Using this, the sources of dust / sand / salt storms are identified on the map, their area is estimated and the relationship between the origin of dust storms and the structure of soil with plant communities is determined. Figure 9.

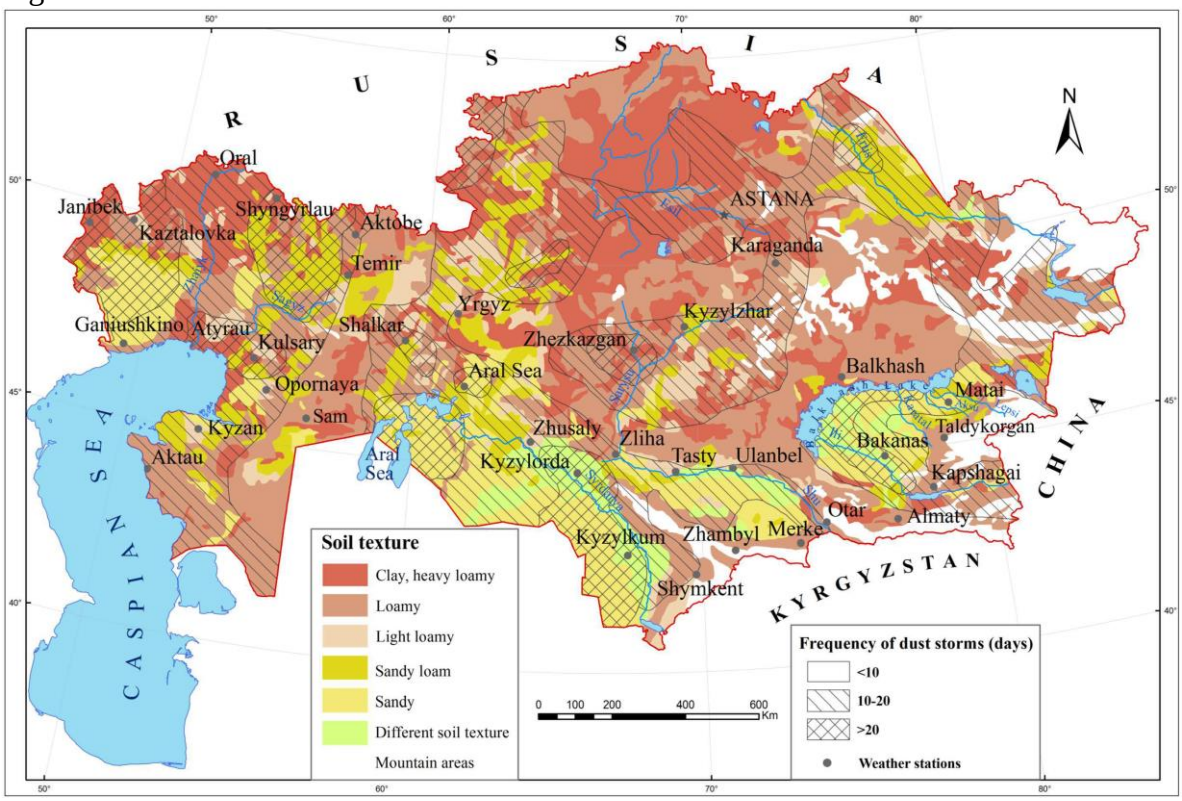

Figure 9. Geographic distribution of soil texture and frequency of dust storms in Kazakhstan

The distribution and frequency of dust storms in Kazakhstan are heterogeneous and patchy and characterized by great diversity. According to the observations of the meteorological station, the regime of high wind speeds and dust storms are characteristic of the continental climate of almost all of Kazakhstan.

In Kazakhstan, a lot of work is underway to map areas of degradation and desertification using space monitoring data and ground survey. So, on the basis of surveys, it can be noted that practically around every village there is a territory with a highly degraded degree. Which ranges

from 1 to 5 km., Depending on the intensity of cattle grazing Figure 10.

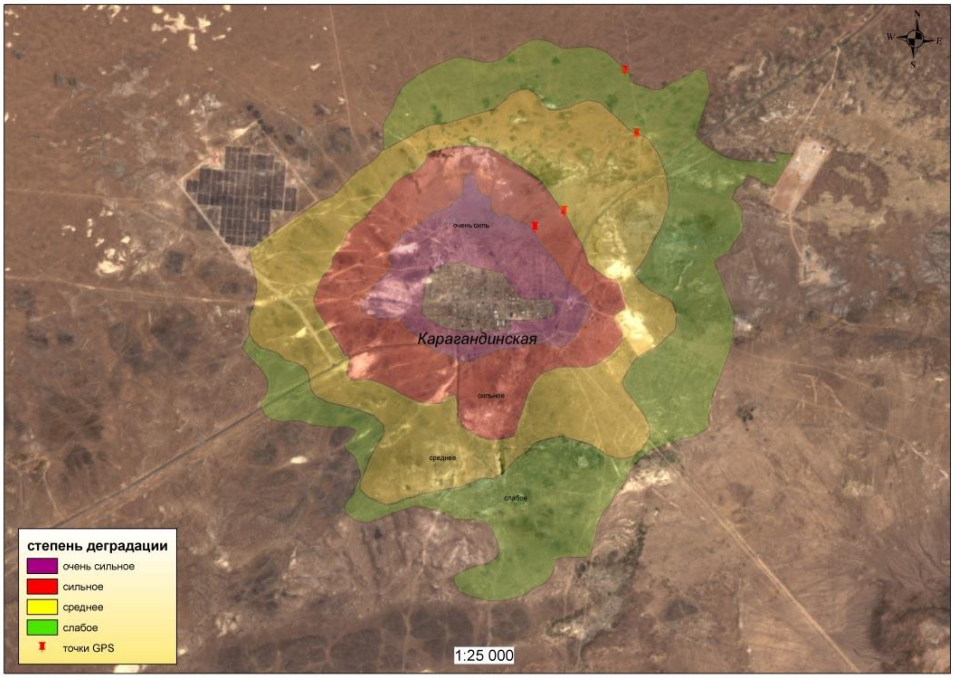

Figure 10. Circuit diagram of the contour of the village of Gulshat, Karaganda region: with very strong degradation - failure; with severe degradation; at medium degradation and at low degradation

On the basis of these data, maps of degradation and desertification of the territory of Kazakhstan were built, which, in turn, can be used to analyze potential sites for the occurrence of SDS.
Evaluating the global overview map on sand and dust storms prepared by Anna Vukovich, Figure 11 with the maps of degradation and desertification developed in Kazakhstan, Figure 12-13, it can be noted that the main parameters of the hot spots of the occurrence of SSDS coincide.

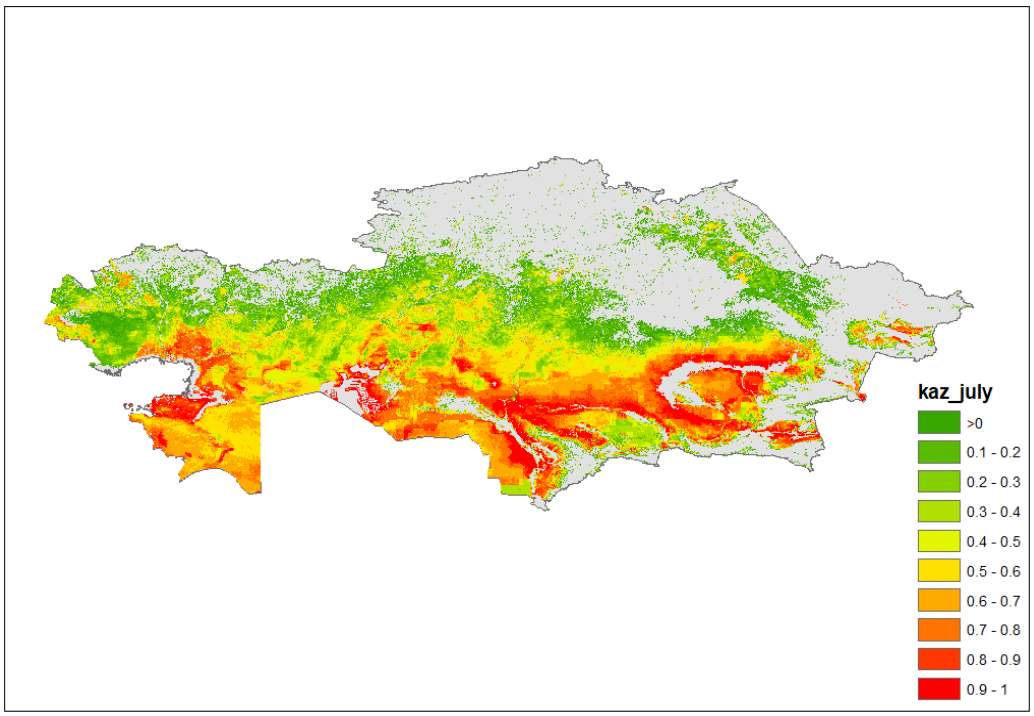

Figure 11. Global overview map of sand and dust storms prepared by Anna Vukovic, July 2018

