MEHMET AKIF ERSOY UNIVERSITY
2006

GEOMED 2016

The 4th International Geography Symposium

BOOK OF PROCEEDINGS

Editors
Recep EFE
İsa CÜREBAL
László LÉVAI

23-26 May, 2016
Kemer - Antalya - Turkey

ISBN 978-605-66576-1-0

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Causes and Impacts of Land Degradation and Desrtification: Case Study of the Republic of Kazakhstan

Aigul TOKBERGENOVA[1], Gulnara NYUSSUPOVA,
Shnar KAIROVA, Lyazat KIYASSOVA

Abstract

The problem of desertification is a serious threat to the well-being of humanity. In addition to the environmental violations, desertification causes a variety of negative social and economic consequences. Soil degradation is always accompanied by the systematic use by the human. However, over the last decades this process has accelerated; just at a time when population growth and forecast of further growth necessitate sharply increase the food production. It is estimated that annually about 50-70 thousand sq. km of fertile land becomes unusable. The main reason for this disastrous phenomenon is the desertification. The main natural factor contributing to desertification processes in Kazakhstan is its landlocked situation determining the continental and arid climate, the scarcity and uneven distribution of water resources, in its turn causing widespread of sands and saline soils. Conditions for developing of land degradation processes are caused by violation of the seasonal peculiarities of soil formation and by drought impacts. Natural features of Kazakhstan cause a weak environment resistance to anthropogenic influences (about 75% of the countries are exposed to high risk of ecological destabilization). Mostly the degradation are exposed the pastures adjacent to the rural settlements, milking machines, wells and distant-pasturing territories. As a result of the research authors identified the most vulnerable to desertification agricultural land and proposed measures for the prevention of desertification. Some of the key measures are the forest plantation and using of pasture ecosystems through their conservation and sustainable use for restoring the functional integrity of steppe ecosystems.

Key Words: Desertification, Land Degradation, Pasture, Drought, Ecosystems.

INTRODUCTION

One of the most acute problems of our time is the problem of land degradation or desertification. According to the terminology used in the Convention, "desertification" means land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities. Desertification is significantly different from the observed phenomenon of cyclical fluctuations of bio productivity of plants on the border of the desert ("enlargement or reduction of the desert"), which is shown by satellite data and is linked to climate variations. Agriculture has a huge impact on the ecological balance of most part of the earth's surface. Limited natural resource potential of land for production purposes of agriculture causes the expansion and development of steppe and forest areas, which disrupts the natural balance, increases the degradation processes, reduces soil fertility. The desire to improve the agro-ecological condition of the land is based on the use of man-made technologies, leading to the destruction of land resources, the pollution of air, water resources and forest areas. Water erosion and deflation of soils

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develop, desertification increases, production reduces, its quality becomes lower. Land degradation and desertification is global phenomenon of our time, concerning most countries in the world. International organizations (FAO, UNEP, ICRAF) pay great attention to the measures to combat this dangerous phenomenon. Active and sometimes irrational human activities in arid regions, that occupy about 30% of land area, have created a real threat to the ecological balance. (Abdieva Z.B., and others, 2003).

Study Area: Land resources of the Republic of Kazakhstan. In Kazakhstan, since the 1960s years to the present day the territory exposed to desertification has increased by 10-12%. Earlier mostly arid and sub-arid areas - generally semi-desert and desert zones and areas of intensive economic use – had been exposed to desertification. Nowadays the border of desertification has moved to the north towards the main grain sowing area of Kazakhstan, which occupies forest-steppe and steppe zones.

Materials: Information basis of the work were based on the statistics and stock materials and data regarding on land degradation and desertification problems of Republic of Kazakhstan from Institute of Geography, Statistics Agency, Committee of Land resources management, Department of environmental monitoring, Ministry of Agriculture of RK, as well as monographs, books and scientific publications of scientists.

The problem of desertification and land degradation in Kazakhstan is given large attention both from the Government and scientists and researchers.

The Law "On ratification of the UN Convention to Combat Desertification, Program to combat desertification in the Republic of Kazakhstan for 2005-2015, the National Action Program and Strategy to Combat Desertification, and etc .documents had been adopted in recent years in Kazakhstan.

Among the researchers of Kazakhstan these issues had been investigated such scientists as V.M. Chupahin, A.B. Chigarkin, E.N. Vilesov, A.R.Medeu, Zh.U. Mamutov, V.M. Borovskyi, F.Zh. Akiyanova, I.B. Skorinceva and others.

METHODS OF RESEARCH

The study of the problem of desertification and degradation of lands of Kazakhstan was based on the following methods: comparative - geographical, cartographical, spatial analysis method, economic and statistical analysis.

