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ASSESSMENT OF DEGRADATION OF SEMIDESERT AND ARID STEPPE FIELD LANDSCAPES AND PASTURE LANDS UNDER THE CONDITION OF MODERN CLIMATE CHANGE

Abstract. *It was determined that degradation of pasture soils in semi-desert and arid field landscapes of the Kur depression intensified under the condition of modern climate changes. Temperature rose 1,2^oC, the precipitations amount was 65,7 mm in 1995–2015 in comparison with 1970–1994. These changes are resulted in landscape desertification and soils degradation. Main criteria were adopted for degradation assessment, and plant cover degradation, water erosion, defilation and salinization are concerned here. The features of these processes were defined depending on desertification degrees. The pastures were divided into 3 parts: useful, limited useful, useless. The relief of the useful zone occupies the zones with unchanged morphological signs less than 7^o of inclined degree, and not exposed to negative processes, with the precipitations amount more than 300 mm. The limited useful pastures are: morphological signs changed to a mean degree (inclination of soils is 17–15^o), exposed to changed negative processes to a weak and mean degree, precipitation number is 300–250 mm. The useless soils are: inclination is more than 15^o, morphological features are fully disturbed, strongly exposed to negative processes, the precipitation number is less than 250 mm.*

Key words: *climate changes; arid landscapes; semi-desert and dry field climate; soil degradation; soil usefulness*

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Introduction

In the last half century the natural complexes were mostly exposed to transformation under the condition of the arid climate. Especially the quantitative and qualitative indicators of the pasture areas mostly weakened depending on climatic changes. But the traces of the anthropogenic impacts can show itself in the pastures prominently in arid climate. Under these effects, especially intensive grazing intensified the negative transformation of soil and grass cover [1, 2].

Intensive grazing in the natural pastures under the arid condition intensified erosion, defoliation and salinization processes in the soil, weakened botanical composition, density of grass cover and covering the soil surface, intensified degradation [3]. Taking into account these processes, the assessment of soils degradation in arid landscapes under the climate changes is one of the main problems in its utilization and protection. Study of these processes, definition of its mechanism, assessment of degradation under the climate changes condition are scientifically and empirically very actual.

After the 90s years of the last century in our country the climatic changes affected some areas, including pastures, fertility of soil cover [2]. Taking into account these conditions we conducted assessment of pasture soil degradation in the physical-geographical province of the Kur depression in the semi-desert and arid field Landscapes.

Material and Methods

The researches were conducted in the physico-geographical province of the Kur depression in the Azerbaijan Republic. Bioclimate of this country is mainly arid and it is one-third of the territory. The areas of the unirrigated tillage soils are used as a pasture in the zone, these soils are in the state property. An area of these soils reaches 740 000 hectares in general. These pasture areas are situated in Jeyranchol, Ajinohur, Bozdagh-Gazanbulag, Shirvan, South-Eastern Shirvan and Mughan plains.

Sedimentary rocks of the Cenozoic period are superior in the research zone. An age of the rocks rejuvenates towards the East. The surroundings of the Kur river, including rivers flowing into it in all directions are covered with alluvid deposits, the rocks in the high areas are covered with deluvial and proalival, but the zones near the Caspean Sea are covered with the rocks of marine origin [4, 5, 6].

The plains dominate in the relief, but it is selected by its complexity, the absolute height changes by 28–1000 m. Inclination is from west to east. The west and north-west of the province becomes shattered by a ravine-gorge network. The ancient river valleys in the Kur-Araz lowland and pools near them are characteristic. Ajinohur massive is concerned the lowfront mountainous around water storehouse of Jeyranchol and Mingachevir [7, 8].

The climate of the research zone is semi-desert-arid field [4]. In general it is characterized as arid subtropics. An average annual temperature is 13,1–14,5ºC. An average annual temperature is 13,1–14,5ºC. A quantity of the annual rainfalls vibrates by 250–400 mm [1].

The plant-cover of the zone is worm-word-ephemeral, blackberry, saline grass, concubine-wormwood formations dominate and they are considered a main forage base for animals in the winter months.

Gray-brown, grey, gray-brown, meadow-grey and different salinities are character is tic for arid landscapes. Zonality takes a main place in soils expansion [4]. Durability of these soils against erosion is weak and very sensible against salinity [5]. The modern methods have been used in researches performance. The geographical comparison and half-stationary research methods were applied during the field work.

The mathematic-statistics and GIS were used in collection and analysis of the data. The aridical index of the climate was calculated with the formula of $\alpha_{in} = P|T + 10$ a according to Marton. Here, $P - \alpha$ quantity of rainfalls is measured by cm, T-average annual temperature – by % [9].

