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Research Article

IMPACT OF DROUGHT PROCESSES ON SANDY-DESERT SOILS

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Nurgaliev Najmiddin Abdumajitovich
(Phd) Doctoral Student Of The Department Of Soil Science, National University Of Uzbekistan

Nabiyeva Gulchexra Mirergashevna
Doctor Of Sciences In Biological, Department Of Soil Science, National University Of Uzbekistan

ABSTRACT

Important problems of improving the animal breeding conditions, microorganisms in soil, and land conditions, preventing desertification processes can be solved by combating drought and desertification, mitigating the environmental situation, sowing drought-tolerant pasture plants in desert areas, studying the biological characteristics of soils to increase plant viability in low-humidity lands, and increasing drought-resistant plant cover in high-drought lands.

KEYWORDS

Degradation, vegetation, drought, climate, sandy-desert soils.

INTRODUCTION

Worldwide factors such as climate change, temperature rise, increase in desertification processes, and misuse of natural resources cause land degradation, reduction of vegetation cover, deterioration of soil and water resources, and various changes in the ecological balance, becoming global and regional problems.

The total land area of the Republic of Uzbekistan is 44892.4 thousand hectares, of which 76.6% is in the steppe zone. The desert zone is formed by the Kyzylkum, Ustyurt, Malikchol, Sherabad, Karshi, Kattakum, and Sandykli deserts and the central territory of the Fergana region with a total area of 33,995,000 hectares. The soils of the desert zone consist mainly of sandy deserts, loams, bald soils, and solonchaks; the mechanical composition of these soils consists of medium and light loams formed over alluvial-proluvial and lacustrine deposits [4, 7, 9, 10].

At present, 70%, or 31.4 million hectares of our republic are subject to varying degrees of drought processes, mainly related to natural saline drift dune sandstones and malmrock. The Aralkum desert, covering an area of more than 3 million hectares, was formed due to the drying out of the Aral Sea alone. As a result, the ecological environment in the area deteriorated, thus aggravating desertification processes and causing numerous social problems [13].

In the formation of sandy soils, of great importance is the specific water regime, in particular good water permeability and capillarity since sand completely absorbs rainwater and water penetrates much deeper. For example: in winter and early spring in Kyzylkum 80-120 mm of precipitation falls; this amount causes wetting of sandy soils down to 1-1.5 m [3, 5, 7, 10].

The soil cover of the desert zone is extremely non-uniform and is characterized by its complexity, complex topography, high temperatures (the effective sum of temperatures is 4000-5000 0C), low humus content, high carbonate content, predominance of salinity, local areas of salinity and gypsum [10].

Object of study. The field experimental site of the Research Center is located in the Karaulbazar district of the Bukhara region, in the area of sandy desert soils formed by alluvial-proluvial and lacustrine sediments; it is located on I-II terraces of the Amu-Bukhara canal of the subaerial delta of the Zarafshan River. The vegetation cover of the area under study is 40%. These include white saxaul (Haloxylon persicum Bunge), black saxaul (Haloxylon aphyllum), wormwood (Artemisia tenuisecta), wormwood (Tamarix androssowii), incense (Peganum harmala), wormwood (Salsola arbuscula), black wormwood (Amaranthus retroflexuss), ephemera and ephemeroids: sedge (Physodes carex), sedge (Bmomus tectorum), fennel (Remopyrum Orientale), salt plants (Aeluropus litoralis), camel's-thorn (Alhagi psudoalhagi), etc.

Research methods. Soil sampling, storage and laboratory experiments in the territory where survey work is being conducted are carried out following the interstate standard GOST: 17.4.3.01-83 [1, 10]. Reproduction of drought-resistant pasture plants in desert areas to prevent drought and desertification, mitigate the ecological state, study the biological properties of soils to increase the viability of plants on lands with low humidity, and increase drought-resistant plant cover on lands with high drought, are relevant issues not only for the animal breeding but also for improving the conditions of soil microorganisms, thus preventing desertification processes and creating the possibilities to protect the environmental situation.

Today, climate change, decreased precipitation, and a sharp increase in temperature create environmental problems on a global scale. It is not a mistake to say that drought is a global problem that threatens not only Uzbekistan but also the whole world. The lack of water resources in many countries of the world negatively affects agriculture, causing desertification and drought. In many countries around the world, the extent of dryland formation as a result of climate change is classified as follows (see Table 1).

