Ecological consequences of the desertification process in the agrolandscapes of the Kashkadarya oasis

Abdusali Suyunov[1], *Shukhrat* Suyunov[1], *Farrukh* Khushmurodov[2*], *Samaritdin* Suyunov[3], *Ismoil* Omonov[1], and *Bekhzod* Eshboev[2]

[1]Samarkand State Architecture and Construction University Named After Mirzo Ulugbek, Samarkand, Uzbekistan
[2]Karshi State University, Karshi, Uzbekistan
[3]Samarkand Institute of Archaeology, Samarkand, Uzbekistan

Abstract. This scientific article examines the consequences of entanglement processes in the agro-landscapes of the Kashkadarya Oasis. Special attention is paid to soil degradation, pest infestation, erosion, changes in hydrogeological regimes, and the impact of these factors on the sustainability of agroecosystems. The study identifies the main causes of degradation, including anthropogenic and natural factors such as inappropriate use of land resources, irrigation erosion, rising groundwater levels, climatic changes, and low efficiency of land reclamation systems. Methods of geographic information modeling, landscape analysis, remote sensing, and statistical monitoring are used to assess the dynamics of these processes. The authors propose strategies for sustainable agro-landscape management, including introducing modern irrigation technologies, crop rotation, and measures to restore degraded land and prevent vegetation clearance. Raising environmental awareness among the population and integrating a landscape approach to natural resource conservation is also emphasized. It concludes that comprehensive measures are needed to prevent soil degradation, increase agricultural productivity, and adapt the region to environmental changes.

1 Introduction

One of the most serious ecological and socio-economic problems facing humanity today is the problem of desertification. Desertification is a combination of the interaction of natural-geographic and anthropogenic processes, which means the degradation of ecosystems in arid regions, the degradation of organic life forms, and the reduction of the natural-economic potential of these regions. As a result of the strong impact of human economic activity, the process of desertification is deepening and expanding in the territory of Uzbekistan. According to studies, more than 60% of the territory of Uzbekistan is undergoing desertification at various levels. The rapid progress of the desertification

* Corresponding author: farrux.xushmurodov86@mail.ru

process leads to many socio-economic and ecological consequences. Deterioration of the ecological situation due to the process of desertification is typical for the regions of Uzbekistan, including the Kashkadarya oasis. Therefore, studying the geographical aspects of the desertification processes taking place in the Kashkadarya oasis is one of the urgent problems today.

Desertification is the degradation of land, water, vegetation and other resources, the drying of the climate with the decrease of rainfall, and the destruction of natural ecosystems caused by the expansion of the area of desert areas. The sharp expansion of the desert area in the arid climate region since the 1960s is primarily due to the continuous increase in the number of people in the countries, the expansion of the arable land for the purpose of providing the population with food, the development of agriculture, and in a certain sense, the frequent occurrence of droughts.

It is to study as much as possible the process of desertification taking place in the Kashkadarya oasis. To achieve the goal, the following tasks were taken: collecting and analyzing information on the topic; study and analysis of natural geographical conditions of the region; assessment of desertification in different ecosystems in the region.

Studying the effects of desertification on ecosystems (landscapes) is a research subject.

Many studies have examined the phenomenon of entanglement in agro-landscapes, focusing on the mechanisms of interference and competition between plants, as well as their impact on agroecosystems and crop yields. For instance, David Tilman from the USA has conducted pioneering research on environmental competition and biodiversity, emphasizing the role of interspecific interactions in agroecosystems. Stephen Pacala, also from the USA, has developed models of plant community interactions, including competitive processes, which enhance our understanding of entanglement in agro-landscapes. An important contribution to the study of interactions between invasive and native plants comes from Ingrid M. Parker, who has investigated the effects of competition and entanglement on ecosystem functions. Together, these studies lay the groundwork for developing sustainable agro-landscape management strategies aimed at improving the productivity and stability of agricultural ecosystems.

The agro-landscape is a product of human intervention, shaped by various agricultural activities. Its structure should include the organisational elements of the land and the agrosystem. To accurately assess the efficiency of land use within an agro-landscape, it is necessary to consider not only land productivity, ecological conditions and the distribution of agricultural and natural areas, but also how these factors evolve over time. Such an approach helps to identify and predict potential negative trends within the agro-landscape, allowing timely adaptation to promote more resilient and environmentally friendly agro-ecosystems. Maintaining soil fertility in these systems is highly dependent on the balance between cultivated area and moisture availability.