RESULTS

Having signed in 1994 and ratified in 1997 the Convention to combat desertification, Kazakhstan took a number of commitments such as the application of an integrated approach to the planning and the implementation of activities to combat desertification and its relationship with the fight against poverty, the promotion of awareness and participation of the local population, encouraging the exchange of information, the transmission, acquisition and adaptation of technologies to combat desertification.

According to the data of November 1, 2015 in the structure of the land fund of the country the reserve land - 100.1 million hectares (38.3%) and agricultural land - 100.8 million hectares (38.6%) are dominated (Figure 1).

In the process of reforming of the agricultural enterprises in 1991-2005 the area of agricultural land in the republic decreased by 136.2 million hectares. In subsequent years the land area increased every year and the total increase from 2005 to 2015 amounted to 18.6 million hectares. (Summary analytical report on the state and use of the lands of the Republic of Kazakhstan for 2015. Astana, 2016).

Despite the fact that part of the agricultural land has been transferred to a variety of non-agricultural purposes, this category of land in 2015 compare to 2014 increased to 2.2 million hectares, mainly due to the development of reserve land (Figure 2).

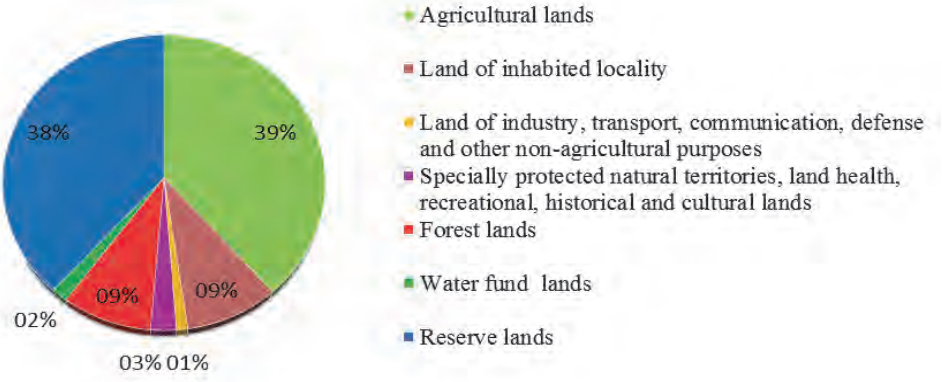

Figure 1. *Structure of the land fund of the Republic of Kazakhstan, on November 1, 2015*

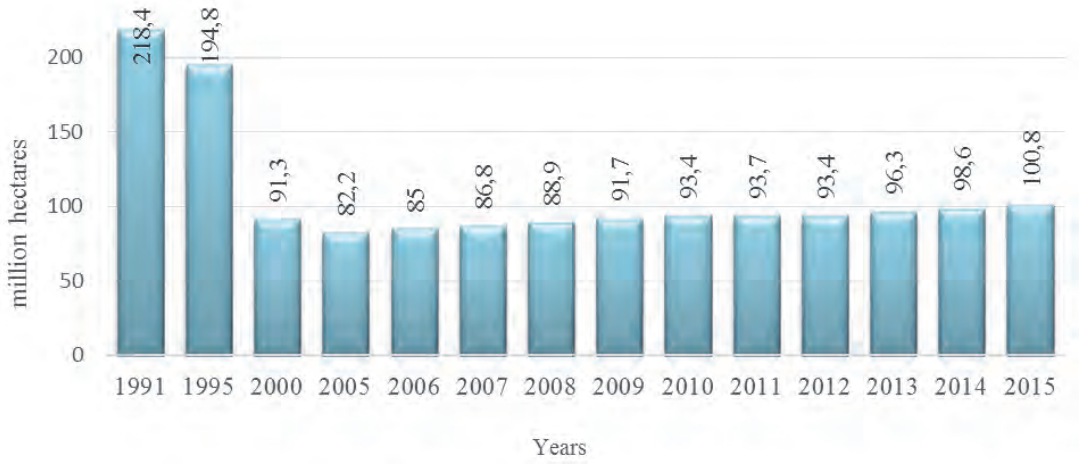

Figure 2. *Dynamics of the agricultural land area in the Republic of Kazakhstan*

The main increase in 20 years took place in Aktobe, East Kazakhstan, Karaganda, Kostanay, North Kazakhstan oblasts. At the same time due to non-use of the land for agricultural production and their lack of demand in a number of areas these lands were converted to reserve lands. This trend is observed in Atyrau, Zhambyl, Kyzylorda and South Kazakhstan oblasts (Figure 3)

In the country in varying degrees, to 26.5% of pasture area are degraded, and it has been happening for over 10 years, but these pastures continue to be used, and they need to be removed from circulation (Figure 5). The general trend towards deterioration of pasture condition is still present, but there are successful examples of reducing degradation due to the back in to the circulation of a number of pasturing areas and the dispersal of livestock from settlements. Currently, the state program to restore the watering wells on pasturing areas with equity participation of land users is launched, that will organize pastures turnover and mitigate impacts on biodiversity. The degradation of pasture areas increases the effect of

extending the processes of desertification, accelerated by the observed climate change. The latter makes the winter warmer, the distribution of rainfall throughout the year more uneven, and summers drier. In mountainous areas, the risk of natural disasters - floods, etc. increases, which can also cause local destruction of existing landscapes and ecosystems. (http://www.zakon.kz/4746870-kazgidromet-na-planete-ozhidaetsja.html).