Table 1

Classification of climate and drylands based on aridity index by subspecies (Haipeng Yu. et al., 2021)

№	Dry lands	AI
1	Hyper-dry	AI<0.05
2	Dry	0.05≤AI<0.2
3	Semi-dry	0.2≤AI<0.5
4	Dry subhumid	0.5≤AI<0.65
5	Moist	AI≥0.65
6	Cold	PET<400 mm

The climate classification based on the above aridity index consists of 6 subtypes of drylands. According to this classification, for AI <0.05, the land is considered hyper-dry, it has very few plants, mostly seasonal, and only some plants survive the hot summer heat. At 0.05°C and AI<0.2, plants in dry areas grow very slowly. At 0.2°C and AI <0.5, the land is considered semi-arid, such areas have plants, but there is often a shortage of water. At 0.5°C and AI<0.65, dry sub-humid lands have plants well scattered around but the water shortage is somewhat noticeable. At AI≥0.65 the land is taken as a wet area, and water needed by plants in such areas is very well distributed, there is no shortage of water. At PET<400 mm, there is a cold zone; in such areas, frost-resistant plants are dispersed.

Six dryland subtypes were classified using AI. Aridity index and drought level are the indicators that express water scarcity in a given area. The aridity index (AI) is a simple but convenient numerical indicator based on water scarcity in an area over a long time, it is calculated based on the ratio P/Pet. (AI) is the unit of measurement most commonly used to determine the climate in a given area.

The aridity index is determined by the following formula:

$$AI = \frac{\sum_{i-1}^{30} \left(\frac{P_i}{PET_i} \right)}{30}$$

Here, AI is the aridity index, P is the amount of precipitation, PET is potential transpiration [6].

Table 2

Analysis of the drought process and its significant changes in the area under research

No	Years	Annual precipitation (mm)	Annual evaporation (mm)	AI	Types of drought
1	2012	131.7	1793.4	0.07344	Dry
2	2013	147.7	1786.8	0.08266	Dry
3	2014	159.8	1074.6	0.14871	Dry
4	2015	148.4	1756.2	0.0845	Dry
5	2016	181.0	835.9	0.21653	Dry
6	2017	156.9	1073.3	0.14618	Dry
7	2018	93.6	1984.6	0.04716	Hyper-dry
8	2019	153.2	1128.6	0.13574	Dry
9	2020	141.9	1788.6	0.07934	Dry
10	2021	107.7	1969.3	0.05469	Dry
11	2022	122.3	1869.4	0.06542	Dry

Based on the above classification, the aridity index of the area under study was determined for the first time using the given formula.

Table 2 shows the results of the studies based on analyzed climate data from the Center for Hydro-meteorological Service for the period of 2012-2022.

The analysis showed that in 2013, the annual precipitation was 147.7 mm, in 2018 - 93.6 mm, in 2021 - 107.7 mm, and in 2022 - 122.3 mm. This is less than in 2013, by 54.1 mm, 40.0 mm, and 25.4 mm, respectively. The overall result shows a higher probability of transition from the dry type of drought to the hyper-dry type. The subject of the study was sandy desert lands, significantly affected by the drought process in this area; this, in turn, led to negative changes in soil and vegetation cover. For this reason, the aim was to calculate the aridity index of the area under study (Fig. 1).

