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**SOILS
FOREST ECOSYSTEMS**



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SOILS

FOREST ECOSYSTEMS

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DEHUMIFICATION OF SOILS IN THE NORTHERN KAZAKHSTAN REGION

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ABSTRACT.

The dehumification of soils in the North Kazakhstan region is one of the most pressing problems due to the inadequate control of the cultivation technology of agricultural crops with the intensive occurrence of soil erosion. This paper considers the processes of dehumification of humus by the main types of soils in the North Kazakhstan region. The results of the research have demonstrated that humus in soil types has been decreased in 30 years from 1.78% to 30.2% since 1978 to 2018. The content of humus in 9 types of soils of 14 districts range from 1.83% to 11.5%. The mechanical composition of soils is divided as loamy-soils and heavy-loamy, medium-loamy and friable sub-sand, and sandy loam. The processes of dehumification of gumus are directly related to the soil types, mechanical composition and vegetation of steppe zone, and technology of cultivation of agricultural crops in agriculture.

Keywords: soil, mechanical composition of soil, soil types, soil erosion, humus.

INTRODUCTION

One of the most urgent issues of scientific research is the study of the dehumification mechanisms of soils, which has been gradually diminished in the last 50 years [1].

Today's major problems in agricultural production are degradation of soils in arable lands. The degradation of soil represents a subgroup of natural and anthropogenic processes, which leads to the change of functions, properties, and modes, and decreasing the real property value of soils [2-5]. Degradation brings immense changes to the qualitative and quantitative composition of land resources, and in some cases causes destruction and elimination of soul cover.

The global estimation of the anthropogenic degradation that was held in 1990 in the framework of the GLASOD project demonstrated that more than 80% of all degraded soils of the Earth are eroded [6].

The total area of the North-Kazakhstan region is about 7 million 331,567 hectares, including agricultural land that amounts to 7 million 84,142 hectares. In the structure of agricultural lands, the cropland is 5 million 381.6 thousand hectares, grassland is 406.735 hectares, virgin lands are 71.923 thousand hectares, hayfields - 15.913

thousand hectares. Croplands with perennial plantings and vegetable gardens cover 2.6 and 0.2 thousand hectares [7-8].

Massive development of virgin and fallow lands in steppes of the North Kazakhstan was carried out between 1954 and 1960. In the sixties, after the development of light and carbonate southern black soils in the North Kazakhstan region, soil erosion took place and the balance of mineral nutrients and organic matter in the soil began to deteriorate. Significant changes in soil content and dehumification processes have occurred over the last 30-40 years due to the rapid expansion of such tendencies.

Reduction of humus content in the soil leads to a decrease in phytosanitary conditions in the soil, degradation of human and water-physical properties, destruction of nutrients, soil compaction, and dehydration [9-10]. Therefore, the decline of humus in soil content is one of the main reasons for soil degradation.

From the beginning of the virgin soil development in the North Kazakhstan region, the natural composition of soil humus in cultivated lands has decreased to 30%. That is to say, the humus content in soil recyclable layer has decreased by 20-30%, and nitrogen decreased by 13-30% compared with virgin lands, which caused the dehumification processes [11-12]. The North Kazakhstan is a region with significant potential for grain cultivation and production. Therefore, it is very important to increase soil fertility and preserve crops to improve production and improve the quality of grain there.

Study area. The North-Kazakhstan region is located in the Northern part of the Republic. The continentality of the climate was estimated by the L. Gorchinsky index (k) [13]. According to this index $k < 20$ in mild ocean climate, in a moderate ocean mantle - $k = 20.1-30\%$, in a moderate continental climate - $k = 30.1-50\%$, in continental climate - $k = 50.1-70\%$, in harsh continental climate - $k = 70.1-90\%$, in strong continental climate $k > 90\%$ (in Verhoyansk $k = 100\%$). In the region's territory the continentality index ranges from 59.1 to 70. Therefore, the region's climate is considered to be as continental. The rainfalls range from 300-340 mm, $\frac{1}{2}$ of which occurs during the warm season of the year. The northernmost point is $55^{\circ} 26' N$, the southern - $52^{\circ} 13' N$, western - $65^{\circ} 57' E$ East, Eastern - $74^{\circ} 02' E$ East. The maximum distance between the North to the South is 375 km, and from the West to the East - 602 km. The total area of the region is 98 thousand km^2 , from which 58.8 thousand km^2 are croplands, which accounts for 60% of the territory [14].