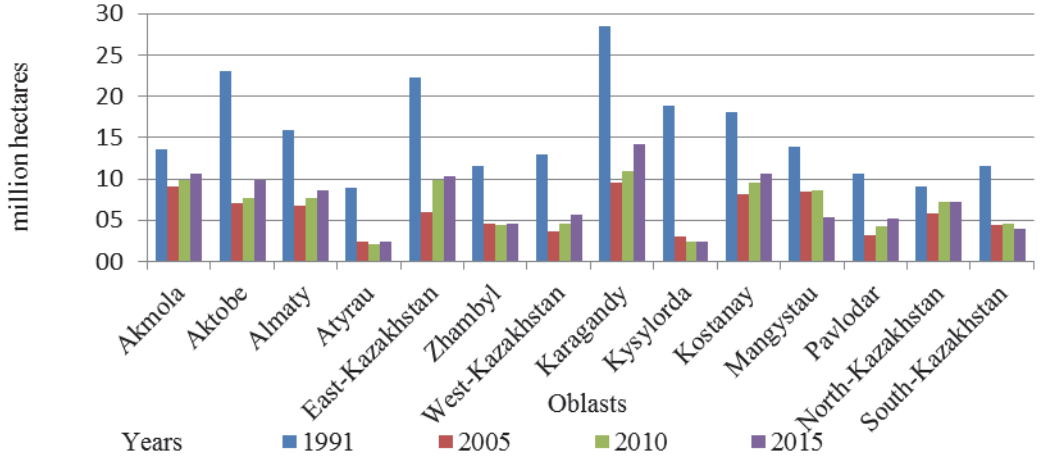

Figure 3. *Dynamics of the area of agricultural land by the oblasts of the Republic of Kazakhstan*

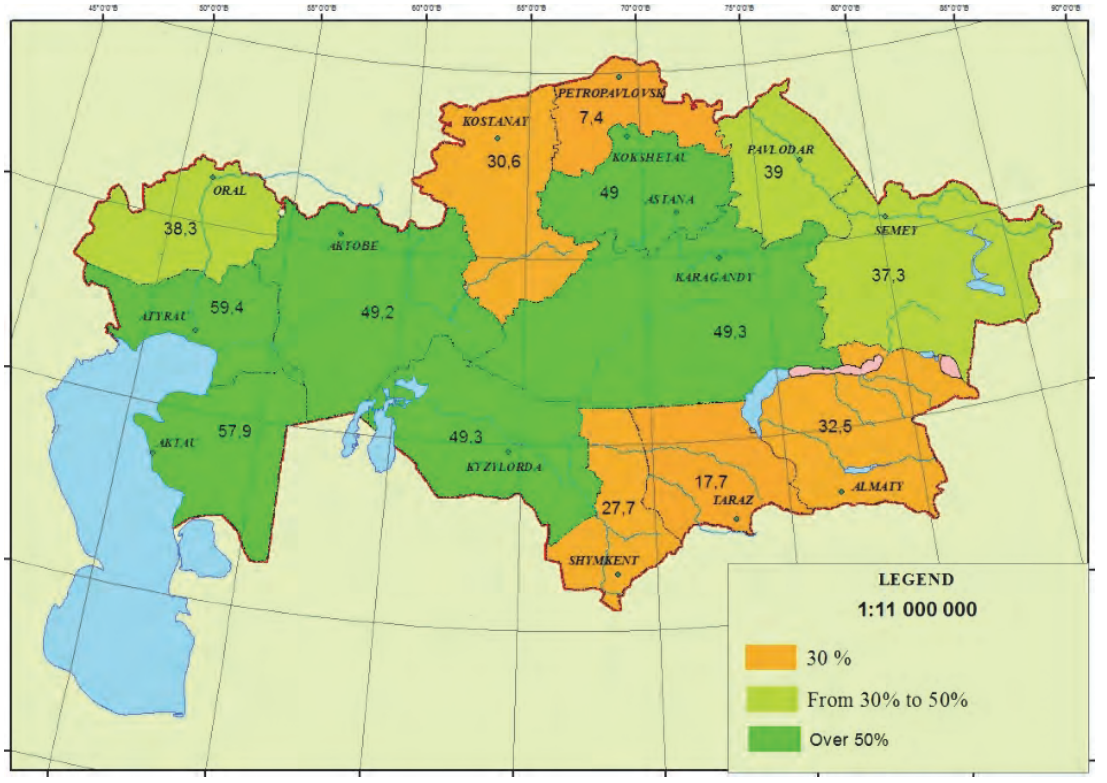

Figure 4. *The proportion of reserve land in the oblasts land fund, on November 1, 2015, %*