2 Materials and methods

Among the important scientific approaches and principles in the study of the topic, the ecological-landscape principle, the systematic complex approach forms the basis of the research, and the use of landscape indication, in which aerospace, cartographic, paleogeographic, geographic-comparative, statistical, geo-informational modeling (GIS modeling) and other methods allow to achieve the main result. gives Many scientific researches have been carried out about the Kashkadarya region and its nature in the fields of natural geography, landscape science, reclamation geography. On the geological structure and climate of the Kashkadarya oasis, L.M. Rasulov, O. Yu. Poslavskaya, L.N. Babushkin, I.A. Khasanov, A.M. Mamatov, F.M. Khushmurodov Scientists such as conducted scientific research.

The process of desertification is a combination of natural-geographical and anthropogenic factors leading to the destruction of landscapes, i.e. ecosystems in arid regions, degradation of organic life forms (French word "degradation" and gradual degradation of natural resources) - it is clear that the economic potential is reduced. As a result, the standard of living and the population's health are greatly affected, eventually leading to population migration.

The United Nations Convention to Combat Desertification summarises studies and definitions of desertification and defines it as follows "Desertification is caused by various factors, including climate change and human activities. It is the degradation of land in arid, semi-arid, and sub-humid regions. In this definition, the word 'land' includes soils, local water resources, land surface, and vegetation cover (or crops).

The problem of desertification was first recognized globally at the UN International Conference in Nairobi in 1977, which adopted a program to combat desertification. The development of the desertification process depends on the interaction of natural and anthropogenic factors and the natural and economic conditions of the area. Natural factors create conditions for the development of the desertification process under certain conditions. The desertification process is mainly anthropogenic and has serious socio-economic and political consequences.

At present, 33% of the world's land area is considered desertified or at some risk of desertification, and 70% of agro-landscapes in arid regions are subject to varying degrees of desertification. According to A.G. Babaev, as a result of desertification, the prolonged drought that occurred in the southern coastal zone of the Sahara in 1968-1973 left the region in a devastating and tragic state. As a result, many countries suffered huge economic and social losses. In particular, pastoralism and spring-fed agriculture lost productivity, there was a shortage of fodder for livestock, millions of animals died from lack of water and more than 250,000 people living in the coastal zone died.

According to UNEP, 50,000 km² of agricultural land is lost every year to desertification in the context of climate change. The economic damage caused by desertification amounts to $42 billion. 135 million, forcing people to live under the threat of forced migration. However, the social damage caused by desertification is known to be much greater. The desertification process has an indirect effect on the regions involved in the process, i.e. it causes a decrease in water resources, biodiversity, and zonal climate change in other regions. As a result, it leads to a decrease in productivity in many regions, food shortages, and an increase in food prices.

The documents adopted by the United Nations at the International Conference on Environment and Development, held in Rio de Janeiro from 3 to 14 July 1992, play an important role in combating desertification. Attended by more than 1,500 experts, scientists, and heads of state from over 160 countries, the conference adopted important international documents on the problems of sustainable development and defined the attitudes of countries to environmental problems and future environmental policies. At the conference, humanity adopted the "Graph of Sustainable Development in the XXI Century", which depicts the transition from the present to the future.

In 2002 and 2012, international summits on sustainable development were held in the city of Johannesburg, South Africa. For example, on 20-22 June 2012 at the International Conference on Sustainable Development were discussed the issues of "green economy" and "sustainable development".

The 12th chapter of the agenda of sustainable development of the XXI century includes the problem of combating desertification and drought. The need to adopt the UN Convention to Combat Desertification is stressed. At present, the Convention has been ratified by more than 150 countries of the world. In particular, the Republic of Uzbekistan

ratified the UNCCD on 7 December 1994. The UN Convention to Combat Desertification proclaims 17 June as the International Day to Combat Desertification.