Results and Discussion

The climate changes show themselves in quantitative indicators of the temperature and rainfall. These indicators of the climate are different in 1970–1994 and in 1995–2015. An analysis of the temperature was performed on the basis of the meteorological stations in the physico-geographical province. It is known from the analysis that increase of the temperature in the winter is observed in all other stations (Table 1).

Table 1 – Difference between the temperatures on seasons in 1970–1994 and 1995–2015

№	Metrological station	Height, m	Winter	Spring	Summer	Autumn	Annual
1	Kurdamir	2	+1,1	-0,5	+1,6	+1,8	+1,1
2	Mingachevir	93	4,4	-0,5	-0,1	+1,1	+1,2
3	Imishli	-3	-0,1	-0,1	+1,8	+1,9	+0,9
4	Beylaqan	55	+1,0	-0,2	+1,8	+1,8	+0,9
5	Goychay	94	+0,5	-0,1	+1,1	+1,7	+0,8
6	Zardab	-5	+1,1	-0,4	+1,7	+1,9	+1,1
7	Bilasuvar	4	+0,6	-0,2	+1,2	+1,6	+0,8
8	Salyan	-22	+0,8	+0,2	+1,3	+1,8	+1,0
9	Shamkir	165	+0,9	-0,1	+0,9	-1,0	+0,2
10	Ganja	309	+0,8	-1,2	+1,2	+1,3	+0,6
11	Aghstafa		+0,9	-0,2	+1,1+	+1,2	+1,0

Increase of the temperature is 4,4ºC in Mingachevir, the least one is 0,5ºC in Goychay. The temperature gets decreased 0,1–1,2ºC in all other stations of Salyan in the spring months. The temperature gets increased in all other stations except Mingachevir station in the summer season.

The temperature is high in all the stations in autumn except Shamkir. The most temperature increase is observed in the autumn season [10, 11].

An average annual increase of temperature is noted in all the stations in autumn. The highest indicator was 1,2ºC in Mingachevir, the least one was 0,2ºC in Shamkir. We can come to such a conclusion that the temperature which is a main element of the climate rose in the zone.

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Table 2 – Difference between the rainfalls on seasons in 1970–1994 and 1995–2015

№	Metrological station	Height, m	Winter	Spring	Summer	Autumn	Annual
1	Kurdamir	2	-7,0	+30,9	-18,5	-20,1	-14,7
2	Mingachevir	93	-12,6	+25,6	-3,3	-65,8	-65,7
3	Imishli	-3	+5,3	+43,0	-18,2	-19,9	+10,2
4	Beylaqan	55	+12,3	+36,5	-19,4	-29,3	-0,1
5	Goychay	94	+5,1	+17,6	-22,7	-36,6	-30,5
6	Zardab	-5	+5,8	+6,2	-23,5	-20,1	-31,7
7	Bilasuvar	4	+10,5	+34,6	-12,1	-39,6	-6,6
8	Salyan	-22	+1,5	25,7	-19,3	-24,6	-16,7
9	Shamkir	165	-12,1	+0,1	+7,6	-44,7	-49,1
10	Ganja	309	-1,6	+27,3	-1,9	-19,8	+4,0
11	Aghstafa	340	-13,4	+21,2	-18,9	-23,5	-34,6

It is seen from Table 2 that reduction of average annual quantity of rainfalls was observed in all the stations except two stations (Imishli and Ganja). Reduction of rainfalls happened in summer and autumn. A quantity of annual reduction of rainfalls was 4,0–65,7 mm (Table 2). The change indicators of the temperature and rainfalls are a reason for natural degradation development for the semi-desert and arid field landscape.

At present the bioclimate parameters of the semi-desert and arid field landscape zones in the Kur valley were shown on Table 3.

Table 3 – Bioclimate parameters of the semi-desert and zones with arid field landscape