The proportion of land in the reserve land fund of the republic as a whole is 38.3%. In the structure of land fund in oblasts it ranges from 7.4% - in North Kazakhstan to 58.4% - in Atyrau oblast (Figure 4).

In the total area of the land fund of the republic (area is 272.5 million hectares) the agricultural land occupies 221.6 million hectares (81.3%) and non-agricultural land- 50.9 million hectares (18.7%), including the forest area and tree and shrub plantings -15.0 million hectares (5.5%), land under water and swamps - 8.8 million hectares (3.2%) and other non-agricultural land - 27.1 million hectares (. 9.9%). The structure of the land fund for the lands of the republic is presented in Figure 6.

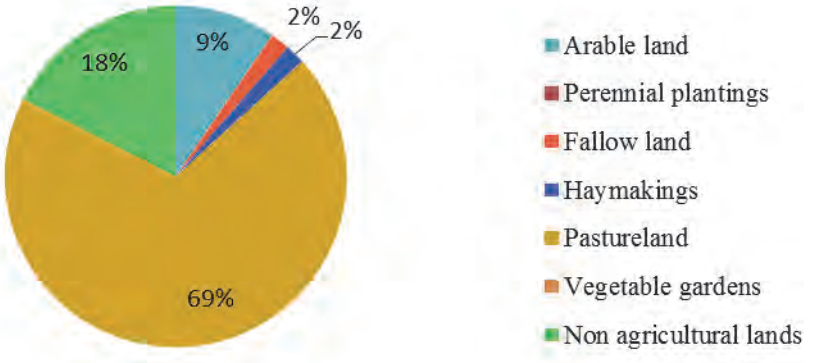

Figure 5. *The proportion of agricultural land in the structure of farm land of the Republic on November 1, 2014, %*

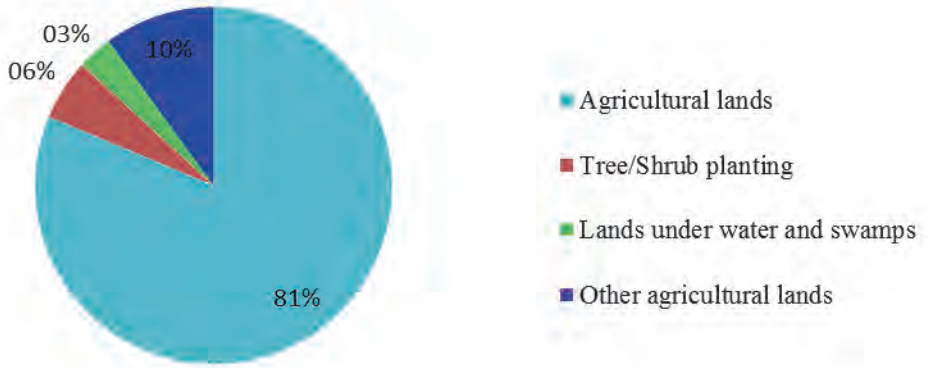

Figure 6. *Land fund structure on November 1, 2015, %*

In recent years the area of agricultural land does not change significantly. There are some changes in the composition of lands due to the transformation and transfer from one category to another. In the structure of farmland the arable farmland is 24 934.7 thousand hectares (11.2%), including irrigated -1 597.0 thousand hectares (0.7%), fallow land - 4 798.4 thousand hectares (2. 2%), hayfields - 5 131.1 thousand hectares (2.3%). Natural pastures - 186 526.6 thousand hectares (84.2%) are dominated, mostly desert and semi-desert

types.

As a result of the loss of land, the area under major crops is reduced from 35.21 million hectares in 1990 to 21.5 million hectares in 2015, including grain - respectively from 23.4 to 15.2 million hectares. Approximately 83.0 million hectares of land were transferred into the reserve land; 10.2 million hectares into part of forest land, 16 million hectares – into the category of settlements land for pasture use, up to 10 million hectares of arable land were transferred into the fallow land as a result of low productivity. The process of natural recovery of these lands without reclamation will require at least 20-30 years.