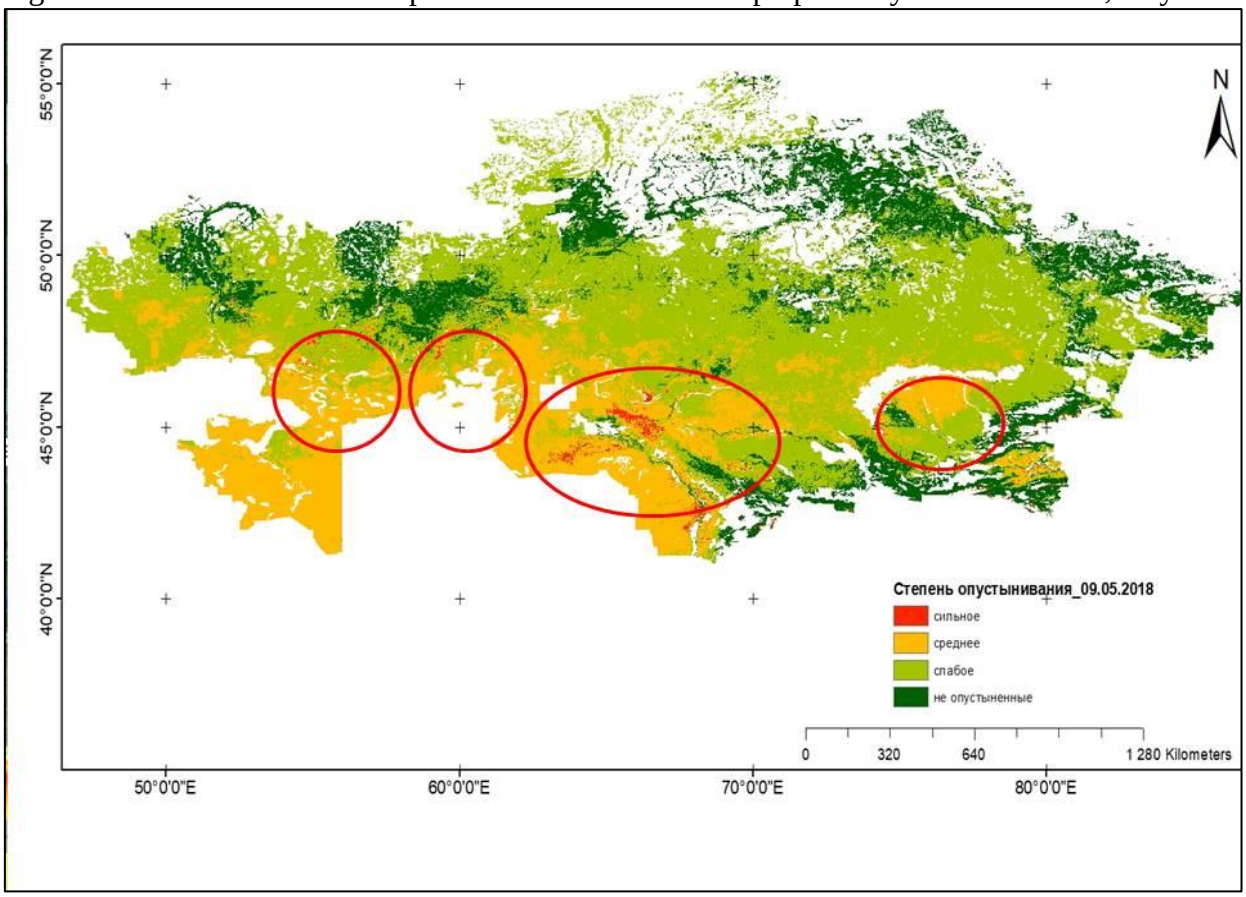

Figure 12. Extent of desertification in May 2018

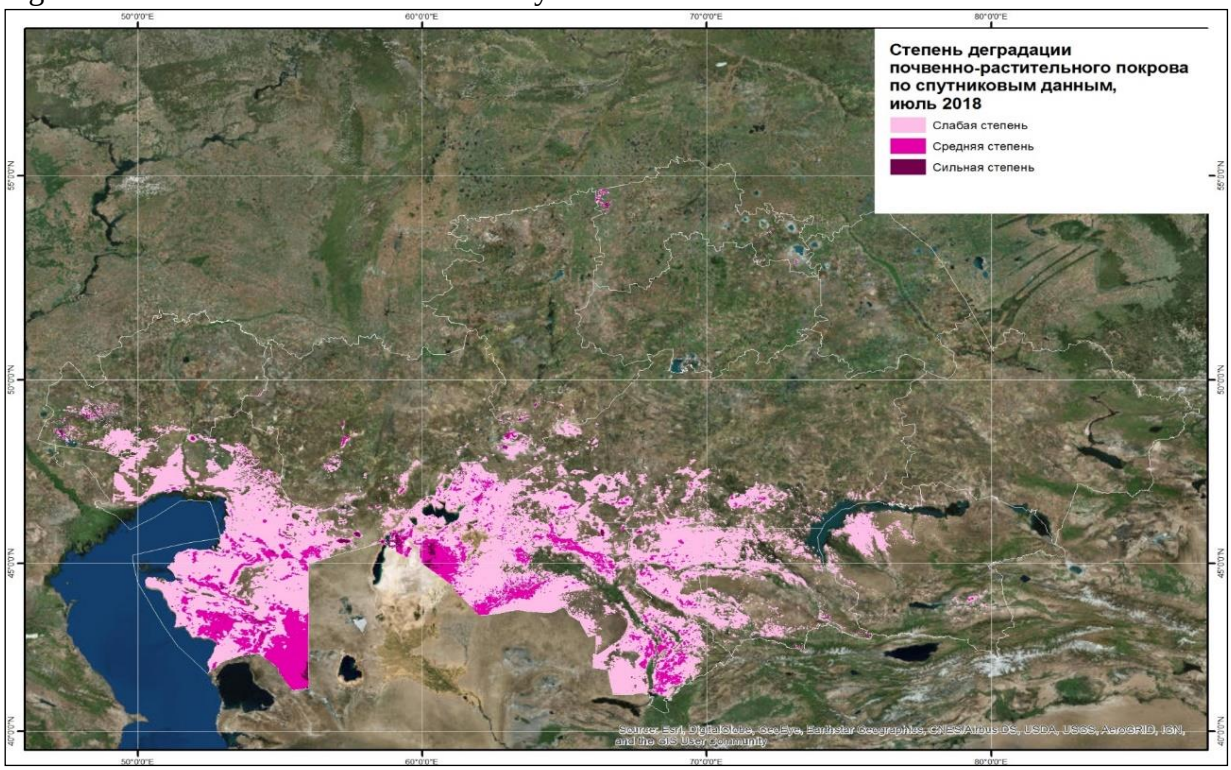

Figure 13. Degradation rate July 2018

Comparing the values obtained on the global map with the values obtained using the NDDI dust index on the SDS vulnerability map for 2020 (Figure 14), we get quite strong differences. On the global map, all dust storms are concentrated mainly in the desert zone, although, according to our

estimates, the possibility of SDS occurrence in the steppe and even in the forest-steppe zones of Kazakhstan is quite probable.

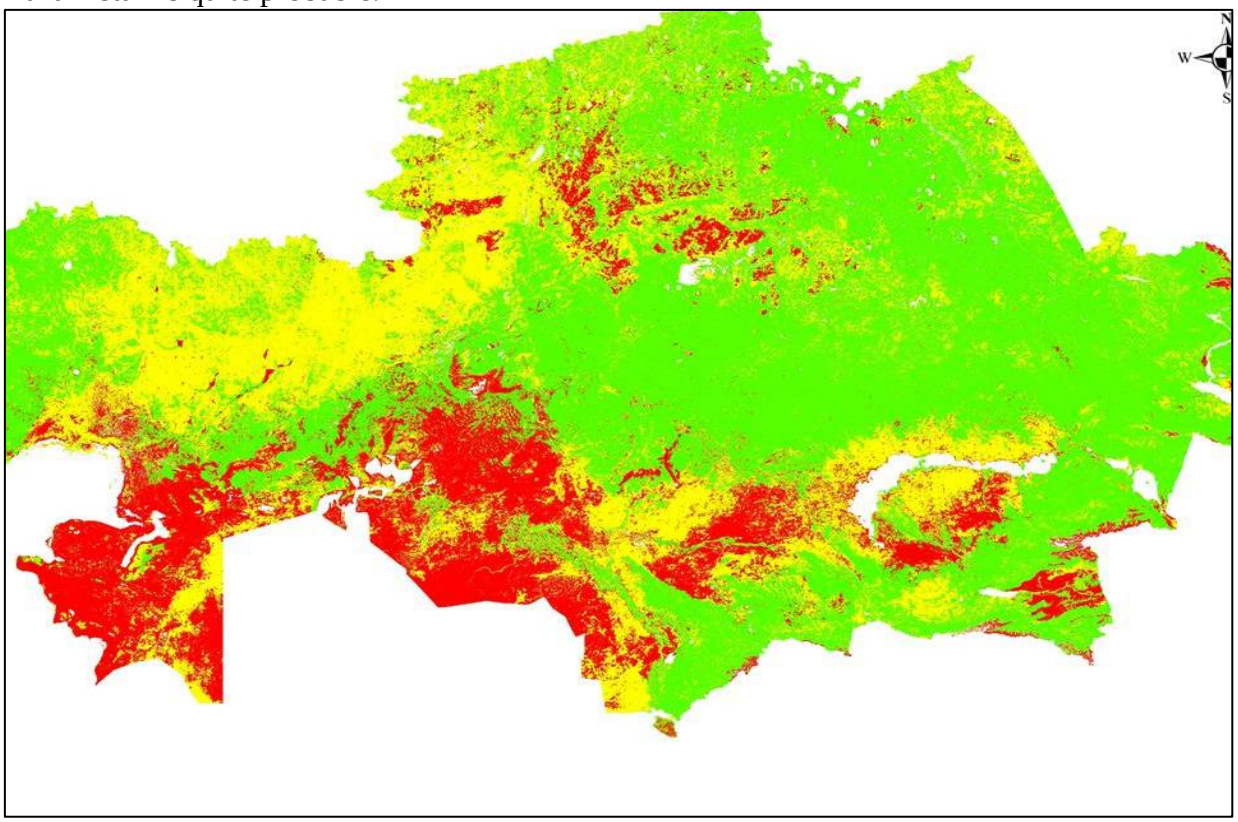

Figure 12 SDS vulnerability map for 2020

In Kazakhstan, there are also other methods of SDS recognition.

A method for a comprehensive assessment of the mass carry-over of aleurite particles from the drained part of the bottom of the Great Aral Sea using information from space has been developed. The lack of observations of meteorological stations on dry bottom surfaces was made up for by calculating the fields of pressure, wind speed and dynamic speed using the mesoscale hydrodynamic model WRF. The size distribution of aleurite particles is a priori given by a logarithmically normal function with an average geometric size: = 50 μm, = 0.23 - for one version of calculations and = 35 μm, = 0.27 - for the second. For a strong storm on May 7, 2007, the vertical profiles of solid discharge in the surface layer of the atmosphere up to a height of 170 m, the total mass discharge in this layer and in the boundary layer of the atmosphere were calculated. The aerosol mass carried over the storm reaches 8 and 16.4 million tons for the corresponding particle sizes [28].

Geometric dimensions of the dust cloud for the most intense sandstorms in the West of Kazakhstan were determined using satellite images. For example, on October 10, 2004, the blowout area was 18,800 km2, and the runway length reached 370 km. As a result of the expected climate warming, it can be expected that deflationary processes in Kazakhstan will increase not only in the mass of the transported solid material, but also in the area of distribution, which will significantly complicate the geoecological problems of the region [29].

According to the previously published methodology for complex calculations of the mass transfer of particles during dust storms using information from a satellite and calculating the pressure, wind speed and dynamic velocity fields using the mesoscale hydrodynamic model WRF, we estimated the removal of the mass of aleurite and salt particles from the dried part of the bottom of the Big Aral for a strong storm April 28 ... 29, 2008 The size distribution of aleurite particles is a priori given by a logarithmically normal function with an average geometric size: = 50 μm, = 0.23 - for one version of calculations and = 35 μm, = 0.27 - for the second. The vertical profiles of the solid

mass flow rate of the particles are calculated at different wind speeds. The aerosol mass carried over the storm reaches 2.6 and 5.4 million tons for the corresponding particle sizes [29].

A GIS technology for monitoring and modeling dust storms has been developed, which makes it possible to perform a comprehensive analysis and evaluate the scale of the aerosol removal process. A test run of the model was carried out based on the calculations of dust storm episodes in the area of the test site south of Zhezkazgan [30].

The dispersed composition of sand particles in the Aktobe region is considered. Movable and semi-fixed sands meet here with two types of size distribution functions - normal (Gaussian) and logarithmically normal. The average size of sand particles with a normal distribution function varies in the range of 175 ... 290 μm, the average geometric size of sands with a logarithmically normal function varies from 156 to 317 μm [30].

Knowledge of the sources of SDS is required to assess the risks and impacts of SDS, plan mitigation measures for SDS, predict SDS, and establish early warning systems for SSDS. Mapping the spatial and temporal distribution of SDS sources requires understanding the causes, formation and activation of SDS sources. For this, a GIS center (or a similar structure) should be created, in which the SDS monitoring will be carried out, modeling of the early occurrence of SDS. It is assumed that this structure will accumulate knowledge on the SDS and notify the population to submit it to the appropriate authorities to respond to the threat of the SDS (for example, the Ministry of Emergency Situations). The structure will have to conduct not only space monitoring, but also collect ground-based monitoring data (Kazhydromet). The organization of this structure is one of the stages of the NAP to combat SDS.

3. NATIONAL POTENTIAL TO REDUCE THE IMPACT OF SDS

3.1. Preparation of a list of developed national policies and strategies to combat SDS

In the Republic of Kazakhstan, there are no separate national policies and strategies to combat SDS, they are included as components of national policies and strategies to combat desertification, in the field of environmental protection, use and sustainable management of natural and land resources, in programs and projects to implement other international obligations.

Fighting SDS, SLM is usually recognized as an important environmental problem, but rarely - as a priority economic or political problem, therefore, more intensive lobbying of problems at the appropriate political level is necessary.

The success of combating SDS depends on the participation of all stakeholders in this process: the state, big business, science, the public, rural producers and the population, as well as the support of international institutions. It is based on the organization of sustainable land use and the reduction of land degradation.

Within the framework of the GEF-UNDP project “Providing support in updating the National Action Plan, as well as in the process of reporting and reviewing the effectiveness of activities under the implementation of the UN Convention to Combat Desertification in Kazakhstan”, Strategic measures to combat desertification in the Republic of Kazakhstan until 2025 have been developed [24].

Strategy area (1) on capacity building is divided into 2 subsectors: (a) enhancing supportive environments and (b) integration into land planning and management. The first covers all issues of integration and improvement of policies, as well as measures aimed at national legislative and institutional frameworks, and the second includes measures to strengthen institutional and labor capacities in planning and implementing SLM, developing a monitoring and information system, and measures to improve the planning system. land use.

Strategy area (2) Sustainable agriculture will contain pilot projects and large-scale investments to improve management practices of (a) rainfed and (b) irrigated land.

Strategy area (3) Sustainable pasture management includes ongoing activities of the GEF and developed projects, mainly related to the support of distant pasture grazing and management of wild artiodactyls.

Strategy area (4) Sustainable forest management includes, as a main component, a forest conservation and restoration project that includes the creation of a favorable environment, activities and major investments in identified priority regions. CACILM will additionally implement forest-type and management projects not covered by this project.

Strategy area (5) Targeted research will include specific applied research projects or research components of large projects.

Strategy area (6) Integrated resource management aims at SLM activities in selected areas by integrating different sectors, including integrated water resources management projects in relation to basins and catchments. At the moment, in Kazakhstan, none of the projects has been assigned to this area, but aspects of it are part of the projects falling within this area.

Strategy area (7) Protected area management includes projects directly related to SLM issues. It is preliminarily planned to implement within this framework the issues of land reservation to complete the formation of a system of protected areas and the creation of integrated protected areas that combine protection and sustainable use.

Strategy area (8) Mitigation of the negative effects of the Aral Sea crisis will focus on the design and implementation of mitigation measures with measurable environmental and socio-economic benefits. The program overlaps with strategy areas (4), (5) and (7).

Strategy area (9) Rehabilitation of territories aims to include projects to rehabilitate disaster areas. Not a single project has yet been classified in this area.

Strategy Area (10) Coordination and Management The National Strategy includes all necessary activities for the coordination and management of CACILM at the national level.