Metrological station	Height, m	Annual number of rainfall, mm	Average temperature of air, °C			Aridi-tion index	Type of natural plant cover
			January	July	Annual		
Kurdamir	2	308	3,2	25,8	14,5	1,25	wormwood-ephemer
Mingachevir	93	289	2,5	24,9	13,7	1,22	wormwood-ephemer
Imishli	-3	306	3,8	25,3	14,5	1,25	wormwood-blackberry-saksual
Beylaqan	55	321	2,7	24,8	13,8	1,35	wormwood-ephemer, wormwood-blackberry
Zardab	-5	305	3,2	25,2	14,2	1,26	wormwood-ephemer
Salyan	-22	285	2,8	25,1	14,0	1,19	wormwood-ephemer-sirkan
Bilasuvar	4	312	2,7	24,7	13,7	1,31	wormwood-ephemer-blackberry-concubine
Goychay	94	466	2,6	24,2	13,4	1,99	arid bushes, mountain xerophytes, ephemer concubine-wormwood
Shamkir	165	384	3,0	23,8	13,4	1,64	mountain xerophytes, ephemer concubine-wormwood
Ganja	309	287	3,1	24,1	13,6	1,21	arid bushes, mountain xerophytes, ephemer-concubine
Aghstafa	340	363	2,3	23,9	13,1	1,57	thin arid forest, bushes, ephemers

Here, an annual number of the rain-falls changes by 285–466 mm. The average annual temperature vibrates by 13,1–14,5°C. The highest temperature is observed in Kurdamir and Imishli (14,5°C), the lowest one (13,15°C) in Aghstafa. Addition index is 1,19–1,99. A type of the natural plant cover in the zone is wormwood-ephemeric, wormwood-ephemer-blackberry, concubine, arid bushes and mountain xerophytes (Table 3).

Criteria of the soil degradation assessment is defined in connection with landscape desertification in the Kur valley. The results are shown on Table 4. Change of the plant cover degradation was analyzed depending on desertification degree. The weak changes of the local and corresponding plants happen under the climate changes, slight transformation of the plants in mild desertification, transformation of the plants in mild desertification, transformation of a great part of the plants in strong one, transformation of all the plants in the strongest one except ephemers. Covering

of plant cover the soil surface in this criterion and forage loss of the pastures were shown as a criterion.

Table 4 – Assessment criteria of soil degradation in connection with landscapes desertification in the Kur depression

Modern state of the assessment criteria	Desertification rate			
	weak	mild	strong	very strong
I	Degradation of plant cover			
Character of plant cover	Plant conforming to climate condition weakly changed	Plants are slightly transformed	A great part of plants is transformed	All the plants except ephemers are transformed
Change of local plants according to climatic conditions, %	‹75 ‹25	75-50 25-50	50-25 50-75	‹25 ›75
Plants cover the surface, %				
Fodder loss of pastures, %	‹25	25-50	50-75	›75
II	Water (rain erosion)			
Erosion type	Weak surface washing	Surface washing formation of furrows	Surface washing, formation of ravines	Strong surface washing, formation of ravines, hollows, furrows
Washing of a horizon, %	‹25	25-50	50-75	75-100
Turf layer spilling in the pastures, %	‹25	25-50	50-100	100
III	Defoliation process			
Defoliation development, (for general zone), %	Very weak development of defoliation	Zone is exposed to defoliation 10-25%	25-50% of the zone is deflated	Plants cover spoiled surface was covered with absorbed sediment
Change of granulometric composition on the soil surface	Clayey and heavy loamy	Mean and light loamy	Sandy	Covered with sand
IV	Salinization process of the soil			
Salinity of the soil up to 0-10 cm, %	‹0,5	0,5-1,0	1,0-2,0	›2,0
Middle depth of subsoil waters, cm	›200	150-200	100-150	‹100
Mineralization of subsoil waters, g|l	‹1,0	1,5-5,0	5,0-10	›10

The main indicators of degradation are erosion, defoliation and salinization processes in the soil. These factors are also degradation criteria as desertification degrees. A ratio of the areas to total area included in the criteria as a percentage.

Prolonged drought and intensity of sudden precipitation intensify erosion under the condition of climate change. Weak soil surface cover increases amount of the washed soil. The development degree of defoliation process has a great role in soil degradation assessment. The winds in the arid condition blows away a thin part of the soil and reduces fertility and pasture production. The main criterion is the

percentage of the area where deflation develops and its effect on changes in the granulometric composition. The indicators of these changes depend on development rate of desertification is taken into account.

Table 5 – Assessment of pastures fitness based on main morphological features

Morphological features of soils and main indicators of landscape	Fitness rate of pastures		
	Useful	Limited useful	Useless
Inclined indicators of the zone and slopes	0,0-7º	7-15	›15
Granulometric composition	Mainly light and mean loamy	Sandy and heavy loamy	Clayey and sandy
Thickness of humic layer, cm	50-70	30-50	‹30
Humus amount, on the upper horizon, cm	1,5-70	1,0-1,5	‹1,0
Structural index-amount of water-resistant aggregates, calcareous, CaCO, %	28-30 ‹8	18-28 8-12	‹18 ›12
Upper horizon of salinization, cm	no	10-25	›25
Amount of precipitations, mm	›300	300-250	‹250
Production of grass cover (dry mass), cen|ha	›7,0	7,0-1,5	‹1,5

Salinization process is one of the main reasons of degradation of the Kur depression soils. There is no need for proof that the modern climate changes, i.e. increase of temperature and evaporation, reduction of rainfalls intensify salinization process. From this point of view, we can say that a main criterion of soils degradation is salinization under the condition of the climate changes.