Erosion is one of the most dangerous types of land degradation, causing the destruction of soil erosion and blowing the top layer of humus-accumulative horizon, and the loss of their fertility. In many cases, erosion arises and develops due to anthropogenic impact. On the territory of the country, along with the erosion of soil the dehumification of soil is the most common of all types of degradation. Erosion causes huge economic and environmental damage, as it threatens the very existence of the soil as the main means of agricultural production and the independent component of the biosphere. The development of erosion processes is caused by both a set of natural conditions (climate, landscape, soil texture, etc.), and the degree of human impact on them and by the intensity of use of land, primarily agricultural one.

Depending on the main factor of soil destruction and the loss of their fertility there discern water and wind erosion. According to the rate of the erosion it is divided into the normal and rapid. Normal is always in the presence of any kind of drainage, it develops slower than soil formation and does not lead to noticeable changes in the level and shape of the earth's surface. Rapid is faster than soil formation, leads to soil degradation and is accompanied by a marked change in landscape. For reasons of erosion there are natural and human-induced erosion. It should be noted that human-induced erosion is not always rapid, and vice versa. (Gusakov V.G., 2010).

According to the data on the qualitative characteristics of the land in the Republic of Kazakhstan there are more than 90 million hectares of eroded and erosion-exposed lands, of them there are actually eroded - 29.3 million hectares. There are 24.2 million hectares or 11.3% of agricultural land in the country exposed to wind erosion (deflated). According to the degree of manifestation of deflation process of land there are three subgroups:

• slightly deflated, include slightly deflated homogeneous soil contours and their complexes with moderately - and highly deflated 10-30% and 30-50% of sand. The total area is 2.2 million hectares (9.1%);

• moderately deflated, include the soil with moderately deflated homogeneous contours, their complexes with medium -, highly deflated from 30 to 50% and 30-50% of sand and sandy soil plain area of light-brown, brown and gray-brown zones and subzones. The total area is 4.9 million hectares (20.2%);

• highly deflated, include the soil with highly deflated homogeneous contours, their complexes with their predominance, moderately deflated and highly deflated soil complexes from 30 to 50% and all the sand too. The total area is 17.1 million hectares (70.7%).

Eroded lands are one of the largest groups of reclamation area, adversely affecting the quality condition of the land and their productivity. Wind erosion manifests itself in the form of deflation of sand and automorphic soils, saline soils and dust storms. Besides natural factors (yielding soil, light texture, active wind activity, etc.) anthropogenic factors play a significant role. In the development of soil deflation. Unregulated grazing (excessive load), shrubs cutting down , chaotic off the roads vehicular traffic promote intensification of

deflationary processes that alter the structural composition, bulk density and humus content, causing land degradation and loss of fertility. The strongest negative impact of wind erosion can be shown during droughty years, when there is the acute shortage of soil moisture. The most active erosion processes are in the vast tracts of sand of Kyzylkum, Moyunkum, large and small Barsukov, Saryishikotrau, in the regions that are in the desert, semi-desert and steppe zones in the soils of light mechanical composition and carbonate soil.

The main areas of agricultural land exposed to wind erosion are located in Almaty oblast - about 5 million hectares, Atyrau and South-Kazakhstan - 3.1 million hectares each, Kyzylorda - 2.8 million hectares, Zhambyl and Aktobe - more than 2.0 million hectares.

The largest proportion of eroded agricultural land (more than 30% of the total area) is located in Almaty, Atyrau and South Kazakhstan oblasts. The lowest proportion of eroded land (5%) as a part of agricultural land is registered in Akmola, Karaganda, Kostanay and North Kazakhstan oblasts. Soils exposed to water erosion (eroded) of the total area of eroded lands cover an area of 4.9 million hectares or 2, 3% of agricultural land. Water erosion is observed in all regions of the country and the intensity of its development is affected by the nature of the relief (steepness and length of slope, size and shape of the watershed), the amount and intensity of precipitation, the type and texture of the soil, carbonate content, salinity, water permeability and the nature of the use of land. The largest areas of eroded soils in the fund of agricultural land are located in the South-Kazakhstan (1.0 million hectares), Almaty and Mangistau (0.8 million hectares each), Akmola (0.6 million hectares) oblasts. (Summary analytical report on the state and use of the lands of the Republic of Kazakhstan for 2015. Astana, 2016).

To fulfill the obligations of the UN Convention to Combat Desertification and to prevent degradation and desertification of land, Kazakhstan is taking certain measures.

One of the most effective steps of Kazakhstan in this direction is the implementation of the regional integrated program "Central Asian Countries Initiative for Land Management (CACILM)", aimed at combating desertification and drought in the context of the UNCCD and supporting the productive functions of land resources.

DISCUSSION

The main economic impact of desertification and land degradation include reduced crop yields and pasture productivity, reducing the livestock capita and their productivity and export potential of agriculture. In this regard, the identification of factors of degradation and desertification of the Republic of Kazakhstan is an urgent task (Chupahin V.M., 2010).