The Concept for the Republic of Kazakhstan's Transition to a Green Economy 10 views desertification as a major concern and envisages adhering to the principles of green agriculture, which will ensure the development of the sector and at the same time preserve and improve the environment. Among them: a) prevention of land degradation and restoration of degraded land; b) prevention of further overgrazing; c) efficient use of water; d) rational use of resources; e) minimization and reuse of waste; f) capture of carbon dioxide.

The Ministry of Agriculture is implementing the state policy of phased restructuring of the agricultural sector. The program of the Government of the Republic of Kazakhstan “Agro-business-2020” includes the definition of development prospects for each village, on the basis of which investments will be distributed. Strategic measures to combat desertification can have a positive impact on sustainable land management practices as people are motivated and supported to move out of so-called ecological disaster zones and to move away from unsustainable land use practices (such as farming in unproductive areas).

The Government of Kazakhstan has introduced a number of mechanisms to support rural producers by providing agricultural machinery on a lease basis; subsidizing the cost (up to 40%) of mineral fertilizers, seed preservatives and herbicides, subsidizing the cost of water delivery services to agricultural producers. However, this government support has reached only a small fraction of agricultural producers. On the other hand, subsidies run the risk of supporting unsustainable land and water use, as well as discouraging the adoption of new, more sustainable and adapted practices.

Land degradation issues are viewed more as environmental problems and therefore are minimally included in rural development policies and joint intersectoral programs at various levels. Insufficient implementation, as well as lack of supportive mechanisms at the lower local level, bureaucratic procedures, limited access of most farmers to credit resources (lack of collateral,

credit history and high lending rates), remoteness from markets, are significant barriers to the implementation of acceptable policies. limited opportunities to apply scientific advances, professional development and consultation, and lack of effective incentives for SLM. The land taxation system is based on land category and soil quality, but does not take into account the market value of land and does not provide incentives for SLM.

Kazakhstan has a well-developed system of laws related to SLM, however, most of the laws are not acts of direct action and for their implementation it is necessary to develop many by-laws at various levels. There are certain gaps, duplications and contradictions in the legislation, the elimination of which is being carried out systematically. We should also note the shortcomings in the enforcement of these laws. The legislation on forest and land resources has not developed a legal basis for joint resource management. Frequent changes in legal regulation create some legal uncertainty that hinders sustainable land management.
During the period of formation of a market economy in Kazakhstan, the functions of state bodies have changed. Having abandoned direct diktat to agricultural producers, they are engaged in providing them with economic support, regulating the process of land allocation and controlling their sustainable use.
The main institutional barriers at the republican level are: a) uncertainty of responsibility and authority for SLM, insufficient coordination of actions; b) the absence of a specialized working body for SLM that collects and analyzes current information, prepares the necessary management decisions; c) lack of experienced and qualified personnel.

At the local level, a serious obstacle for SLM is difficult access to appropriate knowledge and technologies, and credit resources. The Farmers' Association of Kazakhstan, the Farmer of Kazakhstan Fund, as well as the regional agricultural authorities provide some advice to agricultural producers. Larger agricultural enterprises attract private consulting companies, which are financially unaffordable for most small farmers. Microfinance organizations in Kazakhstan can provide credit resources in accordance with the credit products they promote. A number of microfinance organizations offer loans for rural producers, which can be group and individual, collateralized and unsecured. They are distinguished from banking institutions by the simplicity of registration and the absence of the need to provide the borrower's credit history. At the same time, few villagers are ready to take out such loans, since not everyone can provide group guarantees for the return of such a loan or are afraid to issue personal property on the security of the loan being issued.

3.2 Regional Strategies Relevant to SDS Management

With the support of the World Bank / GEF ($ 9.5 million) and the Government of the Republic of Kazakhstan ($ 40 thousand), the project “Drylands Management” was implemented: “Rehabilitation of fallow lands in the Shetsky district of the Karaganda region.” Works were carried out under the projects “Combating desertification and rehabilitation of saline lands in the Aral Sea region” and “Balanced land use in the Ili-Balkhash basin” (GTZ-CCD / BMBF). Within the framework of two grants for the restoration of degraded lands (GEF), methodological developments were carried out on the standards for the withdrawal of land resources, pastures, plant raw materials, on the criteria and methods for assessing the transformation of ecosystems, space monitoring at two test sites in the south of the country. Ecological zoning and assessment of desertification in a number of regions of the country (Caspian, Aral, etc.) The UNDP / UNSO project “Management of pasture ecosystems” has been implemented in the Aral district of the Kyzylorda region. The State Program “Drinking Waters” was developed and adopted, in which great attention is paid to the issues of water supply to the population of the country, as well as to watering of pastures. The Program for the Development and Provision of Humanitarian Aid to the Aral Sea Region (KAZ / 98/008), co-financed by key UNDP funds, the Kapasiti-21 Trust Fund,

UNSO and the International Fund for Saving the Aral Sea (IFAS), consolidated the previously launched activities. In addition to working on environmental issues in the areas of irrigation, land reclamation, desertification, forestry and fisheries management, the Kyzylorda Oblast Water Supply, Sanitation and Healthcare Program ($ 16.4 million) also aims to address the problems of quality drinking water, employment of the population, health problems, improvement of sanitation and living conditions. The project is integrated into the overall Regional Program for Central Asia. The project "Regulation of the Syrdarya river bed and preservation of the northern part of the Aral Sea" between the Republic of Kazakhstan and the IBRD has been implemented. The project began in 2001 and will continue until 2007 (the loan amount is $ 64.5 million and the contribution of the Government of the Republic of Kazakhstan is $ 21.3 million).

International cooperation is of great importance in the fight against SDS. Law of the Republic of Kazakhstan dated December 6, 2001 No. 264-II "On membership of the Republic of Kazakhstan in the IMF, the International Bank for Reconstruction and Development, the International Finance Corporation, the International Development Association, the Multilateral Investment Guarantee Agency, the International Center for Settlement of Investment Disputes, the European Bank for Reconstruction and Development, Asian Development Bank, Islamic Development Bank "defines the legal conditions for membership of the Republic of Kazakhstan in international organizations (6 articles).

In accordance with the Resolution of the Government of the Republic of Kazakhstan "The List of International and State Organizations, Foreign Non-Governmental Public Organizations and Funds Providing Grants" dated December 28, 2001 No. 1753 in order to implement the Code of the Republic of Kazakhstan dated June 12, 2001 "On taxes and other mandatory Payments to the Budget "(Tax Code) 151 organizations operate in the republic, including 48 international organizations, 28 state organizations, 75 foreign non-governmental public organizations and foundations.

Kazakhstan also signed the following Declarations:

- Nukus Declaration on the Problems of Sustainable Development of the Aral Sea Basin, 1995;
- Issyk-Kul Declaration on Regional Cooperation of Central Asian Countries, 1995;
- Almaty Declaration on Sustainable Development of Central Asian Countries, 1997

On a bilateral basis, relations of the Republic of Kazakhstan in the field of environmental protection are developing with various international and non-governmental organizations, as well as with such financial institutions as:

- The World Bank and its regional office in Kazakhstan;
- The Global Environment Facility;
- United Nations Development Program;
- Asian Development Bank;
- The United Nations Environment Program and its European and Asian Offices;
- European Bank for Reconstruction and Development;
- TACIS;
- United Nations Commission on Sustainable Development UNESCO;
- NABU;
- Flora and Fauna International;
- FAO;
- WWF;
- ICARDA;
- European Environment Agency;

- International Union for Conservation of Nature;
- World Center for Monitoring and Conservation of Nature.
- Assessment of desertification and droughts, SDS, environmental, economic and social impacts in order to take adequate measures.

In 2003, the CA countries developed and signed the Subregional Action Program to Combat Desertification (SAPCD). In the same year, the Global Environment Facility (GEF) announced a new Sustainable Land Management Program to support the implementation of the UNCCD. In this regard, in 2003, at the initiative of the CCD Global Mechanism, the Forum on Partnership Development was held in Tashkent, which brought together representatives of national organizations and donors to identify problems and ways to address land degradation issues. Representatives of the ministries of nature protection, agriculture and water management, economy and finance were invited to the forum from each CA country. A Central Asian Strategic Partnership Agreement (CASPA) was developed to assist Central Asian countries in their work to implement the CASPA. The main task of the CASPA is to develop partnerships between the countries of Central Asia and donor organizations for the implementation of the CCD in the region.

At present, the CASPA unites the following organizations: the CCD Global Mechanism (GM), the Asian Development Bank (ADB), the Global Environment Facility, the United Nations Development Program, the German Society for Technical Cooperation (GTZ), the Canadian and Swiss International Development Agencies, the International Development Fund Agriculture (IFAD), International Center for Agricultural Research in the Dry Areas (ICARDA), World Bank, United Nations Environment Program.

Central Asia, taking into account the magnitude of land degradation in the region, was selected by the GEF Secretariat as the region for pilot country cooperation under the Operational Program on Sustainable Land Management (GEF-15). Thus, a project to improve the national action plan to combat desertification in the Republic of Kazakhstan was developed to combat land degradation by promoting sustainable land management (SLM), which in turn will contribute to ensuring environmental integrity as well as improving living standards. rural population in the Republic of Kazakhstan.

On March 14, 2005, the final seminar on the project "Resolving the problems of water scarcity and drought in Central Asia caused by climate change" was held in Tashkent. It was noted that insufficient attention is paid to climate change issues in the CA region. The region has enough pressing problems that need to be addressed. Even insignificant changes in air temperature - by only 1 ° C - are accompanied by a sharp change in the frequency of extreme situations. Therefore, all over the world, various natural disasters have become more frequent: floods, droughts, tsunamis, etc. So, since 1999 we have had 2 catastrophically dry years, as a result, some zones received 35-50% of the assigned water.

In 2004, with the support of UNCCD and ADB, the Central Asian countries jointly developed the Central Asian Countries Initiative for Land Administration (CACILM). The goal of CACILM is to combat land degradation and improve the living standards of rural populations in Central Asia. The main objective of the program is to create and develop interagency partnerships in countries and partnerships between countries and donors, defining national priorities in the field of sustainable land management and developing a strategy for their consistent and effective implementation. The duration of the program is 10 years.

The Central Asian Countries Initiative on Land Management (CACILM) is the first multi-country program to combat land degradation and improve rural livelihoods launched by the parties to the Strategic Partnership Agreement in 2004. A practical step to achieve the goals of the UN Convention to Combat Desertification (UNCCD) was presented at the 5th Session of the UNCCD Implementation Review Committee, Buenos Aires, Argentina, March 2007, as the only multi-country partnership that has achieved success in implementing the UNCCD.

The goal of the CACILM Program is to restore, maintain and strengthen the productive functions of land resources in Central Asia, while maintaining their ecological functions, which should subsequently lead to an increase in the social and economic well-being of people who depend on these resources, or Fight land degradation and improve living conditions in rural areas regions.

CACILM Partnership: 5 Central Asian states (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan); international partners (ADB, CIDA, GTZ CCD, GEF, GM, ICARDA, IFAD, SDC, UNDP, UNEP, World Bank, FAO.

Launch of the CACILM program - 10 years of multi-country activities. The total budget of the program is $ 1.4 billion. Funding commitments by the end of 2008 amount to $ 155 million, of which $ 20 million is GEF grant funds / 14 /.

Within the framework of the project "Preservation of forests and increase in forest cover of the territory of the republic", financed by a loan from the World Bank, a grant from the Global Environment Facility (hereinafter - GEF) and the republican budget, in the period from 2007 to 2015, afforestation was carried out on the drained bottom of the Aral Sea on an area of 61 thousand ha / 57 /.

State forestry institutions of the Akimat of Kyzylorda oblast at the expense of the local budget from 2015 to 2018 planted 5 thousand hectares of saxaul per year on the drained bottom of the Aral Sea. A total of 20 thousand hectares have been planted.

In accordance with the Agreement on Cooperation between the Forest Service of the Republic of Korea and the Committee for Forestry and Wildlife, since 2017, the project “Phyto-forest reclamation of the drained bottom of the Aral Sea in the Kyzylorda region” is being implemented.

In order to implement this project, a working project was developed “Creation of plantings on the drained bottom of the Aral Sea on an area of 30 thousand hectares.”

In the period from 2018 to 2019, plantings of black saxaul have already been created on the territory of the Aral state forestry institution of the Kyzylorda region on an area of 10 thousand hectares.

At present, the Committee for Forestry and Wildlife is considering the issue of raising funds for forestry work on the remaining 20 thousand hectares.

Also, in 2019, the GEF preliminarily supported funding for the Agroforestry for Climate Resilience and Rangeland Restoration in Kazakhstan project. Within the framework of this project, work will be continued on afforestation of the drained bottom of the Aral Sea.

In order to preserve the saxaul plantations of the republic, by order of the Committee for Forestry and Wildlife of August 13, 2015 No. 211, a ban on felling in saxaul plantations was introduced on the sites of the state forest fund, which will have a positive effect on combating desertification in the Republic of Kazakhstan.