The pasture soils assessment was performed depending on abovementioned indicators. The results of this assessment have been given on Table 5. We divided the suitability rates of pasture soils into 3 degrees based on morphological characters: useful, limited useful, useless.

a) Useful pasture soils.

The surface of the useful pasture soils must be higher than inclined 7º. Erosion accumulation process is weak in such surface. In suitable pastures with disturbed morphological features of the soil, the granulometric composition of the soil is required to be light and medium clayey. Thickness of humic horizon can't be less than 50 cm and humus content is required to be 28–30% and carbonate content to be less than 8%. Salinization of such soils mustn't be more than 7,0 centner as a dry mass in a hectare. The useful pasture soils are situated in Jeyranchol, Ajinohur, Mughan.

b) Limited useful pasture soils.

The soils concerning this usefulness rate are on the slopes with 7–15º inclination. Potential riskiness of the development of erosion-accumulation process is higher in this inclination. They are distinguished with sandness and heavy loamness of granulometric composition. Thickness of humic layer is 30–50 cm, humus amount is 1,0–1,5% on upper horizon, a quantity of water-resistant aggregates is 18–28%, calcareous 8–12%, upper horizon of salinization is 10–25 cm. Production of grass cover is up to 7,0–1,5 in a hectare with the amount of precipitation 300–250 mm. Limited useful soils widespread in Shirvan, Mughan, South-eastern Shirvan, Ajinohur and Jeyranchol.

c) Useless pasture soils.

The slope of such plots of land covers areas with complex relief conditions of 15^0 high fragmentation. Granulometric composition is sandy and clayey. Thickness of humic horizon in soil profile is less than 30 cm, humus amount on the upper layer is less than 1,0%. Its quantity is less than 18%, calcareous is higher than 12% on water-resistant upper horizon. Upper border of salinization is 25 cm. Precipitations are less than 250 mm in such zones. Such soils are in Jeyranchol, Ajinohur and south-eastern Shirvan.

Conclusion and Recommendation

We can come to such a conclusion that the pasture soils in the Kur depressions lose their usefulness under the condition of modern climate changes and under anthropogenic effect. This is a reason for desertification and soils degradation. A development level of these processes was shown to prepare fight measures against soil degradation-desertification. The criteria of soil degradation assessment in the pasture soils was defined depending on climate changes. They are divided into 3 rates according to degradation development in pasture soils: useful, limited useful, useless.

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ОЦІНКА ДЕГРАДАЦІЇ НАПІВПУСТЕЛЬНИХ ТА ПОСУШЛИВИХ ПОЛЬОВИХ ЛАНДШАФТІВ ТА ПАСОВИЩ ЗА УМОВ СУЧАСНИХ ЗМІН КЛІМАТУ

Анотація. Встановлено, що деградація ґрунтів пасовищ у напівпустельних і посушливих польових ландшафтах Куринської западини Азербайджану посилюється за умов сучасних змін клімату. Температура зросла на 1,2°С, кількість опадів у 1995–2015 рр. в порівнянні з 1970–1994 рр. становила 65,7 мм. Ці зміни призвели до опустелювання ландшафту та деградації ґрунтів. Для оцінки деградації було прийнято низку основних критеріїв. До уваги беруться деградація рослинного покриву, водна ерозія та засолення. Визначено особливості цих процесів залежно від ступеня опустелювання. Пасовища поділяються на 3 види: придатні, обмежено придатні, непридатні. До придатних належать зони з відсутністю морфологічних змін (нахил ґрунтів менше ніж 7º), не вражені негативними процесами, з кількістю опадів більше 300 мм. Обмежено придатні мають такі ознаки: морфологічні зміни середнього ступеня вираженості (нахил ґрунтів 17–15º), вражені негативними процесами слабкою і середньою мірою, кількість опадів 300–250 мм. Непридатні ґрунти: нахил більше 15º, морфологічні ознаки повністю порушені, сильно вражені негативними процесами, кількість опадів менше 250 мм.

Ключові слова: зміни клімату; посушливі ландшафти; напівпустельний і посушливий клімат; деградація ґрунту; придатність ґрунту

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