The problem of desertification is a problem of global importance. 70% of the world's arid lands or nearly 3.6 billion hectares have been degraded. In Central Asia, the total area affected by desertification amounts to more than 1073 thousand km^2, that is due to the extensive use of land and leads to their degradation. (Abdullayev A.K., 2010).

In the absence of cooperation with agricultural enterprises to improve their recovery of agriculture and soil fertility Kazakhstan by 2025 will be able lose up to 50% of its farmland because of soil erosion and degradation.

The Republic of Kazakhstan is the ninth largest in the world in the area of its territory. The country is characterized by desert, semi-desert and steppe, and the combination of the arid and continental climate makes the ecosystems vulnerable to desertification / land degradation. Another factor influencing the aggravation of the problem is human activities. Currently, the desertification processes take place in all regions of Kazakhstan. Moreover, there is the tendency to their acceleration. At present, nearly 180 million hectares out of the

272.5 million hectares of the country's territory are subjected to desertification, which is 66 percent of the land (Figure 7). Wind erosion swept flat lands: more than 20 million hectares of arable land and 25 million hectares of pasture are exposed to it. Water erosion hit 19.2 million hectares of land, and if we add to this man-made desertification caused by industrial activities, the loss of humus in soils and salinization of irrigated lands, then, in general, the problem appears to be quite serious. Over the past 40 years, the humus content in the soil decreased by 20-30%, while the total damage of the Republic of Kazakhstan is estimated at $ 2.5 billion (http://news.caravan.kz/news).

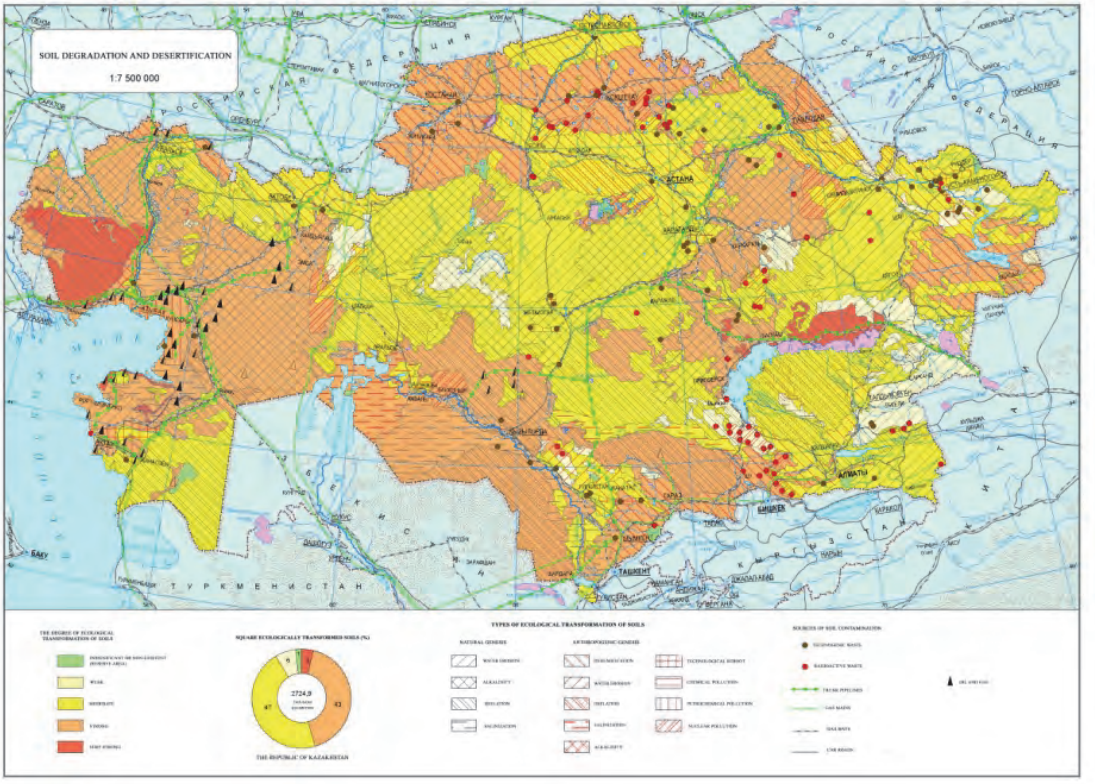

Figure 7. *Desertification and Land degradation territory in the Republic of Kazakhstan*