According to professor and desert inhabitant S. Abbasov, the first typological classification of Central Asian deserts was made by L.S. Berg. He divided the deserts of Central Asia into four types according to the composition of the parent rock: sandy, clay, salty, and stony. M.G. Popov in the typological classification of Central Asian deserts from the geobotanical point of view of L.S. Based on the types of deserts distinguished by Berg, he distinguished the following types of deserts 1) Hamad deserts (old rocks without gypsum and young rocks with gypsum); 2) sandy deserts; 3) saline deserts; 4) wormwood-rocky deserts (serir); 5) ephemeral clay deserts.

E.P. Korovin and D.N. Kashkarov in their article "Types of deserts of Turkestan" ("Types of deserts of Turkestan") divide the deserts of Central Asia into two types of deserts according to climatic peculiarities, the origin of fauna and flora. These are 1. Mediterranean-type deserts, which occupy the southern part of Turkestan (Central Asia). 2. Deserts of Central Asian type, which belong to the northern part of Turkestan. In addition to these main types, deserts are divided into four types according to the nature of the parent rock: sandy, clay, solonchak, and gypsum. Here the authors used the edaphic principle in addition to climatic-biogenetic principles in the typological classification of Central Asian deserts. For example, within the deserts of Central Asia (northern desert), sandy, wormwood-shock, wormwood, and wormwood-betagal deserts are distinguished.

A decrease in the productivity of arable land is observed in all regions of Uzbekistan, including the oases of the Kashkadarya basin. The decrease in the amount of humus and perennial plants in the soil has a positive effect on this. Soil productivity is usually calculated in terms of credits, and the evaluation criterion is set from 0 to 100 points. We do not care how the score is calculated, but it should be noted that the higher the score, the more productive the soil. We know from sources that since the early 1990s the credit rating of irrigated land in Uzbekistan has fallen from an average of 55-65 points to an average of 10 points. According to this indicator, the soil quality score in the irrigated areas of the Kashkadarya basin ranges from 41 to 51 points, which is 15 points lower than the average score for our republic. It can be seen that the reliability of the soil cadastre in the oases of the basin is at the level of "average" or "below average".

In 2012-2013, the quality of irrigated land in the regions of southern Uzbekistan was assessed. As a result, the average credit rating of irrigated agricultural land in Surkhandarya province was 56.0, and in Kashkadarya province - 52.5. Compared with the 1999 indicators, the average credit rating in the republic increased by 3 points, and in Surkhandarya and Kashkadarya provinces by 2 points.

The agro-landscape is considered the basis of human life and activity and is a unique system. By studying agro-landscape systems it is possible to learn the laws of material and energy transformation, adapt them to agricultural production and determine whether it is ecologically safe and economically acceptable. The ecological-landscape principle makes it possible to achieve maximum uniformity of natural conditions in the conditions of land use, which contributes to solving the problems of production specialisation, production control, land cadastre and economic evaluation of land. It is also necessary to take into account the existing socio-economic conditions of land use by agricultural enterprises, the specific location of settlements, general economic and other engineering facilities.

Agro-resource conditions and agricultural specialisation are specific to each region. The following types of resources can be distinguished in agricultural production:

- Agro-climatic resources.
- Soil and land resources.
- Plant food resources.
- Water resources.

The study of agro-landscapes should be based on important scientific approaches and principles. These include the ecological landscape principle, the systems approach, the landscape indicator, geo-information modelling, etc. The application of these principles has been developed in recent years on the basis of Geographic Information Modelling (GIS), the process of applying data derived from digital images of the earth's surface. This makes it possible to achieve maximum uniformity of natural conditions in land use, solve problems of production specialisation, effectively implement production control, land cadastre and economic evaluation of land. Moreover, in the process of agricultural land use it is necessary to take into account the existing socio-economic conditions, especially the location of settlements, general economic and other engineering facilities.

In modern landscape-ecological studies, more and more attention is being paid to the watershed concept, according to which the watershed, as a separate, integral geosystem of the landscape sphere, is the most promising for the integrated study of nature and nature management. The river basin is a natural, highly functional, holistic, self-regulating, paradynamic and paragenetic geosystem with clearly defined boundaries. These characteristics allow us to consider the geosystem of the river basin as a functional integral system as an objective basis for a comprehensive solution of problems in the field of territorial protection of landscapes.