In 2018, the Akimats of the regions approved Step-by-step plans for increasing the volume of forest reproduction and afforestation until 2030, which provide for the allocation of funding from local budgets for the purchase of forest planting equipment and equipment, the implementation of silvicultural activities and the creation of green zones.

In general, the Step-by-step plans are supposed to carry out the reproduction of forests and afforestation in the republic in the amount of 1.5 million hectares (indicators from 2011 to 2030), which will bring the forest cover of the republic to 5% and achieve the goals set during the meeting of the Round Table of Ministers on restoration forest landscapes in the Caucasus and Central Asia (Bonn Challenge).

In September 2013, Kazakhstan opened for signing the Green Bridge partnership program - international cooperation to ensure green economic growth through technology transfer, knowledge exchange and financial support for the implementation of investment projects in the Central Asian region. This program will act as a regional coordinator and international contributor to the development and implementation of clean technologies, and will also contribute to the development of innovative investment solutions for real and economically viable projects in a number of key sectors for sustainable growth of the green economy.

In 2016-2018, consultative meetings and seminars were held in Central Asian countries and Turkey to agree on the CACILM-2 project document (CACILM-2), where the project implementation structure and regional coordination of the project were discussed and agreed upon. The main principles of project preparation were:

• Involvement of national project partners to incorporate country interests

• Creation of effective partnerships between countries, between partners in INRM / SLM

• Creation of a platform for the CACILM 2 program outside the scope of the project

The overall objective of the project is to scale up Integrated Natural Resource Management (INRM) in drought-prone and saline agricultural production landscapes of Central Asia and Turkey.

The following components are discussed:

Component 1: Multicountry Cooperation and Partnerships to Facilitate Effective Implementation of INRM

Component 2: Incorporating sustainability into policy, legal and institutional frameworks for ICM

Component 3: Scaling up climate-smart farming practices in drought-prone and / or saline production landscapes.

The project plans to introduce an agricultural innovation system (AIS) in Central Asia, which has a systematic approach, where rural advisory services (currently preferring the term "informative and advisory services" are provided by several entities, including various private sector service providers, NGOs and organizations) Producers The project will also support the development of training modules to train farmers on INRM and Committee of forestry and wildlife (CFW) to different approaches to scale up support for consultancy services for INRM.

Regional coordination of the project will be carried out by the CACILM-2 Regional Council (RCI), which acts as a steering committee for the project chaired by the ICSD and consists of representatives from all five CA countries and Turkey (UNCCD coordinators) and a leading FAO technical officer. RCI provides policy guidance, review of results based on annual workplans and budgets, and provide recommendations for addressing any challenges facing the project. RCI will be critical to ensure that:

• close relationship between the project and other ongoing projects and programs relevant to the project;

• sustainability of the main results of the project, including scaling up and replication; and,

• effective coordination of other government and regional partners working under this project.

Technical Expertise and Assessment Council (TEAC): TEAC is made up of leading national and regional experts in INRM, ILM and salinity management. It works on an expert basis, and is responsible for reviewing the technical and scientific reports of the project before their final distribution, making proposals for new research, including applications from students to conduct

fieldwork for graduate theses at project sites, etc. Review criteria includes: (i) scientific value; (Ii) relevance to the project; and (iii) cost effectiveness.

The CACILM Secretariat functions as a regional coordination group and acts as the RCI secretariat. The CACILM Secretariat operates under the leadership of the Regional Project Coordinator (RPC).

National Coordinating Teams (NCTs) are responsible for the development of mainstreaming policies in all participating countries and the operation of demonstration sites where needed, and are led by the CACILM Regional Secretariat. The NCT works closely with local communities and other local stakeholders at the demonstration sites. The NCT is supported by the CACILM National Councils, which function as the National Steering Committees. Each NCT is composed of a National Project Coordinator (NPC), other dedicated national consultants who support the activities of the demonstration sites, and local rayon / oblast staff seconded to the project. The PCs report to the CACILM Regional Secretariat.

Project partners - CAREC, ICBA (saline areas), ICARDA (dry areas), Bioversity International (seed production), WMO, UNCCD (forecasting), IWMI, WOCAT (technologies, water).

The multi-country integrated five-year regional project of FAO and GEF was launched at the end of May 2018, its unique feature is that a significant part of the project cost, amounting to 76 million US dollars, was covered by the participating countries themselves - Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Turkey and Uzbekistan (almost US $ 50 million). The five-year project with a budget of more than US $ 75 million is one of the largest natural resource's initiatives co-financed by the governments of the participating countries. This is already the second phase of the regional program CACILM (Central Asia Initiative on Sustainable Management of Natural Resources), the foundations of which were laid in 2003, when Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan in response to the challenges of climate change, the threat of desertification and degradation of fertile soil agreed to act jointly.

The main objective of the project is to disseminate and adapt to local conditions the best practices for the efficient use of natural resources.

One of the main achievements of the large-scale regional program over the past two years is effective interaction and a high level of understanding between countries at the level of national and international partners, government agencies and other UN agencies. The second achievement was achieved thanks to a well-coordinated team of professionals who organized the project's activities locally, in countries. Field work is currently underway in eighteen pilot zones in arid, saline and soil degraded regions of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

Rationale for the need to combat drought and SDS at the regional level

The countries of Central Asia (CA) are highly susceptible to SDS, especially in areas outside the highlands, where a semi-arid and arid climate prevails. Most CA regions are characterized by a dry and continental climate with hot summers. Strong winds and sparse vegetation are often observed at the end of the dry season.

Recognizing the increased risk of SDS, the Parties to the UNCCD have adopted decisions to address the negative impacts of droughts [decisions 29 / COP.13 and 23 / COP.14] and the SDS [decisions 31 / COP.13 and 23 / COP.14].

In order to help the participating countries to improve their preparedness and resilience to drought and SDS, in cooperation with a number of partners, the UNCCD secretariat developed mechanisms for promoting policies in the field of SDS management, supported the states in developing national plans, methodologies and tools for drought management, including a package of drought management measures, and a complete list and basemap of sources of SDSs.

The problem of desertification, SDS is complex and multifaceted - it is related to water supply and management of water resources, agricultural practices, soil and vegetation cover quality, climate change and biodiversity conservation. The complexity of the situation is recognized in the UN Convention to Combat Desertification itself, where attention is paid to its synergy with other international conventions. In view of the connection between the problem of desertification and drought and the problem of poverty, the creation of new jobs, an increase in employment, an improvement in education and training, along with the development of resource-saving technologies and the introduction of the principle of resource-saving into legislation, will cause movement in the right direction.

SDS is a common phenomenon in Central Asia that causes significant damage to the economy and society. Although there are borders between the Central Asian states, as well as between other states, they do not coincide with natural boundaries, which facilitates the conditions of climate change, the transboundary transfer of technogenic pollutants with air masses.

There are good conditions for regional cooperation in Central Asia, which is based on existing land management projects sponsored by the UN Convention to Combat Desertification and the GEF and other regional initiatives.

To build multi-country cooperation and ensure an effective fight against SDS, it is necessary to combine efforts with existing regional initiatives and processes that are engaged in similar tasks: CACILM-2, the Interstate Commission on Sustainable Development, IFAS, the Annual Environmental Conference in Central Asia, hold joint meetings with the national coordinators UNCCD, etc.

Through a comprehensive risk reduction strategy for SDS, including monitoring and early warning systems, CA countries will strengthen regional support and capacity to effectively improve their preparedness and resilience to relevant environmental disasters, focusing on proactive management in line with national disaster risk reduction and mitigation plans. their implications as well as national management plans.

IMPROVING THE ORGANIZATIONAL MECHANISM AND IMPROVING THE KNOWLEDGE ON COUNTERING SDS

The necessary actions to combat SDS are divided into short-term I stage, medium-term - II stage and long-term - III stage in terms of their implementation. Long-term actions include measures that can be started at any stage, but will be continued over the years. They cannot be fully implemented in a short time.

Short term actions include:

• improvement of the environmental management system;

• Inventory analysis of land degradation: arable land, pastures, hayfields, forests;

• development of legal and regulatory frameworks for the use of land resources based on ecological zoning;

• development of measures for rational forest management, increasing forest cover and protection;

• development of a development and location scheme, creation of a network of specially protected natural areas;

• development of mechanisms for economic stimulation of actions to combat SDS and balanced use of natural resources.

Medium-term actions include:

• organization of monitoring of SDS;

• development of measures for adaptation of agricultural production to climate change and drought manifestations;

• improvement and widespread use of soil-protective technology for the cultivation of agricultural crops;

• rationalization of the use of natural forage lands, creation of seeded pastures and hayfields on degraded lands;

• restoration of vegetation cover on fallow lands withdrawn from agricultural use.

Long-term actions include:

• forest-pasture land reclamation during desertification;

• consolidation of mobile sands in order to protect pastures, settlements and economic facilities;

• reclamation of secondary saline lands in the area of irrigated agriculture;

• mining and phytomeliorative reclamation of technologically disturbed lands;

• organization of environmental education, education and raising the awareness of the population about the problems of SDS;

• development of traditional trades, crafts, agricultural sectors.

In the rational use of natural resources, it is especially important to improve the organization of territories in order to prevent the processes of land degradation, including the environmentally sound use of land on a landscape-ecological and regulatory basis; creation of a network of specially protected natural areas; development of legal and regulatory frameworks for land use. Economic mechanisms for a sparing nature management regime should be developed.

The plans should provide for measures for superficial and radical improvement of degraded pasture and hayfields; restoration of fertility of arable lands; prevention of wind and water erosion, irrigation and watering of pastures; reforestation and afforestation; greening of cities and towns, mining and biological reclamation of technologically disturbed lands, the development of traditional trades and crafts.

In accordance with the conceptual program for the development of the agro-industrial complex, the main provisions for combating SDS should include:

On arable land:

- conducting intensive grain farming on more fertile soils (area 16-18 million hectares) with the optimal use of chemical and biological methods;
- transformation of a part of low-productive arable land (area 6-8 million hectares) into fodder lands and the creation of sown hayfields and pastures on them (tinning);
- reconstruction of the irrigation system and elimination of secondary salinization of irrigated lands;
- development of reclamation projects suitable for various forms of management (peasant, farm, collective, etc.), providing for the rational use of irrigation water and prevention of desertification of the soils of the irrigated zone;
- for effective protection of soils from water erosion, a complex of soil protection measures with a contour-strip organization of the territory on the slopes is recommended, taking into account their steepness and exposure and including soil-protective crop rotations, techniques
- soil treatment and fertilization system depending on the degree of soil erodibility;

- increasing the humus balance of soils in Kazakhstan by saturating crop rotations with perennial grasses, maximizing the use of straw, stubble crops, intermediate crops, green fertilizers.

On pastures:

- restoration of seasonal use of pastures on the basis of distant pasture breeding;
- watering of pastures;
- land reclamation of degraded lands, including the consolidation of sands;
- reconstruction of old mine wells;
- monitoring the state of the seasonal use of pastures, the introduction of standards for the use of pastures.

All economic plans for the development of the Republic of Kazakhstan, including: agro-industrial complex, mining, placement of enterprises, settlements, communications and others, must take into account the protection of the environment from SDS and the improvement of the ecological situation.

The fight against SDS in Kazakhstan, concern for the preservation of natural resources is a national task that can be successfully solved only with the direct and active participation of legislative and executive bodies, non-governmental organizations and the local population.

The program of actions to combat SDS cannot take into account all regional features and diversity of natural conditions in Kazakhstan. Therefore, on its basis, for each region, it is necessary to develop, taking into account local conditions, its own regional strategies, which should become an integral part of the overall action plan.

Currently, a number of environmental measures are being taken in the republic.

Measures to improve the economic environment:

- an economic mechanism of nature management was introduced, contributing to the prevention of damage to the environment, stimulation of rational use of natural resources and the formation of an additional source of financing for environmental protection measures;
- Introduced payment for the use, protection and reproduction of natural resources;
- established payments for environmental pollution;
- a republican fund for environmental protection was created; in all regions and large cities regional funds for nature protection have been created. They allocate funds and, on a competitive basis, carry out work to preserve natural objects, to prevent degradation of the natural environment and to plant greenery, reclamation of technologically disturbed lands;
- regulatory frameworks are being developed for the introduction of an environmental insurance system.