Soil forming materials are mostly quaternary loams and heavy clay loams. In the most Northern part of the region there are subzone of degraded black humus with fields of gray sylvogenic soil, and in the southern part there are located ordinary medium-humic black soil. For ordinary medium-humic black soil – forest steppe with kolks, and in the southern part – open steppe [15-16].

Research methods. Soil samples were taken from soil layers of 0-25 cm of croplands to determine soil content. The soil samples were determined by I.V. Tyurin's method of humus identification [17]. Agrochemical maps of soil have been developed according to the method of mapping analytical maps.

The research is conducted in the Aityrtau, Akzhar, Akkayin, Yessil, Zhanbyl, M.Zhumabayev, Kyzylzhar, Mamlyut, G.Musrepov, Tayinshin, Timiryazev, Ualikhanov, Shal Akyn districts and 9 districts of Petropavlovsk city of North

Kazakhstan oblast, and there was carried out the monitoring of humus content in croplands of above-mentioned areas and the mechanical composition of soil was determined as well. The total cropland is 4868.50 hectares, of which 2340.25 hectares of cropland was studied.

Results and Discussion.

Mechanical Composition of Soils Under Study

The majority of the black humus soil of the region are loamy and heavy-loamy (Fig.1). The component of the physical clay in it ranges from 55 to 66%, which are mostly widespread in drained and slightly drained slope of watersheds that border with the Yessil river valley, predominantly in the territory of Kyzylzhar, G. Musrepov, M. Zhumabayev, Shal Akyn, Timiryazev, Yessil, Mamlyut, Tayinshin, Ualikhanov, and Aityrtau districts. More light in mechanical components of middle loamy soils and light loamy soils with components of physical clay of 25-30% are represented predominantly in Yessil river valleys. Soil-forming there takes place in old alluvium.