3 Results and Discussion

The concept of sustainable development recognized and implemented in all countries of the world, including Uzbekistan, is based on equal rights of nature, economy and social spheres. In all regions, including the Kashkadarya oasis, rational use of natural resources, their protection, and finding solutions to existing environmental problems are the basis of sustainable development. From this point of view, the use of nature and its protection is an important means of sustainable development.

The Kashkadarya oasis is located in the south of Uzbekistan and includes the Karshi steppe, the Kitab-Shahrisabz basin, Hisar and Zarafshan mountains, and sub-mountain slopes. Kashkadarya oasis is separated by the southwestern branches of the Hisar mountain range located in the southeast of Kashkadarya, and in the north by the northwestern branches of the Zarafshan ridge located in the Zarafshan valley. The land surface rises from west to east and north-east and mainly consists of delta plains, foothills, medium and high mountains. The territory is crossed by the Kashkadarya river from the northeast to the southwest. The climatic conditions of the Kashkadarya Valley are unique, with significant variations in annual and daily temperatures, uneven distribution of precipitation throughout the year and low rainfall, high air and soil temperatures in summer, and low temperatures in winter, resulting in dry air and excess moisture from the soil differs by evaporation.

According to experts, 23 hectares of land around the world are becoming desert every second. If this trend continues, by 2050, 95 percent of the Earth's surface could be desertified, leaving more than 3 billion people in need of food. Every minute, 9 square meters of territory of Uzbekistan is becoming desert. Desert scientist prof. According to L. Alibekov, the total area of arid climate lands is about 40 million. km^2, which is about 25% of the land area, where 20% of the earth's population (800 million people) live. Desertification is mainly influenced by natural and anthropogenic factors. According to N.F. Reimers (1990), anthropogenic deserts cover 10 million square meters of land surface. km^2 area or 6.7%. According to some researchers, most of the deserts are the product of human activity. Currently, desertification of different levels of the land area of our planet is developing in an area of 25 million km^2. Anthropogenic factors include improper irrigation of land and land pollution of agricultural land, unreasonable use of natural resources, ie industrial waste, mining of stone, sand and minerals. V.A. Rafikov states that currently the

following forms of desertification processes are being observed in the South Aral Bay area: - land salinization; - drying up of lakes and reservoirs; -land degradation; - salinity of surface and underground waters; - flooding of irrigated lands; - migration of soil and salts, etc.

The problem of combating desertification was first adopted at the global level at the 1977 United Nations conference in Nairobi with the Plan of Action to Combat Desertification. The International Convention to Combat Desertification defines desertification as follows: "Desertification refers to land degradation in arid regions due to a variety of factors, including climate change and human activity." Especially in the Kashkadarya oasis, which is located in the center of Central Asia, the process of desertification is mainly formed due to the irrational use of land resources, the increase in the number of livestock, the cutting of bushy plants in the deserts as firewood, the development of the mining industry, that is, under the influence of natural and anthropogenic factors. Due to the fact that more than 70% of the territory of Uzbekistan is located in the desert and semi-desert regions, events such as salinization of irrigated lands, wind and water erosion, and the rise of ground water level in pastures are taking place in large areas. As a result of this, the productivity of the land used in agriculture is gradually decreasing, the production of food, fodder and industrial raw materials is becoming more complicated, and the quantity and quality of landscapes are being degraded, such as the impoverishment of natural landscapes.

Just as all the early civilizations of the world arose and developed in areas of irrigated agriculture, agriculture in Central Asia probably arose mainly on the basis of artificial irrigation. As a result, irrigated agriculture causes a number of negative environmental consequences and leads to desertification. L. According to Alibekov, these are mainly irrigation erosion; accumulation of agroirrigated cultural layer of the soil; secondary soil salinity; pollution of ground and soil (waterlogging); pollution of surface and underground water; shallowing of rivers; is manifested by the subsidence of the terrain.

The Kashkadarya oasis has been irrigated since ancient times, and irrigated agriculture has developed. It is easy to observe that natural geographical processes such as water erosion, wind erosion, gravity processes, floods, silting, swamping, salinization, and siltation have the most negative effects on agriculture in the irrigated agricultural zones of the oasis. The area of irrigated land in the region has expanded due to the construction of many water structures during long historical periods. There are more than 5157 km of canals in the Kashkadarya oasis, which serve agricultural crops and households. But most of these canals were built in the last quarter of the last century, and currently do not fully meet agrotechnical requirements. Because a certain part of these canals was not concreted, and as a result of the water seeping from them into the ground water, the ground water level of the area rose. To prevent this, there is a shortage of drains. 50 pog.m per hectare of irrigated area in the Karshi desert. the ditch should be right, but this indicator is almost 23 pog.m. does not exceed.