Measures to preserve natural resources:

- 1 volume of the Red Data Book of Kazakhstan (vertebrates) was republished, 2 volumes of the Red Data Book of Kazakhstan (invertebrates), 3 volumes of the Red Data Book of Kazakhstan (plants) were prepared, work is underway to prepare 4 volumes of the Red Data Book of Kazakhstan (Green Data Book - plant communities);
- a bank of germplasm of rare and endangered plant species in Kazakhstan was created, - a collection of varieties, lines and forms of agricultural plants, herds of breeds of domestic animals, a museum of valuable microorganisms for industrial and medical purposes was organized;
- On the highly deserted area of the Syrdarya Karatau foothills on an area of about 100 hectares, a new botanical garden of the Turkish-Kazakh University named after Ahmed Yassawi. To date, a gene pool of fruit, berry, ornamental plants has been created in the garden, in total about 2000 species, varieties and forms;

- in the field of forest conservation and reforestation, special attention is paid to optimizing the size of the allowable cut in the regions of the republic. In recent years, it has been significantly reduced and in general for Kazakhstan is determined at 2.5 million cubic meters, including for coniferous farming - 0.75 million cubic meters. (was 1.7 million cubic meters);
- improved system of final felling. In the mountain forests and belt forests of the Irtysh region, predominantly selective and gradual felling is recommended as the most effective from a forestry-biological and ecological point of view. It is planned to develop scientifically based standards and, on their basis, to clarify the division of forests into categories of protection and national economic significance.
- In Kazakhstan, reforestation activities were carried out on an area of more than 322 thousand hectares, of which more than 208 thousand hectares were sowed and planted. Protective plantations have been created on an area of about 25 thousand hectares, including 10 thousand hectares of pasture shelter plantations on sands, gullies and other inconvenient lands. Works on greening of cities and settlements were widely developed. More than 10,000 tree seedlings are planted annually in each city. NGOs are also involved in this work.
- In the steppe and dry-steppe regions of Kazakhstan, the following are widely used: soil-protective crop rotations with strip placement on light soils of grain crops, fallow and perennial grasses; flat-cut soil cultivation, which maintains stubble on the surface to protect the soil from deflation and the accumulation of winter precipitation to combat drought; a system of fertilizers and plant protection products to improve soil fertility and control weeds.
- A technology has been developed for improving low-productivity forage lands in relation to specific zonal conditions; an assortment of species - improvers (phytomeliorants) of specific pasture-hay-growing ecosystems, taking into account soil and climatic conditions, was experimentally established.
- A sanitary protection green zone has been created around the capital of Kazakhstan, Nursultan; the issue of creating such zones around a number of regional and industrial centers is being considered.
- In the area of ecological disaster in the Aral Sea region on the territory of the drained seabed, in order to reduce wind erosion, forest reclamation works were carried out on an area of about 652 thousand hectares, of which about 17 thousand hectares have already been planted.

Measures to increase the knowledge and awareness of the population on SDS:

- to carry out on a systematic basis in the republic in educational institutions (schools, lyceums, gymnasiums, secondary specialized institutions, higher educational institutions) and in out-of-school institutions - stations of young naturalists
- Strengthen the role of the mass media (press, television, radio) in expanding the knowledge of the population on SDS
- Conduct conferences and scientific and practical seminars. To involve not only specialists and managers of enterprises, but also many public organizations
- In higher educational institutions, to increase the tendency to expand the infrastructure of environmental education, to open new departments, courses, master's degrees in ecology
- Involve NGOs in expanding knowledge and awareness on SDS. Involve the local population in activities to combat SDS.

• Disadvantages

- Educational work in the field of combating SDS is far from perfect, is not purposeful and does not correspond to a huge scale.
- The republic lacks a unified environmental monitoring system and a stationary network for monitoring the SDS. The SDS analysis is based on scattered information from various ministries and departments according to inconsistent criteria. There is no SDS monitoring service in the republic
- There are no uniform criteria for assessing the SDS in the republic.
- Non-state legal entities and farms in difficult economic conditions of the market (lack of working capital, worn-out equipment, lack of fertilizers, pesticides and high-quality seeds) feel the need for cooperation and government support for the implementation of these activities. In this regard, the problems of the SDS are not sufficiently perceived by new economic entities.

4. ANALYSIS OF THE ACTION PLAN FOR COMBATING SDS IN THE REPUBLIC OF KAZAKHSTAN

For the implementation of the action plan to combat SDS in the Republic of Kazakhstan, an analysis of the available materials was carried out (materials of the implemented international and domestic projects, individual researchers, scientific institutions, summary analytical reports of the Committee on Land Management for the last 15 years, etc.). The results are presented below in tabular form. To select strategic planning approaches, an assessment of the strengths and weaknesses, opportunities and threats associated with the legal and institutional structure at the country level was carried out (Table 1). The compilation of an analysis on the SDS is aimed at identifying and distributing factors, both positive and negative, to develop a structured comprehensive understanding of the main factors that determine the implementation of an action plan to combat SDS in the specific conditions of the Republic of Kazakhstan.

Table 1 Strengths, Weaknesses, Opportunities and Threats in the SDS Action Plan related to the legal and institutional framework at the country level

Strengths:	Weaknesses:
Political, legal and regulatory - a functioning well-developed system of laws related to SLM - availability of medium-term and long-term strategic plans and projects, adopted taking into account the experiences gained from the time of independence by various national and international organizations in the implementation of programs on land management and environmental protection, as well as interaction with International Conventions. - Adoption of strategic measures to combat desertification of the Republic of Kazakhstan until 2025, which covers an extensive program to integrate SLM issues into the planning and budgeting process at the national level, with the aim of identifying areas for priority investment and technical support, as well as providing effective mechanisms for broad	There is no centralized coordination mechanism in Kazakhstan between donor and national organizations. The only coordination mechanism between donors focused on the implementation of the CCD and SLM issues is the Strategic Partnership Agreement (SPA). - the presence of the majority of laws that are not acts of direct action, for the implementation of which it is necessary to develop many bylaws at various levels. - the existence of certain gaps, duplications and contradictions in the legislation, - lack of a specialized working body for SLM, collecting and analyzing current information, preparing the necessary management decisions - frequent changes in legal regulation, which create some legal uncertainty, hinder sustainable land management.

participation the public in the formulation, design and implementation of measures. -implementation of projects for conducting geobotanical surveys and soil surveys for 2017-2021 - provision of consulting services within the framework of the UNCCD Global Mechanism.	- difficult access to relevant knowledge and technologies, credit resources at the local level; - violation of the norms and requirements of land legislation in the activities of local executive and authorized bodies. - insufficient and (or) insufficient availability of information resources, - the local nature of the implemented projects, which were not widely spread, - lack of full-scale scientific research in Kazakhstan - lack of a system of information exchange to combat desertification in full. Educational institutions and peripheral areas are deprived of access to information technologies, do not have relevant information - lack of a developed standard assessment of the current situation and an agreed procedure for updating and analyzing monitoring data, which leads to re-citation of outdated and questionable data on the scale, nature and impacts of land degradation - weak financial support for research work, lack of trained scientific personnel and outdated material and technical base of scientific organizations, as well as extremely limited interest of the agro-industrial business in the problems of desertification. - local coverage of implemented projects aimed at solving local problems, - insufficient dissemination of the lessons learned and the results achieved due to the general difficulty of disseminating project approaches based on external funding (grants) in the absence of such financial resources. Efforts have been directed towards addressing hotspots of land degradation on a limited scale, without deeply addressing the causes of land degradation and the scope for wider application of measures to tackle it. The measures applied were mainly aimed at technical solutions inherited from the Soviet practice of resource management, without a thorough analysis of their sustainability and economic viability under completely changed conditions. Users of local resources are not considered as key participants in the SLM process and bearers of knowledge, experience and legitimate interests in the use of resources - lack of experienced and qualified personnel;

	- outdated material and technical base of scientific organizations
Opportunities: Institutional - more intensive lobbying for SLM problems at the appropriate political level. Reliable analysis of true scale and damage from land degradation needed - improving the legal and institutional environment, technical support, strengthening organizational measures and facilitating access to credit for investment in infrastructure. - strengthening coordination, mobilization of financial resources for the successful implementation of cost-effective and sustainable programs. - ensuring synergy of projects related to the UNCCD, CBD, UNFCCC, other conventions and implemented in cooperation with donor organizations and the Government of the Republic of Kazakhstan. Political, legal and regulatory - Creation of a more favorable environment that will facilitate the voluntary association of small agricultural producers for joint action on the practical application of the principles of sustainable agriculture. - guaranteeing the long-term rights of users of resources, stimulating payment and taxation systems, providing economic support (for example, simplified access to resources, equipment, financial resources and sales markets, reducing bureaucracy). -stimulating public participation and ensuring transparency in decision-making. - application of a scientifically based intersectoral approach to land management, taking into account the environmental, economic and social aspects of land degradation. - improvement and harmonization of the Legislative Framework for Land and Other Natural Resources in order to maintain sustainable practices in the use of resources and to eradicate unsustainable land use. - activities to build capacity and stimulate cooperation between government agencies, local administrations, private advisory organizations, NGOs and other civil society organizations	Threats: Environmental - global environmental problems associated with climate change; - lack of coordination and synergy of activities; - high initial financial costs, difficulties in obtaining loans; - insufficient financial support; Political, legal and regulatory - lack of clear responsibilities of local authorities in addressing land degradation problems; - political uncertainty about policy and strategy coherence Social, informational and educational - lack of political influence of environmental authorities; - insufficient information from private entities at the local level;

- avoid highly specialized strategies that lead to fragmented policies, unclear priorities and distributed government budgets; - promoting sustainable agricultural development and sustainable development in rural areas; Economical financial - developing links between planning and financing; - improving the investment and business climate.	

6. National Action Plan for Dust and Sandstorm Management in Kazakhstan

№	Action plan	Action plan subparagraphs	Interested organizations
1	Develop a method for assessing the risk of SDS	1.Create a working group of SDS experts (meteorologists, geographers, sociologists, experts in agriculture, community development, gender, age and disability, health professionals, engineers responsible for infrastructure at risk associated with SDS, etc.) 2. To develop strategies for risk management of SDS. 3. Develop methods for responding to SDSs in terms of reducing the impact of SDSs.	JSC Kazhydromet, Ministry of Emergency Situations, MEGNR, Ministry of Agriculture, Institute of Geography and Water Security, Akimats, Local government bodies, local communities.
2	Develop a method for assessing the economic damage from the impact of SDS	1. Develop a method for assessing the economic damage from the impact of SDS 2. Develop a provision justifying the amount of costs and the nature of measures to prevent SDS for vulnerable areas of the Republic of Kazakhstan.	MEGNR, MoA, MES, Institute of economy
3	Develop a method for assessing the impact of SDS on human health	1. Develop a method for assessing the impact of SDS on human health 2. Continue research to assess the impact of SDS on human health in vulnerable regions of the Republic of Kazakhstan. 3. Provide additional funding for this task. 4. To attract international institutions and funds to solve the problem. 5. Analyze international experience in solving this problem.	Ministry of Health of the Republic of Kazakhstan. Institute of Public Health of the Republic of Kazakhstan.

4	To create a GIS center for mapping, monitoring and modeling of SDS	1. To develop an early warning model for SDS. 2. Develop a Vulnerability Map from SDS. 3. Conduct every ten-day monitoring of the SDS of the territory of the Republic of Kazakhstan and neighboring states. 4. Develop a map of social vulnerability of the population, taking into account gender policy (including analysis of gender, age and disability), what is the degree of vulnerability and what are the causes of this vulnerability. 5. To develop a GEO portal of the risk of SDS with general access and the possibility of a mobile version of the product. 6. The GEO portal should contain information on the threats of a SDS, an action plan in the event of a SDS, emergency response measures at a SDS, etc. 7. Provide for regional cooperation to prevent the occurrence of SDS.	JSC Kazhydromet, JSC "National Center for Space Research and Technology
5	Develop methods to reduce sources of SDS in agriculture	Salinity control as a source of SDS: - phytomelioration - sowing of perennial grasses on secondary saline soils; - the use of irrigation installations with a metered water supply mode; - demineralization of water used in irrigation; - subsurface irrigation; - use of vertical drainage; - plastering; - application of organic fertilizers; - washing of soil covers with fresh waters.	MEGNR, Ministry of Agriculture, Akimats, Local governments, local communities.