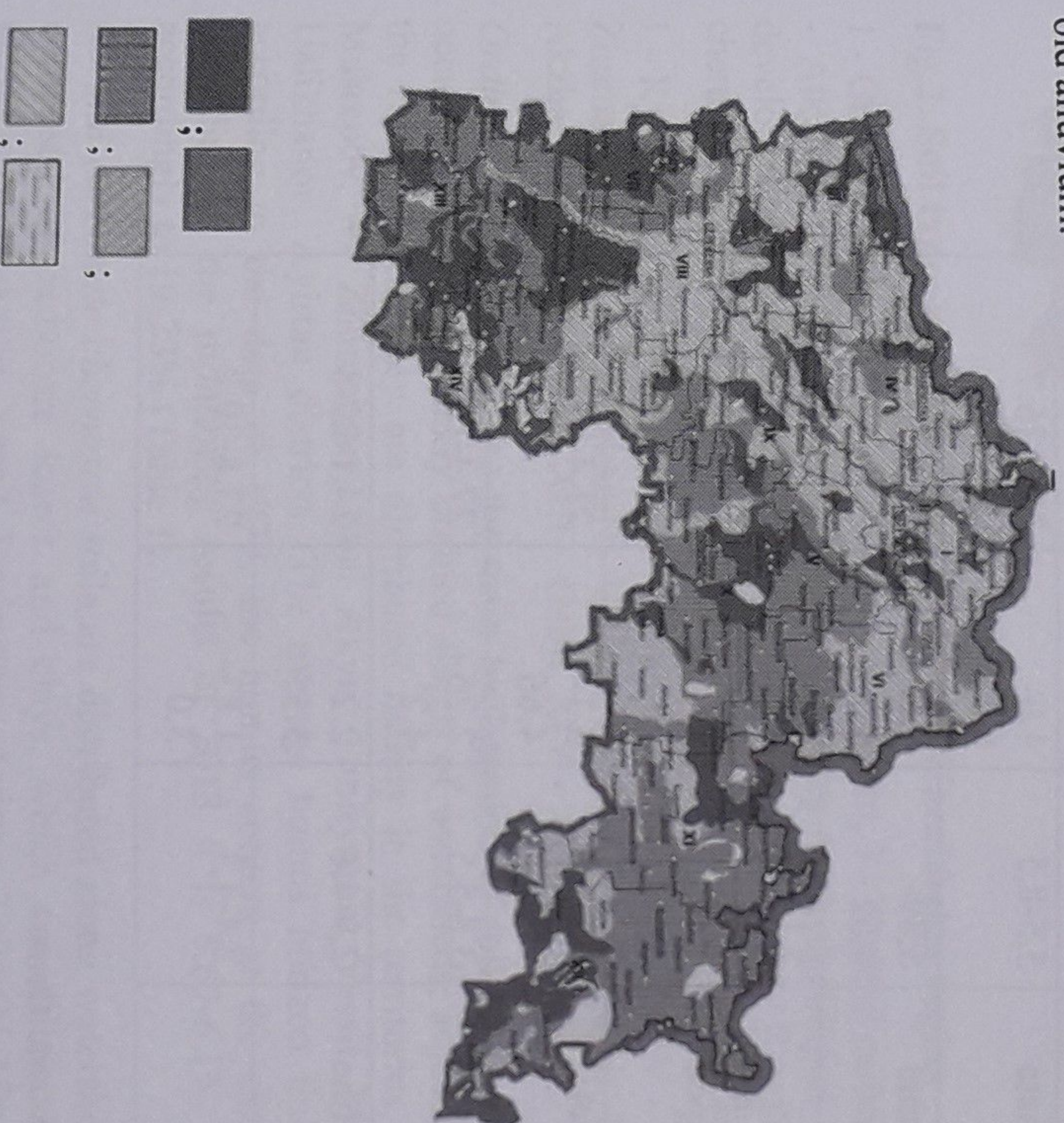


Fig.1. Soil map. Mechanical Composition of Soils Under Study 1 -

They are also can be found in the lower elements of relief, and in some cases in lower terrace above the flood-plain of rivers and lakes. They are mostly distributed in the basements of Zhanbyl, Akkayin, M. Zhumabayev, Yessil, Kyzylzhar, Mamlyut, Akzhar, Ualikhanov, Gabit Musrepov, Aityrtau districts. The sandy loam soils are rapidly formed in the large overflow lands on the layered alluvial deposits, and the vast mass of this soil are confined to the flood plain of the Yessil river. The soil-forming material are mostly old alluvial. They are predominantly distributed in the Zhanbyl, Mamlyut and Kyzylzhar districts.

Humus Composition of Soils in Under Study

Table 1. Dehumification processes of soil content in the soil of the North Kazakhstan region (1978-2018)

Soil type	1978 year humus content %	2018 year, humus content %	Decreases accordingly to %
Gray forest solodic	7.33- 12,6	6.7- 11.5	8.59-8.7
Ordinary chernozem	7,0-8,1	5.67- 6.5	19-19,7
Normal chernozem	4,79- 8,27	3.75- 6.52	21.7-21.2
Normal chernozem	carbonate 5,5-8,5	4.0- 6.23	27.3-26.7
Alkaline chernozem	normal 5,89- 8,52	4.26- 6.04	27.7-29.1
Ordinary underdeveloped and incompletely developed chernozem	5,1-7,4	3.82- 5.71	25.1-22.8
Southern chernozem	normal 4,2-5.9	3.3- 4.66	21,4-21,2
Southern chernozem	carbonate 3,8-5,5	2.76- 4.2	27.4-24.0
Southern chernozem	alkaline 2,9-4,6	2.2- 3.55	24.1-22.8
Dark chestnut soils	2,4-4,3	1.83- 3.0	23.8-30.2

Characteristics of soil conditions:

Gray forest solodic soils occupy a relatively small area of 76 thousand hectares in the Northern part of the region, mainly within the Zhambyl, Mamlyut and Kyzylzhar districts. Soils develop under grassy birch, birch-aspen forests and forest outliers. Its humus horizon thickness is 30-40 cm. According to the 1978 data, the humus content at the surface is 7.33-12.6%, according to the monitoring results of 2018 it comprises of 6.7-11.5%, and decreases, respectively, to 8.59-8, 7% (table 1). The humus content in Gray forest solodic soils after 30 years is 8,59-8,7%.