The total alteration of ecosystem in Kazakhstan took place more than 50 years ago after a massive plowing of steppe and forest steppe zones. Grassland steppe plowing on the plains is up to 90%, on low hills is up to 30%. Dry steppe is plowed up to 50-60%, and low hills are up to 10-15%. On the other types of landscapes suitable for grazing, until the late 1980s, there was rapidly degrading pastures. After the collapse of the Soviet Union and the economic collapse of the 1990s the restoring of natural ecosystems on fallow lands and abandoned pastures began. For the last 5 years, on the one hand, the recovery of natural ecosystems has been continuing, on the other hand - previously abandoned areas have been back into the economy and there was increasing local overgrazing near settlements due to the growth of livestock. According to data for 2015, up to 15% of agricultural lands are used inefficiently, about 125 million hectares of pastures are not irrigated and not used, 9 out of more than 20 million hectares of pasture adjacent to settlements are classified as degraded. Due to the lack of adequate control in Northern and Central Kazakhstan 5.6 million hectares

of arable land are affected by water erosion and the yield of grain crops reduced by 20 - 30%.; the degradation of agricultural land in 9 out of 14 oblasts of Kazakhstan, including grassland, is 30-50% and somewhere is higher. Soil salinization, water and wind erosion, reduction of humus, repeated salinization with release of water after irrigation are marked on more than 90% of the arable land of the country. Nowadays the problems of the irrational use of land and livestock grazing economy are aggravated by numerous small agro-industrial and livestock units which do not have sufficient resources for the full management of territories. (Fifth National Report of the Republic of Kazakhstan on Biological Diversity for 2011, Astana, 2012).

According to the Land Management Committee for 2015, up to 15% of agricultural land is used inefficiently. About 125 million hectares of pastures are not irrigated and not used, due to irrational use more than 20 million hectares of pastures adjacent to settlements are classified as degraded. The extent of desertification and land degradation of the Republic of Kazakhstan can be seen at Figure 8.

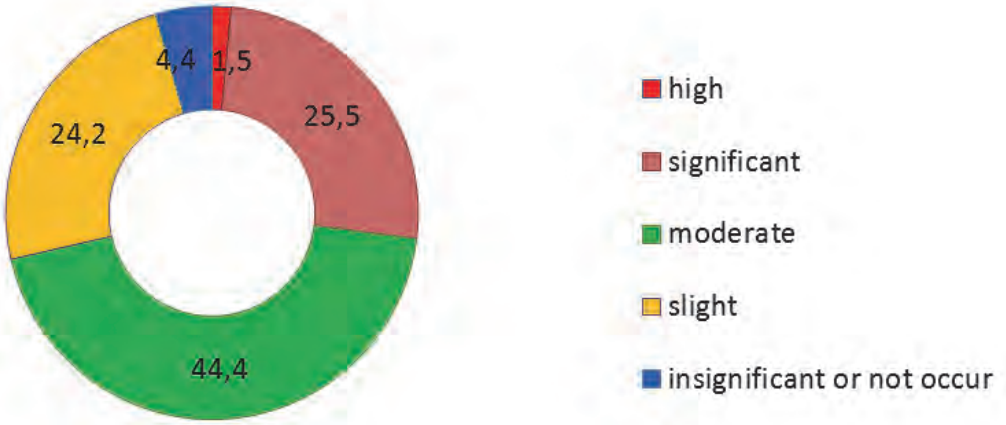

Figure 8. *The extent of desertification and land degradation of the Republic of Kazakhstan, %*

Natural sources (factors) of land degradation are a sharp continental climate, natural stocks of salts in deposits of alluvial plains, deflation, erosion and mudslides, salt and dust aerosols from the dried bottom of the Aral Sea and others.

Industrial sources: liquid and solid emissions from industrial plants and oil and gas sector, emissions of transport and radiation-chemical pollution, waste of military space complex, greenhouse and ozone-depleting gases, waste in the areas of mining, oil and gas and construction of linear and point structures not accompanied by remediation activities.

The main natural factor contributing to desertification processes is a landlocked position of the country, that determines the arid climate, the scarcity and uneven distribution of water resources, widespread sands (up to 30 million hectares), saline and salted soils (more than 93 million hectares). These natural features of Kazakhstan cause poor resistance of the environment to human impact, such as illegal logging, fires, unsystematic recreation, soil and groundwater contamination. (Regional Action Plan on the protection of the environment, approved by the decision of the Interstate Commission on Sustainable Development, Astana, 2001).

About 43% of the population lives in rural areas, and most of them are dependent on income, directly or indirectly related to the agricultural sector and land use. Kazakhstan

ranks sixth in the world in terms of its pasture resources (188 million hectares), and the total area of degraded pasture land as of January 1, 2010 amounts to more than 48 million hectares, which is about 26%. /Resolution of the Government of the Republic of Kazakhstan, 2010/

In addition, there are 180.2 thousand hectares of disturbed land. The main reasons of degraded pastures can be seen on the bellow table.