Soil erosion starts mainly in places where the relief is uneven and high and the erosion base is large. Water (irrigation) erosion; accumulation of agro-irrigation on the cultural layer of the soil; secondary salinization of soils; soil and subsoil pollution (overwatering); pollution of surface and groundwater; shallowing of rivers; manifested by land subsidence. On agricultural land, irrigation is divided into leaching and gully erosion. As a result of erosion, 60 times more nutrients are leached out in one year than the amount of fertilizer applied to the land each year.

The role of climate in the development of water erosion is vital. The erosive character of rainwater depends on its speed and volume. In Kashkadarya province, irrigation erosion is widespread on sloping plains and hills (on irrigated lands of grey soil zone), and such

lands become unsuitable for cultivation. This type of erosion is found in agro-irrigated landscapes of Kitab-Shakhrisabz marsh.

In Kashkadarya province, vegetation cover and soil processes have changed under the influence of irrigation. In Kashkadarya Province, the area of land affected by processes that hurt agro-landscapes is increasing from year to year. The example of the Karshi desert shows that the former desert with sparse vegetation has been replaced by a geographical landscape with a completely new vegetation cover of oases. Today, however, the irrigation of land in the Karshi desert raises the level of saline water underground and causes secondary salinization of the soil. It has been observed that seepage water flows to the surface around the main canal and ditches and in some depressions, causing waterlogging of the soil and expansion of reed beds.

Studies have shown that irrigation erosion leads to changes in or deterioration of the water-physical and agronomic-chemical properties of irrigated landscapes. These processes reduce the amount of humus, nitrogen, and other nutrients in the soil.

Their largest massifs correspond to the middle and lower reaches of the Kashkadarya basin. In the following years, the expansion of the irrigated land area in the region also led to the expansion of the land area requiring land reclamation improvement.

Table 1. Irrigated land area of Kashkadarya region.

No.	Years	Area of irrigated land (in thousand)
1.	1915	63.4
2.	1950	120
3.	1970	171.5
4.	2000	453.6
5.	2015	515.4
6.	2019	417.3
7.	2020	417.2

Due to the fact that Kasbi and Mubarak regions are located in the most arid region of the oasis, phenomena such as salinization, wind and water erosion, and groundwater level rise in the irrigated lands of these regions are taking place in large areas. Currently, the mineralization of soil and ground water has increased in these regions, as a result of which re-salinization is occurring. Statistics Department of Kashkadarya Region. According to January 2020 data, the salinized area in the region is 232,309 thousand, 45.2% of the total area to the field compared to 35.9% and the average saline area is 38129 thousand compared to 7.4% of the total area. Currently, about 8 percent of irrigated lands or 325 thousand hectares are considered to be poor lands (Table 1).

Degradation processes of desert landscapes in some regions are directly related to activities related to mining and oil and gas extraction. The development of desertification processes is caused not only by the above-mentioned problems, but also by mining operations in some regions. Changes in natural processes can be observed in the vicinity of oil and gas pipelines or wells. Degraded lands created in Kashkadarya region cause great damage to agricultural fields, pastures and ecosystems. Also, the intensity of anthropogenic impact on the nature of the area causes landscape-ecological problems and causes disturbances in the exchange of substances and energy and the balance of ecosystems.