Fig.2. Soil types and districts in northern Kazakhstan region

1 - Gray forest solodic, 2 – Ordinary chernozem, 3 - Normal carbonate chernozem, 4 - Alkaline normal chernozem, 5 - Ordinary underdeveloped and incompletely developed chernozem, 6 - Southern normal chernozem, 7 - Southern carbonate chernozem, 8 - Southern alkaline chernozem, 10 - *Dark chestnut* soils.

I - Kyzylzhar, II -Petroavl, III – Zhambyl, IV – Mamlyut, V – Akkayn, VI - M. Zhumabaev, VII - Ualikhanov, VIII -Shalkaryn, IX – Yessil, X -Taynsha, XI - Akzhar, XII - Ualikhanov, XIII – Gabit, XIV – Ayrtau.

Ordinary chernozem create the main background of soil cover in the region. They occupy drained and weakly drained slopes of watersheds, adjacent to the valley of the river Yessil. They are distributed mainly in the territories of Kyzylzhar, G. Musrepov, M. Zhumabaev, Shal Akyn, Timiryazev, Yessil, Mamlyut, Tayinshi, Ualikhanov, Ayirtau districts. The average humus horizon thickness is 45 cm. according to the data of 1978, the humus content at the surface is 7.1-8.2%, according to the monitoring results of 2018 it is 5.67-6.1%, and it decreases accordingly to 19-23% (Table 1).

Normal carbonate chernozem soils are distributed along watershed plains, they are composed of carbonate loams and clays, which are distributed mainly in the territories of Akkayin, Yessil, Timiryazev, Ayirtau, Taiynshi, Mamlyut, Akzhar, M. Zhumabayev districts. They are characterized by a high content of carbonates in the upper horizon. According to the data of 1978, the humus content at the surface is 5.5-8.5%, according to the monitoring results of 2018 - 4.0 -6.23%, and it decreases respectively to 27.3-26.7% (Table 1).

Alkaline normal chernozem soils are located in lower reliefs, and they are confined to poorly drained plains. They are usually found in various alkaline complexes near rivers and lakes, and distributed mainly in the territories of G. Musrepov, Akkayin, M. Zhumabaev, Shal Akyn, Timiryazev, Yessil, Zhambyl, Kyzylzhar, Tayinshi, Akzhar, Ayirtau, Mamlyut, Ualikhanov districts. According to the date of 1978, the humus content at the surface is 5.89-8.50%; according to the monitoring results of

2018 it comprises of 4.26-6.04%, and respectively it is decreased to 27.7-29.1% (Table 1).

Ordinary underdeveloped and incompletely developed chernozem (xeromorphic) gravelly stones are confined to the low-top areas, formed on the rocks, which are eluvium of the root massively crystalline rocks. It occupies 7% of the area of the region, and they are located on the territory of Ayirtau district within the Kokshe Upland in the southeast part of the region. According to the data of 1978, the humus content at the surface is 5.1-7.4%; according to the monitoring results of 2018 it is 3.82-5.71%, and it is decreased, respectively, to 25.1-22.8% (Table 1).

Southern normal chernozem develop in conditions of arid steppe. It is formed on elevated plains in natural conditions, mainly on medium and heavy loams of different genesis. It is distributed mainly in the southern part of the region. The thickness of the humus soil horizon is 45–47 cm. According to the data of 1978, the humus content at the surface is 4.2–5.9%, and according to the monitoring results of 2018 it is 3.0-4.46%, and it decreases to 28.5-24, 4% (table 1).

Southern carbonate chernozem soils are distributed mainly in the territories of Akzhar, Ualikhanov, Gabit Musrepov, Magzhan Zhumabayev, Mamlyut, Ualikhanov districts. According to the data of 1978, the humus content at the surface is 3.8-5.5%, according to the monitoring results of 2018 it is 2.76-4.2%, and it decreases, respectively, to 27.4-24.0% (Table 1).

Southern alkaline chernozems are found in various complexes with alkaline. Humus in the upper horizon contains about 4%. *Southern carbonate chernozems* are distributed mainly in the territories of Akzhar, Ualikhanov, Gabit Musrepov, Magzhan Zhumabayev, Mamlyut, Ualikhanov districts. According to the data of results of 2018, it amounts to 2.2-3.55%, and according to the monitoring (Table 1).