		Drip irrigation is applicable where other irrigation methods are impossible or ineffective: - on soils prone to salinity; - when using for irrigation water with a high content of water-soluble salts; - in areas with prolonged droughts and constant strong winds; - with difficult terrain and a large slope of the site (up to 45 degrees or more); - in the presence of sources with a limited amount of water; - on soils with low capacity and very low or high hygroscopicity. -Continue funding scientific research aimed at reducing salinization Decrease in anthropogenic occurrence of SDS sources on arable land: - conducting intensive grain farming on more fertile soils (area 16-18 million hectares) with the optimal use of chemical and biological methods; - transformation of a part of low-productivity arable land (area 6-8 million hectares) into fodder lands and the creation of sown hayfields and pastures on them (tinning); - reconstruction of the irrigation system and elimination of secondary salinization of irrigated lands; - development of reclamation projects suitable for various forms of management (peasant, farm, collective, etc.), providing for the	

		rational use of irrigation water and prevention of desertification of the soils of the irrigated zone; - for effective protection of soils from water erosion, a complex of soil protection measures is recommended with a contour-strip organization of the territory on the slopes, taking into account their steepness and exposure and including soil-protective crop rotations, techniques - soil treatment and fertilization system, depending on the degree of soil erodibility; - increasing the humus balance of soils in Kazakhstan by saturating crop rotations with perennial grasses, maximizing the use of straw, stubble crops, intermediate crops, green fertilizers. In the pastures: - restoration of seasonal use of pastures on the basis of distant pasture breeding; - watering of pastures; - land reclamation of degraded lands, including sand consolidation; - reconstruction of old mine wells; - monitoring the state of the seasonal use of pastures, the introduction of standards for the use of pastures.	
6	Develop methods to reduce sources of SDS in industry	- improvement of interstate water relations. - development of explored groundwater reserves. - desalination of saline and brackish waters. -prevention of the harmful effects of water.	Kazhydromet JSC, Ministry of Emergency Situations, MEGNR, Ministry of Agriculture, Institute of Geography and Water Safety, Akimats

		- regulation of river flow by reservoirs. - modernization of the hydrological monitoring system -development of the recycling water supply system. - development of hydropower resources. - development of the water-transit potential of the republic. Improvement of the administrative and organizational system of water resources management: -creation of a separate institutional body dealing with water policy. -assessment and forecast of water resource potential. -development of the state system of water resources management. -implementation of an integrated water resources management system. -improvement of water legislation. -creation of a system of information and analytical support for water resources management. Improvement of the environmental control system: -implementation of the environmental principle “the polluter pays and fixes”. - the introduction of the best available technologies and economic incentive measures. - to develop new approaches to assessing the impact on the environment. -automated emission monitoring system. -improvement of environmental control	

		-improvement of production and consumption waste management. Climate: - completion of the development of a low-carbon development strategy until 2050. -preparation of the rules of methodological guidance on adaptation to climate change.	
7	Take action to improve governance counteraction to SDS	1. To develop a body for responding to SDS (under Akimats, rural districts, etc.) on the example of civil defense and emergency situations. 2. Develop an action plan for the SDS using the example of an action plan for an earthquake.	MEGNR, Ministry of Agriculture, Ministry of Emergency Situations, Akimats, Local governments, local communities.
8	To develop a mechanism of economic incentives to counter SDS	To develop a mechanism of economic incentives to counter SDS	MEGNR, Ministry of Agriculture, Ministry of Emergencies,
9	Develop by-laws on countering the SDS	Develop by-laws on countering the SDS.	MNE, MEGNR, Ministry of Agriculture, Ministry of Emergencies
10	Introduce amendments to the "Environmental Code of the Republic of Kazakhstan" taking into account the countermeasures of the SDS	Introduce amendments to the "Environmental Code of the Republic of Kazakhstan" taking into account the countermeasures of the SDS	MEGNR, Ministry of Agriculture, Ministry of Emergencies
11	Develop a National Program for Counteraction to SDS	Develop a National Program for Counteraction to SDS	MEGNR, Ministry of Agriculture, Ministry of Emergencies
12	To increase the amount of scientific and technical grant funding aimed at studying and countering the SDS	To increase the amount of scientific and technical grant funding aimed at studying and countering the SDS	MEGNR, MES
13	Develop investment mechanisms based on public-private partnerships to counter SDS	Develop investment mechanisms based on public-private partnerships to counter SDSs	MNE

Conclusion

In recent years, Kazakhstan has been paying significant attention to environmental issues, both in the national and international context. Nevertheless, despite significant positive shifts, Kazakhstan faces a number of environmental problems. Ineffective agricultural practices coupled with pollution from heavy industry led to the deterioration of land and water resources, incl. reduction of biological diversity, which hinders the development of many regions of the country. The area of degraded agricultural land is about 14% of the total agricultural land in Kazakhstan. The country's forest area is shrinking. The drying up of the Aral Sea, disposal of nuclear and biological waste from past tests are also among the most pressing environmental problems. The environmental problems of Kazakhstan are mainly inherited from the times of the Soviet Union, but, nevertheless, the continuation of the deterioration of the environmental situation is noted after the country gained its independence.

Kazakhstan has issued a number of laws and regulations related to environmental aspects. Despite the environmental focus of the legal framework, poor enforcement of laws, especially at the local level, and overlapping legal documents continue to pose a major challenge for improving environmental protection. Strategic plan of the Republic of Kazakhstan for 2011-2015 is the basis for the development of strategic environmental plans of ministries and departments, national companies and regions. The plan includes the provisions of previous regulatory documents, incl. Concept of the transition of the Republic of Kazakhstan to sustainable development for 2007-2024. from 2006. The strategic plan provides for the achievement of the following goals in the field of environmental and natural resources protection: reducing water scarcity and improving the quality of water supply, strengthening waste management systems, providing environmental education and developing international cooperation to strengthen environmental activities.

In order to implement the Development Strategy until 2050, the Government of the Republic of Kazakhstan has put into effect several strategic plans that set priorities and quantitative goals for the country's development until 2050. Currently, the Strategic Development Plan until 2020 is in force. It defines climate change as one of the key factors determining the emerging current trends in the world economy.

Since 2000, Kazakhstan has been actively implementing the Subregional Action Program to Combat Desertification. The priority areas for sub-regional cooperation, as well as areas of particular importance for Kazakhstan, in the SAPCD are: cooperation within the framework of the monitoring system, in particular on hydrological forecasting; transboundary cooperation in water management for irrigation and transboundary hydrological systems; pasture management where transboundary cooperation is required for distant pasture grazing in some areas.

Kazakhstan is a party to a number of international conventions and protocols in the field of environmental protection. The most important of these include the Convention on Biological Diversity, the Framework Convention on Climate Change, the Convention to Combat Desertification and the Convention on the Protection and Use of Transboundary Water Resources and International Lakes. However, the lack of compliance with international conventions is a significant gap in environmental protection and disaster risk management, as well as a lack of local expertise to develop and implement environmental programs.

The Government of Kazakhstan recognizes the urgency of solving environmental problems, and with the support of international donors has developed a number of programs and action plans for environmental protection. In addition to the Strategic Plan for 2011-2015, the priorities and obligations of the government are outlined in the National Action Plan for Environmental Protection, the National Strategy and Action Plan for Biodiversity Conservation, and the Concept of Environmental Security for 2004-2015. to preserve biodiversity, combat desertification, and protect forest and mountain ecosystems.

At the moment, assistance to our country in fulfilling obligations under international agreements is provided by: the United Nations Development Program, the United Nations Environment Program, the United Nations Industrial Development Organization, international development banks (Asian Development Bank, European Bank for Reconstruction and Development, World Bank), European countries, the delegation of the European Union in Kazakhstan. Projects are implemented at the local, republican and sub-regional levels. Republican projects focus mainly on capacity building, awareness raising, technical assistance. Whereas at the local level, projects are mainly demonstration in nature and are developed with an emphasis on local communities, for example, projects of the Small Grants Program of the Global Environment Facility (GEF).

In recent years, at the expense of UNDP funds, projects have been implemented to restore and improve reclamation of irrigated lands in South Kazakhstan, Almaty, Mangistau, Kyzylorda and some other regions of the republic.

Early recognition of SDS, as well as its early warning, is one of the most important problems. The problem is that, in most cases, stakeholders do not receive advance warning. Farmers, especially small agricultural producers, do not receive data on forecasts and early warning of the onset of SDS due to the paid services of Kazhydromet. Prediction of SDS and earlier notification is mainly carried out through folk signs.

Kazakhstan is more strongly susceptible to SDS. Moreover, water supply is problematic in the administration and irrigation sectors due to deteriorating infrastructure. Integrated planning and improved inter-agency coordination are needed.

Every year SDS occurs in several areas, leading to undesirable consequences. The drying up of the Aral Sea changed the circulation processes in Kazakhstan. The acceleration of the hydrological cycle in Kazakhstan has led to an increase in frequency and intensification of natural phenomena.

It is expected that in the twenty-first century, the incidence of SDSs will increase, despite the fact that all climate models predict an increase in precipitation.

Improvement of water saving and increase of productivity of water resources at various levels remain the most effective means of SDS. Monitoring and modeling of SDS processes at the regional level should reduce the impact of SDS.

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Annex A

The origin of SDS

Wind is one of the most powerful natural factors in changing the appearance of the earth's surface. Its activity is most clearly manifested in deserts, which occupy about 20% of the continental surface, where strong winds are combined with a small amount of atmospheric precipitation (the annual amount does not exceed 100-200 mm / year); sharp fluctuations in temperature, sometimes reaching 50o and above, which contributes to intensive weathering processes; the absence or sparseness of the vegetation cover. Especially large areas are occupied by deserts in Asia, Africa, Australia, less in Europe and America [31].

In addition, vigorous wind activity is manifested in non-desert areas - on the coasts of oceans, seas and in large river valleys not covered with vegetation, but in places in semi-deserts and even in temperate climates.

Geological work of the wind consists of the following types:

1) deflation (Latin "deflation" - blowing and waving);
2) corrosion (lat. "Korrasio" - grinding, scraping);
3) transfer;
4) accumulation (Latin "accumulation" - accumulation).

All these aspects of the work of the wind in natural conditions are closely related to each other, manifest themselves simultaneously and represent a single complex process. We can only say that in some places some types of process prevail, in others - others.

All processes caused by the activity of the wind, the forms of relief and sediments they create are called aeolian (Aeolus in ancient Greek mythology is the god of the winds).

Deflation is the blowing and blowing of loose rock particles (mainly sandy and silty) by the wind. For the waving of particles, weakly fixed in the sediments, the wind speed is of primary importance [31].

Table 2: Sizes of debris carried by the wind (according to V. Fet, 1961)

Wind speed m / s	Diameter of particles captured by the wind, mm
4,5-6,7	0,25
6,7-8,4	0,50
8,4-9,8	0,75
9,8-11,4	1,00
11,4-13,0	1,50

The wind speed changes rapidly in space, as a result of which the duration of the stay in the air of particles of various sizes, simultaneously captured by the wind of the same speed, varies greatly. Relatively large particles larger than 1 mm settle quickly at a short distance from the capture site. Particles smaller than 0.1 mm can be suspended in the troposphere for several days or even weeks and be transported over long distances [32].

The capture of fine particles from the surface of loose sediments and soils by the wind is prevented only by dense woody vegetation. Therefore, the waving of soils in the forest zone is minimal, and on the territory of the steppes, wind erosion increases as the degree of soil coverage with grassy vegetation decreases. Great damage to the steppe soils is caused by strong dry winds waving a loose fertile layer of plowed soils, the so-called black storms, which occur at a wind speed of 10-12 m / s and more [32].

The effect of wind is most pronounced in deserts, where the protective role of vegetation is minimal. Constant winds carry huge amounts of dust from desert regions, causing dustiness in the troposphere of neighboring regions. These winds in different countries have received special names: Afghan - affects the plains of Central Asia, North African sirocco - periodically dries up the coastal areas of the Mediterranean region.

Corrosion is the mechanical treatment of exposed rocks with sand particles carried by the wind, which is expressed in turning, grinding, scraping, drilling, etc. This process is similar to the method used in practice for cleaning stone buildings with sandblasting devices.

Sand particles are lifted by the wind to different heights, but their greatest concentration is in the lower surface parts of the air stream (up to 1.0-2.0 m). Strong, long-lasting blows of sand against the lower parts of the rocky ledges undermine and, as it were, undercut them, and they become thinner in comparison with the overlying ones. This is also facilitated by weathering processes that violate the solidity of the rock, which is accompanied by the rapid removal of destruction products. Thus, the interaction of deflation, sand transport, corrosion, and weathering gives the rocks in the deserts a peculiar shape [32].

When moving, the wind captures sandy and dusty particles and carries them at various distances. The transfer is carried out either spasmodically, or by rolling them along the bottom, or in suspension. The difference in transport depends on the size of the particles, the wind speed and the degree of its turbulence. With winds of up to 7 m / s, about 90% of sand particles are transported in a layer 5-10 cm from the Earth's surface, with strong winds (15-20 m / s), the sand rises several meters. Storm winds and hurricanes raise the sand tens of meters in height and roll even pebbles and flat rubble with a diameter of 3-5 cm and more [32].

Forms of aeolian sandy relief:

The regularities in the formation of sandy relief in deserts are closely related to the wind regime, the dynamics of the atmosphere and its circulation, the thickness of the sands and the degree of their exposure. Due to the change in these parameters, a variety of sand forms is observed in deserts. Let us briefly characterize their most common forms: dunes and ridge sandy forms [32].