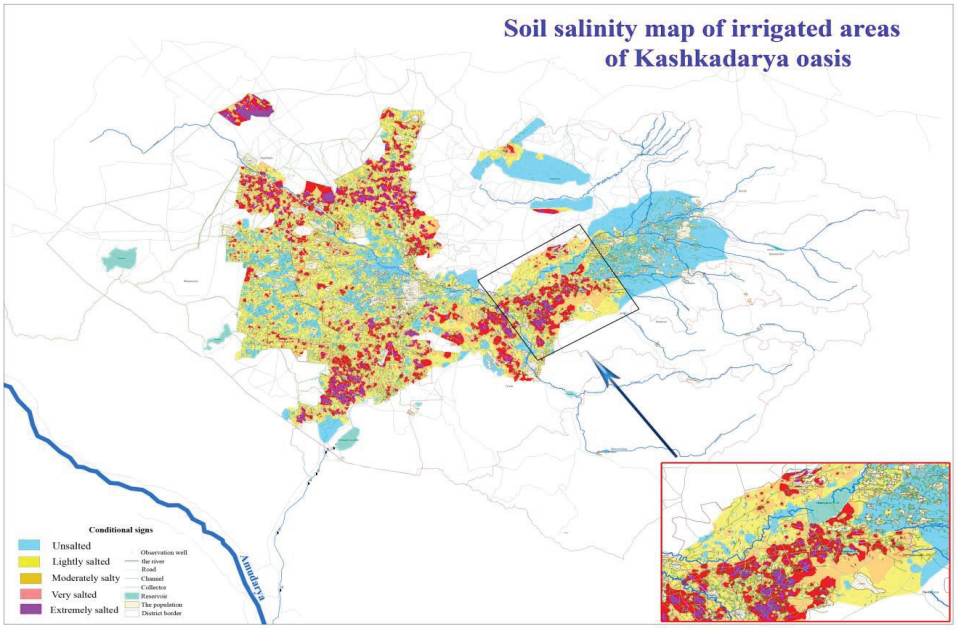

Fig. 1. Soil salinity map of the irrigated lands of the Kashkadarya oasis.

4 Conclusion

The main goals and objectives of this scientific work are to determine the nature and causes of the desertification process occurring in the conditions of our country, to identify and study the factors causing the desertification process, types of desertification, patterns of desertification, its spread, and to develop a strategy to combat this process. One of the most important tasks of the first stage of basic ecological research of arid zones (i.e. in Uzbekistan) is to develop a natural-geographical concept of ecosystems and, based on this, measures to combat the process of desertification.

The factors influencing the development of desertification can be divided into two groups: natural factors and anthropogenic factors. Natural factors include the geological structure of the site, relief, climate, surface water, soil, vegetation cover, and fauna. Climate is the most powerful natural factor influencing desertification. The influence of climate on desertification has also been extensively studied by other scientists. Climatic elements are factors that determine the rate of physical evaporation, transpiration, humidity, recurrence of droughts, and deflation process.

Wind is one of the natural factors that strongly influence desertification. G. S. Kust. Wind increases physical evaporation, and transpiration and rapidly dries the earth's surface. Plants are the strongest indicator of desertification. With normal rainfall and air temperature, uniform plant development on pastures is maintained and no degradation is observed. However, a decrease in rainfall or a prolonged period of chronically high temperatures will hurt plants. In years with such unfavorable weather conditions, favorable conditions for desertification are created. Anthropogenic factors contribute to the acceleration of the desertification process. The factors that influence desertification include geological exploration, communication networks, construction, agriculture, and others.

The factors of desertification are analyzed and reviewed in the order "factor - process - result". The cause is the manifestation of natural and anthropogenic factors, processes, and energy, and the result is the manifestation of desertification in various forms. As a result, it

is possible to establish a causal chain that reflects the occurrence of the desertification process. It should be noted that desertification develops in well-defined natural areas - landscapes. Therefore, desertification should be combated on a well-defined natural territory.

In conclusion, strategic planning of nature use and protection of Kashkadarya region is an important tool for sustainable development. To optimize the use of agrolandscapes in Kashkadarya region, it is desirable to implement the following measures: formation and preservation of land structure and activity at an optimal level, ensuring the necessary diversity and stability of agricultural landscapes; implementation of drip irrigation in irrigated farming; keeping the amount of plant growth in the area in moderation by rationally organizing the feeding of livestock in the pastures; prevention of cutting of bushes and trees by residents; regulating the movement of equipment used in the extraction of underground resources; implementation of efficient use of ditches and drains; provides restoration and preservation of natural coenoses in landscapes. After all, as a result of crop rotation, melioration and agrotechnical measures in agriculture, soil quality improves and desertification is prevented. In order to prevent soil salinization and increase soil fertility and crop yields, i.e. to prevent desertification, it is desirable to change people's attitude towards nature and increase their ecological knowledge.

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