Dark chestnut soils are formed in the steppe zone on the high-level plains on the slopes of the hills. They are distributed in the southeastern part of the region mainly in the territory of the Ualikhanov district. The humus horizon thickness varies within 4.3%, and according to the data of 1978, the humus content at the surface is 2.4-decreased to 23.8 30.2% (table 1).

Humus content in the soil of the North Kazakhstan region has been reduced after 30 years by about 30 percent in the study area, with a decrease of 8.59-8.7 percent in the steppe sandy soils. It is much lower than that of other types of soil because of the lower resistance to erosion processes due to the thickness of the forests and vegetation cover. The dehumification of humus in soils with light mechanical composition and medium and carbonate type soils like Normal carbonate chernozem, Alkaline normal chernozem, Southern carbonate chernozem soils has reduced to 21.2-29.1%. The humus was mostly decreased in Alkaline normal chernozem up to 27.7-29.1% and in Dark chestnut soils to 23.8% - 30.2%. Meanwhile, in the Degraded chernozem with heavy mechanical components it has been decreased to 19.0-20.0% (Table 1, Fig.2).

CONCLUSIONS

From 1978 to 2018 the dehumification processes of humus has been widely occurred in soil types of the North Kazakhstan region. That is, the content of humus was decreased to 8.59-8.7% in *Gray forest solodic types of soil*. The most humus losses occurred in the *Alkaline normal chernozem soil types* - 27.7-29.1% and in *Dark chestnut soils* - 23.8% - 30.2%. Meanwhile, in heavy mechanical *Degraded chernozem* it has been reduced to 19.0-20.0%. Soil types and its mechanical composition directly effects the dehumification processes of humus. The light and medium-sized soils are resistant to erosional and mechanical processes. According to our research, the processes of dehumification of light, carbonate and Alkaline soils are intensively going on.

One of the main reasons for the dehumification of soils is the long-term sowing of the monocrops in the agricultural system and the destruction of transitional farming system, and the wind erosion of large area of soil in dry farms, and the incorrect use of agricultural equipment, soil processing system and mineral fertilizers in the vegetation cover of the steppe zone and in soil treatment system.

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DETERMINATION OF THE SOIL EROSION IN THE HYDROGRAPHIC BASIN OF HOMORACIU VALLEY BASED ON THE MAXIMUM DRAINAGE FLOW

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ABSTRACT

The analysis of the solid torrential flow in the Homoricu river basin was done between the period 1970-2018 depending on the climatic data and the location of the studied area

The study of the morphohydrodynamic phenomena evolution in the studied area was also based on the comparative analysis This research work focuses on the complex phenomena of drainage liquid and solid production, the flow rates of rising and spreading of rain formation in the studied basin. of the longitudinal and transversal profiles of the 1970s and 2018s. The main cause of producing the instability of the slope in hydrographic basin of the Homoricu Valley is represented by the erosion thalweg and banks phenomenon , especially the left bank in the flow direction.

The surface erosion of the land in the hydrographic basin determines the amount of alluvial capacity produced by the dispersed effluent represented by the specific erosion that is turned into real erosion through the effluent coefficients.

Wischmeier, Motoc M. and Stanescu P., have developed the universal soil loss equation destinated for Romania conditions, establishing the value of the parameters for different climatic conditions, relief, soil, crops and means of soil erosion control, based on the researches made on runoff plots for a long period.

In order to determine the evolution of the Homoricu valley thalweg, the longitudinal profile elaborated by ISPIF Bucharest in 1970 was taken as a basic element, which was compared with the topographic elevation of the erosion formation in the depth of 2018.

The estimation of the surface erosion on agricultural land in Homoricu river basin was calculated according to the Maracine Nicolae method for each runoff plots, delineated on the study plan of the hydrographic basin of the erosion formation.

The fluvial erosion calculation was made for the maximum flowrate, which is formed on the base of a torrential formation of the Homoricu Valley, according to the method developed by Maracine Nicolae, as well.

Keywords: surface erosion, thalweg erosion, maximum flowrate, runoff plots