Dunes are usually asymmetrical crescent-shaped sandy forms that resemble a half moon and are located perpendicular to the mainstream. Their windward slope is long and gentle (10-15o), it is usually covered with ripple signs transverse to the wind, resembling small ripples on the water surface, and the leeward slope is short and steep (32-35o). In the transition from a gentle slope to a steep one, a sharp ridge is formed, having the shape of an arc, and pointed ends ("horns") protrude in the direction of the wind. The height of the dunes is different - from 2-3 to 15 m, and in some places 20-30 m and more (Libyan desert). Solitary dunes are rare. With a large amount of bare sand in deserts, dunes in most cases merge with each other, forming large dune chains, resembling sea waves. Their height can reach 60-70 m and more. In tropical deserts, dune ridges longitudinal to the wind are formed in places. A possible sequence of development of the dune relief from the embryonic dune to large dune chains and ridges is visible [32].

Under the influence of the wind at a speed of 4 m / s, more mobile sands move and form irregularities called dunes. The dunes are in most cases crescent-shaped. The surface of the sand looks like a rolling sea. The dunes move in the direction of the prevailing winds. Moving sands are able to fill up not only the excavation, but also the embankment. Sands are first deposited at the foot of the windward slope and gradually subside, then they are deposited on the way in the form of tongues, and then cover a considerable stretch [32].

Annex B

Control measures for SDS

The fight against moving sand is carried out in two directions:

• implementation of preventive measures to help stop the growth of areas occupied by moving sand;

• carrying out active measures aimed at consolidating mobile sands and converting them into forage, forest or other lands.

Preventive measures should include measures for the correct organization of the territory. First of all, it is necessary to allocate protective zones in the sands bordering on cultural lands, around settlements and industrial enterprises, along roads and other objects, where any exploitation of vegetation (grazing, removal and harvesting of bushes, etc.) should be prohibited and carried out forest reclamation / https://ru-ecology.info/index/

Active measures to combat moving sands are carried out by phytomelioration, the use of mechanical protection and other methods. The most rational method for fixing the sands is phytomelioration, which makes it possible to obtain economic products from these lands.

The main directions of reclamation work on the sands:

• consolidation of mobile sands by any means, which may take place when valuable objects are threatened with falling asleep;

• consolidation of sands for the purpose of obtaining pasture lands;

• consolidation of sands in order to obtain fuel wood;

• creation of forest areas on fixed sands;

• green planting around wells, farms, villages, in pastures.

Methods for fixing mobile sands include the creation of biological, mechanical or chemical defenses on them [33].

To create biological defenses, seeds of grasses, trees and shrubs, cuttings and whips of willows and poplars are used. The choice of the main method of work - sowing or planting depends on the nature of the sands. In areas with close groundwater (when the capillary border reaches the surface), sowing seeds gives good results. On powerful moving sands, planting is preferable, since the seeds are easily blown out, and the seedlings suffer from blowing and falling asleep. In forest reclamation work, preference is always given to tree-shrub species - psammophytes. Grasses are usually sown on moving sands in difficult forest conditions or when it is necessary to increase the amount of feed for livestock [33].

The consolidation of sands with shrubs is carried out where it is impossible to grow tree species. One of the widespread techniques is peeling, which is successfully carried out on the sands of the steppe zone, as well as in the semi-deserts of the Northern Caspian region and Kazakhstan. Sheluga is planted with cuttings 30-50 cm long, which are prepared from whips 2 to 3 years old. The drier the conditions, the longer the cuttings cook. They are planted under a planting stake or under Kolesov's sword at a distance in rows of 0.5-1 m from each other, to their full length, leaving only a top of 1-2 cm above the sand surface. Rows, with a distance of 2 m between them, are placed perpendicular to the direction prevailing winds. On the hillocks, landing is carried out horizontally, the top of the hillock is left free for leveling the relief. Planting is best done after rain. In areas with gentle terrain, it is possible to plant with whips under a plow. In this case, the bottom of the plow furrow 25 cm deep, directed perpendicularly to the prevailing wind, is laid by 2-3-year-old shelly whips, then the furrow is filled up. Subsequent care consists in sealing the blown whips [34].

On highly mobile sands, where the cuttings are blown out, the lining method is used: brushwood is laid in rows perpendicular to the direction of the prevailing winds; the distance between the rows is 4 m, the width of the strips is 50 - 60 m with double the distance between them; Poles are laid across the rows and attached to the sand with cuttings at least 70 cm long, cut from the best whips. After 1-2 years, after the cuttings and part of the brushwood take root, the resulting shoots are planted on a stump, and the shelyuga begins to bush intensively [34].

Shelyuga is a short-lived breed; therefore, sheluga is used as the first stage of sand consolidation, which allows sowing or planting of tree species between the rows of shelyuga [34].

On the moving sands of the southern regions with deep-seated groundwater, saxaul, dzhueguns and cherkez are used as sand-formers. Areas of moving sands with close groundwater can be fixed by planting tamarisk (comb) [34].

Afforestation on the sands (psammoles reclamation). The nature of the plantations created on the sands is determined by a complex of forest growing conditions. In the practice of afforestation on the sands, various types of afforestation are used: massive, en-echelon, peg (curtain) [34].

Massive afforestation is possible in sandy areas with better forest growing conditions. Such conditions are found in forest and forest-steppe zones with the most favorable climatic conditions. In the steppe zone, this includes relatively leveled areas with broken black earth, sandy loam. On fine-grained deep-water sands (Lower Dnieper sands, belt forests of Altai and Kazakhstan, etc.), massive afforestation is possible with a plant density of 0.4 - 0.6, which provides them with a sufficient feeding area. In the forest zone, soil preparation for continuous planting of forests is carried out by 30-50-meter wings with the same inter-curtain spaces. In protected areas, continuous plowing is possible. Landing is ordinary. The row spacing is 1.5-2 m, the distance in the rows is 0.5-0.6 m. After 3-4 years, the inter-curtain spaces are plowed open and planted. On weakly overgrown sands, belt tillage is carried out [35].

In the steppe zone, in conditions of greater dryness, narrow-stage soil cultivation is used (the width of the stage is 2 m, the inter-stage space is 1 m). In the inter-curtain spaces, the herbage is kept to protect young crops from sanding. In the middle of the stage, one row of seedlings is planted every 0.6 - 0.8 m.The distance between the rows is 3 m.The soil is prepared in the second half of summer by non-moldboard loosening to a depth of 50 - 60 cm.On the overgrown sands of the steppe zone, the wings with a width of 9 - 12 are first planted with pine m, leaving the same untreated strips, which are plowed up and planted in 3 - 5 years. Soil preparation is carried out according to the early steam system. When cultivating the soil, wide (3 m) edges are left to prevent grasses from drying out the soil at the border with untreated areas [35].

Kulisnoe afforestation is used in dry steppe and semi-desert in areas with gentle relief with root-accessible groundwater. The wings are laid with a width of 25-50 m every 100-150 m. With this arrangement, the inter-curtain spaces provide an inflow of groundwater into the plantations. The soil for planting is prepared in autumn or early spring with moldboard plows to a depth of 30 - 35 cm with simultaneous harrowing. Planting is carried out in the spring. Row spacing 3 - 4 m, distance in rows 0.8 - 1 m. For planting use white acacia, mulberry, elm, apricot, small-leaved elm, pine and Crimean pine, pedunculate oak, etc. [35].

Split afforestation is used mainly on the hilly sands of the southern steppes, semi-desert and northern desert, where the poor sands and terrain conditions do not allow for continuous planting. Basins with a close (2 - 3 m) freshwater level are used for forest plantations. mineralized groundwater. The main species is pine, as the most resistant and undemanding to food and moisture. If a. the capillary border of the groundwater reaches the surface of the sand, black alder can be grown by sowing seeds. Poplar, white acacia, apricot, mulberry, and elk grow successfully on humus sands. If mechanized cultivation is possible, narrow-curtain plowing is done every 3 - 4 m and seedlings are planted at a distance of 0.6 - 0.8 m. If the relief conditions prevent this, the soil is prepared manually with 2X2 m plots and 6 - 8 seedlings are planted on each [35].

Thinning plays an important role in the grove plantations due to limited water supply. By the age of 10–12, no more than 1000–1200 pine trees per hectare are left here, white acacia 700–800, poplar 300–600. Later on, only sanitary felling is carried out.

An improvement in the survival rate and growth of forest cultures on the sands can be achieved by the introduction of mineral and organic fertilizers, as well as the introduction, together with the pine, of nitrogen-accumulating cultures (black alder, white acacia, and oleagus) [36].

For forest plantations, and forest-steppes are allocated unused or little-used land in agriculture. In the steppe, forest plantations are placed on areas of hilly sands unsuitable for agricultural purposes. In the semi-desert, for forest plantations, areas are allocated between hilly sands with root-accessible groundwater (fresh or slightly mineralized) [36].

With agricultural use of sandy areas (forage soil-protective crop rotations), it is necessary to create forest belts.

The creation of a system of protective forest belts as a reliable means of combating PPB is also necessary when laying gardens and vineyards on the sands. The distance between the stripes in these cases should be 100-150 m in the garden and 50 m in the vineyards. The distance between the transverse stripes should not exceed 300-400 m. [36].

The consolidation of sands by sowing grasses is carried out in conditions where forest cultivation is difficult, and also in order to increase the capacity of forage lands on the sands.

The most widespread and valuable herbaceous plants-sand-strengthening are sandy oats (kiyak), aristides, kumarchik [36].

Sowing is done manually in hilly terrain. The use of mechanization is possible on flat areas. With aerial sowing, as well as with random sowing, the seeding of seeds occurs naturally, therefore, under the influence of the wind, the seeds are usually carried away from the rises and accumulate in the depressions, where abundant shoots appear. An even distribution of seeds is ensured by the use of mechanical protections. The best time for sowing is after the first autumn rains [36].

Securing sands with mechanical protections. The action of mechanical protection is based on the complete or partial isolation of the loose moving sand surface from the wind. For this purpose, the surface of the sand is covered with rows or all over with bunches of grass (reed) (covering protection), or the bunches are buried upright in grooves, forming rows directed perpendicular to the prevailing winds. Continuous consolidation of the territory with mechanical protection is expensive and is used only in areas where sands threaten important industrial facilities or agricultural land. More often, mechanical protection is installed by wings 30-50 m wide after 100-150 m. In the inter-curtain spaces, forest plantations are carried out. Only the lower third or half of the windward slope is fixed on coarse sands, and only the top of the dune is crumbled [36].

Consolidation of sands by chemical means. In recent years, significant advances have been made in cementing the surface of the sand using chemical means. The surface of the sand is treated with a bitumen emulsion, which forms a porous film that firmly binds individual grains of sand, but at the same time, it passes sediments well and does not interfere with the germination of plant seedlings [36].

A good effect is achieved by using multicomponent fixers obtained from hot mixtures of bitumen and fuel oil with oil, tar with oil or fuel oil with oil. Films formed as a result of covering the sand surface with various fixatives protect it from blowing out, retain moisture, reduce temperature fluctuations on the sand surface, and give high plant survival [36].

Artificial films that fix the surface of the sand lose their mechanical strength and are destroyed in the 2nd - 3rd year, therefore chemical fixation of sands is a preliminary method for creating a cover of herbaceous or woody vegetation under its protection [36].

Annex C

Phyto-reclamation and reforestation measures to combat SDS in Kazakhstan

Fighting moving sands is a labor intensive and costly company. Currently, there are various methods developed and tested in practice both in Kazakhstan and in other countries [37] A special place is given to phytomelioration. Each natural zone has its own list of phytomeliorants. In the dry and deserted steppes of Kazakhstan, wheat grass, alfalfa, sainfoin, etc. are used to restore pastures. Broken sands are fixed with a hammer [37] In the Aral Desert, Scots pine was used as a phytomeliorant to protect the railway. In the deserts of Kazakhstan, great importance is attached to saxaul, as the most successful forest culture, which is widely used to create protective afforestation along roads and railways, in pastures, on the drained bottom of the Aral Sea [38] Plants are able to fix sand with their root systems, especially horizontal roots, which can reach lengths up to 9 m in saxaul and up to 7 m in zhuzgun [39]. They firmly hold plants in the soil and assimilate precipitation. The consolidation of sand particles by horizontal roots promotes the accumulation of sand and the formation of phytogenic mounds from 2 to 5 m in height.

The processes of ecosystem degradation in the Aral Sea region are taking place against the background of the general desertification of the region as a result of the Aral ecological crisis, which affects not only the components of the environment, but also the living standards of the population and an increase in the incidence of diseases of local residents. By the Decree of the Government of the Republic of Kazakhstan dated June 30, 1992, the Aral Sea region was referred to an ecological disaster region. Sand and dust storms, with which the salt-dust aerosol is carried out from the dried seabed, are especially relevant for the settlements located in the coastal zone. Active wind activity in the region continues throughout the year, especially in summer. The creation of Green Protective Belts around settlements can significantly reduce the transport of salt and sand and contribute to the health of the population. The experience of carrying out phytomeliorative measures on the drained seabed and in the village of Karateren [39] made it possible to undertake new efforts to protect the village of Aralkum from moving dunes. For the local population, the looming sands are a huge problem. The main direction of wind activity is SW-NE. Sand dunes have formed on the western outskirts of the village. Currently, the number of houses that have been covered with sand is about 70.