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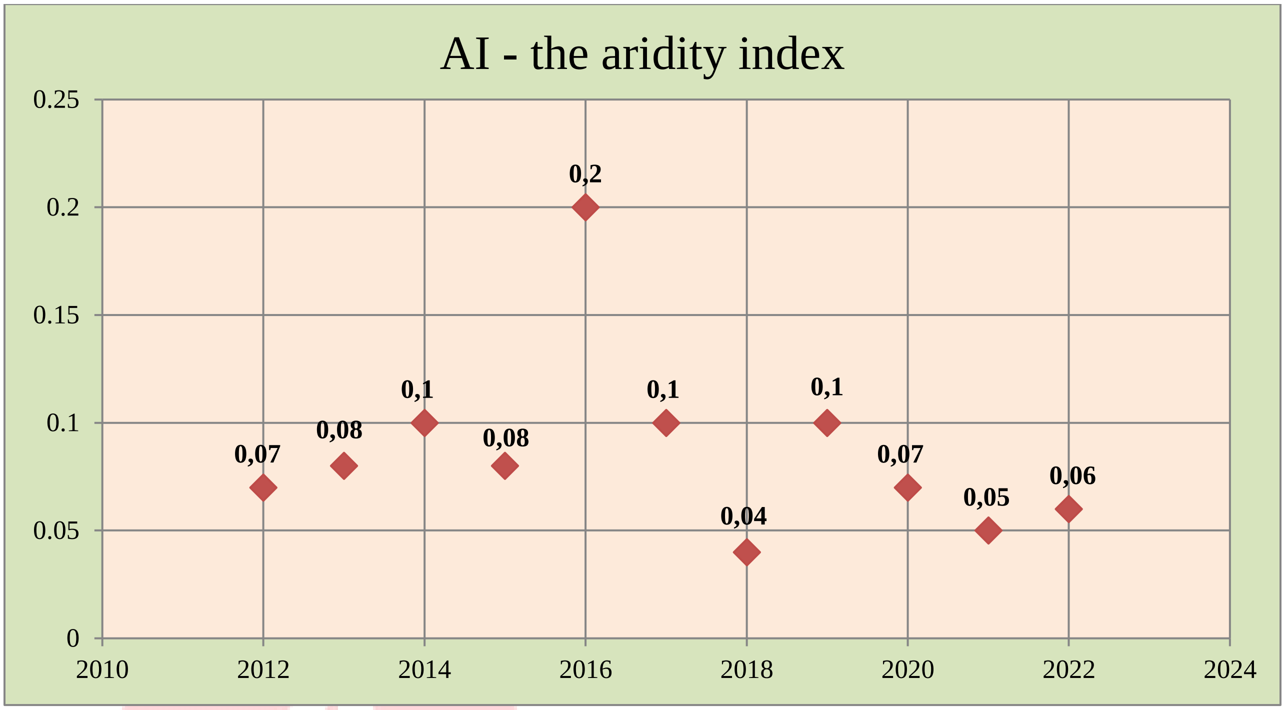

Figure 1. Aridity indices in the area under study

In the figure above, the aridity index was the highest in 2016 and the lowest in 2018 and 2021. The algorithm and graph of the maximum product were developed by MAP to determine the severity of drought in agriculture, so the calculation of the algorithm of the maximum product was difficult. The difficulty was that the data was intended for an approximate solution to the problem of crop yield and the degree of drought was determined using the following formula:

$$x^* \in \operatorname{argmax}_{x\in\mathcal{X}^n}\left\{\sum_{u\in V} f_u(x_u) + \sum_{(u,v)\in E} f_{uv}(x_u, x_v)\right\}$$

Here, X is the definition of drought level obtained concerning yield. We did not determine the level of drought based on the above formula; this method was not used because it includes the crop yield, so, it was not used because there was no irrigated agriculture in the area under study [8].

Below is a classification of drought process assessment widely used in the USA to determine the severity of drought in drought-affected areas; it has 5 drought classifications, i.e. they are divided into the following levels: D0, D1, D2, D3, and D4.

1. D0 - abnormal drought - this classification of droughts is characterized by short-term droughts during summer months, observed in regions where plant growth slows down.

2. D1 - moderate drought - in this classification, droughts occur in areas where arable land and pastures are partially damaged, the level of rivers, reservoirs, and canals lowers, and sometimes there is a shortage of water or restrictions are imposed on the free use of water.
3. D2 - severe drought - in this classification, droughts cause the loss of cropland and pastures in the areas where there is water shortage and restrictions are imposed on water use.
4. D3 - extreme drought - in this classification of drought, the loss of crop yields occurs in areas subject to frequent water shortage and a risk of fires.
5. D4 - extraordinary drought - this classification of drought includes crop areas and pastures.

According to the above classification, in the area under study, short-term droughts were observed mainly in the summer months, accompanied by slow growth of vegetation, partial damage to pastures, and a decrease in the water level of canals and lakes. It was scientifically substantiated that D0 corresponds to the classification of abnormal drought, and D1 corresponds to the classification of moderate drought.

CONCLUSIONS

The results of analytical observations conducted to study the level of drought in the area under study show that according to the data obtained by the Center of Hydro-meteorological Service of the Republic of Uzbekistan, the annual sum of maximum air temperatures in 2012 was 79500c, in 2014 - 79920c, in 2016 - 85230c, in 2018 - 82500c, and in 2020 - 88080c, and the annual precipitation in 2018 was 93.6 mm. The decrease in precipitation, which amounted to 107.7 mm in 2021 and 122.3 mm in 2022, led to an increase in the drought level. It was scientifically substantiated that it negatively affects the growth and development of plants, and the mechanical, physicochemical, and biological properties of soils.

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