Table. 1: *Key Indicators of degradation (desertification) of pastures done by L.Kurochkina (Kurochkina L.Y., and others, 2005)*

Type of desertification	Degree of desertification				Causes of desertification
	slight	moderate	high	very high	
Degradation of vegetation	signs of degradation in drought years	Reducing the size and productivity of plants, rare plants replacement, the appearance of weeds	Replacement of main types of plants by unwanted and annuals, productivity reduction, reducing the seasonality of use	Strong thinning and blocking up with unwanted species	Grazing, cutting of shrubs, littering
Soil degradation	Slight surface disturbance, recovery is possible	Surface loosening or consolidation, salinity increasing, drying	Signs of deflation, silt removal	Strong salinity, waterlogging at flooding	grazing, plowing, pollution, the impact of wild animals

CONCLUSION

The analysis of materials on desertification underlines the predominance of anthropogenic impact on the destabilization of the environment. The most susceptible to desertification are Aral and Ile-Balkash regions with the population of 5.4 million people. The overregulation of river flow resulted in the cessation of flooding, lowering of groundwater levels, an increase in the amount of saline land and reducing the livestock capita. Water shortages have had a negative impact on economic development and people's living conditions. The conditions in wild animals and fish habitat deteriorated. In the Northern and Central Kazakhstan 5.6 million hectares of arable land were affected by water erosion and the yield of grain crops decreased up to 20-30%. In the Caspian Sea region 357 thousand hectares of fertile coastal pastures and hayfields were flooded. The land around industrial centers was contaminated by industrial enterprises emissions. About 10 million hectares of pasture and arable land were withdrawn from circulation at the sites of military-industrial complex. The damage from desertification in Kazakhstan is estimated at tens of million US dollars. Depletion of water resources caused a decline in production, cut jobs, lowered the standards of living of the population and led to the migration of people from the areas of ecological crisis.

Of the 14 oblasts of Kazakhstan, only five (Aktobe, Mangistau, North Kazakhstan, Karaganda and Kostanay), have negative signs (i.e. desertification) on a 30% of forage land. In the other areas, the degradation is up to 30-50% and higher.

On the arable lands everywhere soil erosion and dehumidification intensified. The humus content was decreased by 25-30%. Due to it, soil fertility, productivity of grain crops was decreased. 17 million hectares of arable land were taken out of use, as fallow land and pastures. But the fallow lands, overgrown with tall-weeds, promote the increase of insects – the pests of crops. There were soil salinization, water and wind erosion, reduction of humus, salinization with discharges of water after irrigation on neighboring territories on more than 90% of the republic's territory. Problems with the irrational use of land and livestock grazing economy are aggravated by numerous small agro-industrial and livestock units which are not able to provide a cost-effective use, purchasing equipment, fertilizers, veterinary services for livestock, its relocation, to provide insurance stocks of feed, processing of agricultural products. There are socio-economic problems of the reorientation of farms. Under these conditions, the unsystematic use of high-grade natural land is enhanced, without taking into account the norms of resource withdrawals, i.e. their degradation; the degree of desertification is enhanced.

As a result of the research we identified main conclusions, such as:

1. Kazakhstan is characterized by: climate aridity, arid areas, the uneven distribution of water resources, low forest cover, the dominance of the steppe, semi-desert and desert landscapes that causes poor resistance of the natural environment to techno genic effects, so the problem of desertification in Kazakhstan is very important.

2. Most of the territory of Kazakhstan is located in a zone very vulnerable to anthropogenic desertification, when with the natural factors of desertification the environmental situation is rapidly deteriorating. The main areas of environmental stress and soil degradation in Kazakhstan are the Aral and Caspian regions, as well as abandoned land in the northern regions of the country. The most widespread in Kazakhstan (40.4% of agricultural land) is wind erosion (deflation) of soil on sandy areas and areas of light texture soil and carbonate soil. More than 11% of farmland is affected by water erosion.

3. Economic development indicators have steadily increased trend, there is GDP growth. Positive trends in the industrial and financial sectors of the economy, despite the possibility to support the implementation of social programs, are creating an increase in the load on the environment, in particular, the area occupied by solid industrial and domestic waste, the amount of waste water, emissions of toxic pollutants is increasing. Desertification is accompanied by contamination of soil, groundwater and surface water, reduction of the biological potential of the entire region.

4. The main economic impacts of desertification/land degradation include the decline in crop yields and crop production, declining livestock productivity, reducing export potential in agriculture, slowing the development of food and the light industry, a sharp decline in tax revenues from processing and agriculture sectors.

5. The evaluation found that the major economic and social losses caused by land degradation are not connected with a decrease in volume of the total product produced in the region, but with a decrease in its natural potential.

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