Scientific and practical activities were carried out under a grant from UNDP / Kazakhstan "Demonstration and implementation of mechanical and phytomeliorative methods of fixing mobile sands in the Aralkum settlement on the Aral-Syrdarya project area" in 2016-2017 [40]. The main goal of the project was to demonstrate and implement complex measures to consolidate moving sands to improve the ecological state of the settlement as a whole. Within the framework of the project, phyto-reclamation methods of control were demonstrated together with sand-strengthening measures (mechanical protection) on an area of 2 hectares, work was carried out to train the local population in methods of consolidating loose sand.

To fix the sands and protect the plants from blowing out, cage barriers made of reed (reed), 3 x 3 m2 were installed. For this, trenches were dug to a depth of 30 cm, into which reed mats were installed. Above the sandy surface, the height of the reed barriers was 25-30 cm. 1056 cellular reed defenses were placed on each site (2112 on two sites). Each "cage" of reed mat is capable of holding up to one cubic meter of sandy material annually. Mechanical protection is most effective in combination with phytomelioration methods - planting plants adapted to these growing conditions. A saxaul or zhuzgun bush planted inside such a "cage" fixes the dune even more effectively. In the intervals between the fences, a calm zone forms, and the sand stops moving. The service life of mechanical protections does not exceed 3-4 years. During this time, the sands

must be fixed by plants. For better fixing of the "tops" of moving sands, claying is carried out (a sketch from clay). The claying technique has been well developed in Turkmenistan [41], where the tops of sandy ridges are fixed in this way to protect farm buildings in oil fields, along roads, etc. According to the method, dry clay is injected with a thickness of 2 cm (200 m3 / ha), followed by spraying with water 2 l / m3. Claying of the dunes adjacent to the project area was carried out in the fall of 2017.The list of shrubs and forage crops for phytomeliorative works included local plant species: black saxaul (Haloxylon ammodendron (CAMey.) Bunge ex Fenzl), izen, or twig (Kochia prostrata (L.) Schrad.), Zhuzgun (Calligonum spp), teresken (Krascheninnikovia ceratoides (L.) Gueldenst.), Curl (Atraphaxis spinosa L.).

Based on the experience gained, recommendations were developed [41]. They can be used for laying new sites in other foci of mobile sand formation in the Aral region by local residents and the administration of rural districts.

A project for the retention of sands in the village of Senek, Karakiyansky district, was successfully implemented by the regional department of natural resources and environmental management. A project was also initiated in the village of Ushtagan [42]. The first stage of the project was allocated 20 million tenge from the regional budget. In 2008, the second stage will cost 40 million tenge. In 2009 and 2010, respectively, the third and fourth stages of work to combat desertification were carried out. For the first time in Kazakhstan, such projects are being carried out by Kazakhstani specialists. "The Institute (Research Institute of Geography of the Republic of Kazakhstan.) Has developed a methodology for the implementation of this project, its specialists have analyzed the world experience of sand attack and adapted it on the territory of the Mangistau region using those advanced technologies that exist in the world, in accordance with the funds allocated for the implementation of this project. Ushtagan village is located in the northeastern part of the Bostankum sand massif. The problem of the onset of moving sands for more than 25 years.The sand massif attacked the village, and the local population could do nothing to resist this process, except to dismantle their houses and move them away from the sands. However, today, thanks world experience, the specialists of the Institute of Geography were able to “stop the desert.” A general assessment of the geographical characteristics of the territory, its ecological situation, the state of the soil, flora and fauna, monitoring of climatic conditions, data on wind-sand transport was carried out. and research project. As a result of the research, maps were developed for the relief and hydrogeology of the Sauskan fresh water deposit. A very large block of work has been done to study the vegetation cover. Due to the fact that it was planned to apply one of the methods for stopping the sands - phytomelioration - it was necessary to study the local flora, plant survival. 121 species of plants were identified, plans were developed to implement the phytomelioration method for a particular plant species. For each plant to quickly take root, phytostimulants were used.

The sands are fixed by the installation of mechanical linear or cellular defenses, as well as the outline of crushed-clay materials. Rough-stemmed reed was also used as a material for mechanical protection in the form of a kind of fences, from which mats are woven. The cane was delivered from the Atyrau region, as there is no local material in such a large quantity. Work in these areas will continue, that is, monitoring, scientific research, observation of meteorological conditions, wind speed, temperature regime will be carried out. In addition, research is being carried out on the direction of the speed of movement of sands [43].

One example of the need to consolidate moving sands is the situation in the Shalkar district of the Aktobe region. Within the framework of the project "Study of the territory of the Shalkar region and the development of a plan for the development of green spaces to fix moving sands", the experience of fixing sands was studied, prospecting studies of the soil and vegetation cover were carried out, a technology for creating protective plantations was developed, schemes of recommended measures were proposed and an assortment of tree and shrubs was selected. rocks. An analysis of the earlier work on forest reclamation of the Shalkar region shows that green spaces

are an effective method for improving the quality of landscapes, justified from the economic and practical point of view. When developing a technology for creating protective tree and shrub plantations in the conditions of a dismembered aeolian relief, a manual method of surface treatment with the creation of planting pits, planting seedlings of tree and shrub species and sowing perennial grasses is recommended. It is recommended to install sand-protective permeable barriers on the territory allotted for the creation of protective plantings, the width of which should be at least 50 m. It is recommended to plant trees and shrubs by cuttings and seedlings in early spring or late autumn / 44 /. When implementing the technology for creating protective tree and shrub plantations around settlements, along roads and moving sands, it is recommended to carry out the following measures: - cleaning the territory; - creation of sand-proof permeable barriers; - processing of the fixed surface of the sands with clamps; - breakdown of sites into landing strips; - marking and marking of landing rows and places; - digging in the planting material; - planting and sowing trees and shrubs and perennial grasses; - inventory of protective forest belts; The design of lanes around the villages is recommended, consisting of 4 wings, consisting of two 5-row wings and two 2-row ones. Five-row wings, located to the protected objects, are laid with a width of 20 m, two-row ones located behind them, 12 m wide.The distance between the wings is 12 m.In wide wings, it is recommended to create 5-row plantations of pinnate elm (elm) and three rows of saxaul black. Placing saxaul saplings in the outer rows - after 2.5-3 m. Width between rows of seedlings - 4 m. Placing seedlings in a row - after 3 m. Width between rows in the wings - 3 m. Along moving sand dunes, at a distance of 2 m from their base it is recommended to create a 2-row strip of black saxaul. The placement of seedlings on the landing strips is after 2.5 m.The distance between the rows is 3 m.In the inter-barnacle depressions, it is recommended to create group plantings from the narrow-fruited oak tree, 4-10 seedlings each with a distance of 1.5-2 m. It is recommended to create 2 -x backstage stripes from black saxaul and oleagus sharply. The width between the rows is 4 m. The placement of seedlings in a row is after 2.5-3 m. Depending on the soil conditions around the dunes, it is recommended to use two variants of the planting scheme. In areas where secondary salinization processes have been observed or groups of natural herbaceous vegetation have formed, planting is recommended to be carried out along the outer perimeter of the site. In areas where the entire area of the site has conditions suitable for planting, a spiral planting scheme is recommended, which allows achieving the natural configuration of future plantings, corresponding to natural landscapes, and serves to fix deflated lands. Such a technology will be relevant for fixing dunes in the area of Bozoi / Technical instructions for conducting soil reclamation surveys in the design of land reclamation, removal, conservation and use of the fertile soil layer 1993 /.

To create protective plantings around settlements and moving sands, schemes of measures were drawn up using agrotechnical techniques and planting options, technological indicators were determined, an action plan was developed for the stages of work. In protective plantations made up of their tree and shrub species (elm, saxaul, oak), located in the subzone of brown desert soils, soil care measures are not provided [44]. In the year of the establishment of protective forest plantations, it is recommended to irrigate the planting holes 3-5 times a month during the growing season.

The first plantations were carried out in 1988-1993. by the forestry enterprises of the Kyzylorda region on an area of 54 thousand hectares. From the cultivated volume, 63% remained with the plant survival rate of 28-30%.

Since 2000, forestry activities have been resumed within the framework of international grant projects. The development of phytomelioration technologies is constantly being carried out by the Kazakh Scientific and Production Center for Forestry at 22 sites, with a total area of 400 hectares. In the experiments, the planting of black saxaul, sarsazan, bristly-haired comb, chingil, eremosparton, teresken, astragalus leafless zhuzgun and saltpeter were tested. Planting was carried out with 2-year-old seedlings in early spring or late autumn using traditional moldboard plowing and furrowing technology. Surveillance of survival rate was carried out at the sites. The analysis

of the results showed that from the entire assortment for 4-5 years only black saxaul, comb and sarsazan took root. The highest rates of survival were obtained in spring plantings: saksaul 66%, sarsazan up to 78%, and in autumn it is two times less. The survival rate of saxaul in spring plantings is 0- 136 42%, sarsazan - 0-78%, in autumn plantings - 0-23% and 0-28%, which is due to varying degrees of soil moisture, strong salinization of soils and groundwater / Instructions for conducting large-scale soil surveys of the lands of the Republic of Kazakhstan 1995 /.

Within the framework of international projects, in 2002, the Institute of Botany and Phytointroduction of the Republic of Kazakhstan on an area of 262 hectares planted saxaul, comb and sarsazan taking into account planting technologies and environmental conditions [45] Planting was carried out: • mechanized planting of seedlings with simultaneous sowing of seeds; the creation of plantings on sand-accumulating furrows manually using a growth stimulator (sodium humate); • rows with a distance between plants of 1.5 m, and between rows of 10 and 20 m; • manually with holes with a loose layer of sand with the introduction of a growth stimulator, mineral fertilizer (NPK) and compost (rice husk); • linear-rectangular and spiral. The survival rate using different technologies ranged from 12 to 97%. The analysis showed that the most promising period is spring, the most suitable crop of saxaul (seedlings of 2 years old), and favorable conditions are soils of light texture with a sand cover. On soils with a heavy texture, sand-accumulating furrows and the replacement of clay soil with sand give good results. When planting saxaul and tamarix seedlings by a mechanized method with simultaneous sowing of saxaul seeds (50 ha each) along the inter-sand depressions, survival rate was 12-14%. It is necessary to carry out reclamation (sanding) or use other types of plants. When planting saxaul seedlings by a mechanized method with simultaneous sowing of saxaul seeds (50 hectares) on soils of light texture with a blown sand cover, a good survival rate was determined, which was 37%. After two years, the survival rate of seedlings is 26%. Preservation of saxaul seedlings - 300 ind./ha. When planting along sand-accumulating furrows by hand, the survival rate of saxaul seedlings was 7.6%. In the area with the accumulation of sand in the furrow, the survival rate of seedlings was 24.4%. When planting saxaul seedlings in holes with a bulk layer of sand by hand, the survival rate of seedlings was 91.6%. When planting saxaul saplings by a mechanized method on coastal salt marshes of light texture in depressions between barnacles, the survival rate of seedlings with spiral planting averaged 76%. In the area with a surface layer of aeolian sand of more than 1 cm, survival rate was 98%.

The planting results showed that early spring is a more promising season. The most suitable forest crop is saxaul / 43 /. Experimental work has established that the most favorable ecological conditions for protective plantations are inter-sand depressions with light texture soils. On soils with a heavy texture, sand-accumulating furrows should be created with the replacement of clay soil with sand. The methods are promising when using fencing of plantations. The experience of fixing the territory of the drained bottom of the Aral Sea and moving sands showed that frontal landings do not give a good result, they are not profitable from an economic point of view. It is advisable to create group plantings of black saxaul and shrubs, which will serve as seed banks for natural overgrowing of the surrounding area / Omarbekova A., 2013 /.

The most rational and environmentally friendly method of fixing the centers of mobile dunes of desert pastures is the cultivation of sand-strengthening forest bushes. However, the survival rate of seedlings without artificial regulation of the water regime of sandy soils is usually very low, and irrigation in sandy deserts is difficult to achieve due to the low moisture capacity of the soil, which requires frequent watering in summer and the high cost of water delivery. Hence, the conclusion follows - all types of means should be used to ensure the autonomous improvement of the water regime of the foci of mobile sands of desert pastures, using the entire natural potential of the landscape. According to the author, this can be the use of new materials - synthetic highly swellable polymer hydrogels (SPH) and their substitute materials with high moisture capacity [45]

Experiments in the use of SPH in crop production have shown that they significantly increase the moisture capacity and water retention capacity of sandy soils / Kazansky K. Since 1998 /.

Therefore, the use of SPH when planting seedlings or sowing seeds of pasture plants on sandy desert soils can be considered as a means of increasing their survival rate.

In Kazakhstan, projects are annually initiated to combat sand transfer and SDS, both scientific and industrial. But they are aimed at combating the processes, although they should be aimed at preventing the phenomenon.