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THE INFLUENCE OF RECREATION ON THE PROCESSES OF SOIL EROSION IN THE FORESTS OF THE WEST KAZAKHSTAN REGION

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Abstract: The relevance of the topic is determined by the increasing demand for forest recreational resources of the West Kazakhstan region. The forests of the West Kazakhstan region are under the influence of recreational activity, which is growing every year and leads to the transformation of the natural environment. The purpose of the study is to determine the influence of recreation on the processes of soil erosion in the forests of the West Kazakhstan region. An increase in the recreational load and the steepness of the slopes leads to degradation of the forest floor and grassy cover. The remnants of these materials move downhill under the influence of visitors, and the soil surface is compacted. The porosity coefficient of the upper soil layer decreases as recreational loads increase. This leads to a decrease in soil water permeability and an increase in surface water runoff. The study showed that the runoff coefficient, the air-dry mass of the forest floor and the porosity coefficient are closely related. These relationships characterize an increase in the water runoff coefficient with a decrease in the air-dry mass of the forest litter and the porosity coefficient. In the field in 2023, based on the morphological description of the profiles, the degree of soil erosion in the selected woodlands was determined.

Key words: West Kazakhstan, natural resource state, river basin, soil, erosion, RUSLE, GIS

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INTRODUCTION

Classification of water erosion taking into account genetic, spatial and other features was proposed by V.N. Petrov in 1980. The landscape-genetic classification of water erosion was improved by L.F. Litvin in 2002, who identified the types of natural-anthropogenic erosion with various economic uses of land: agricultural, pasture, forestry, construction,

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recreational, etc. During recreational digression of forest ecosystems, the destruction of forest litter and soils occurs. Recreational use of these forests can lead to landscape changes, especially due to deterioration of the quality of forest litter, reduction of organic matter and compaction of forest soils. This in turn leads to the formation of water runoff on the surface and activation of soil erosion during heavy rains (Ivonin et al., 2000; Dragovich, 2015; Salesa and Cerdà, 2020).

Recreational digression is the process of negative changes in ecosystems under the influence of recreational loads. In the process of such a change, the ecosystem successively passes through five stages. According to OST 56-84-85 (Industry Standard, 1995), the stage of recreational digression is the stage of changing the biogeocenosis (ecosystem) as a result of exposure to recreational loads. Recreational use of forests can lead to negative changes in the entire forest ecosystem. Under the influence of such use, the destruction and degradation of forest litter occurs, and with it the properties of soils change. As a result, the soil layer is compacted and its porosity is reduced, which prevents the normal penetration of moisture and nutrients. Degradation of the litter also negatively affects soil microorganisms, which play an important role in its fertility. In addition, during the recreational use of forests, bonfires are formed, which leads to the burning of humus and an additional deterioration in the quality of the soil. All these processes eventually have a negative impact on the growth and development of plants, animals and other organisms that make up the forest ecosystem. Recreational use of forests can cause adverse changes in soils, forest structure, vegetation, young growth, undergrowth and wildlife (Lynn and Brown, 2003; Cassios, 1987; Wang and Watanabe, 2022; Evju et al., 2021; Telyuk et al., 2022; Jeffrey, 2023).

The primary cause of soil degradation is the deterioration of the forest floor, which occurs as a result of its compaction, crushing, thinning, fragmentation and complete destruction until the mineral horizon is exposed. Deterioration of the litter leads to simultaneous deterioration of soil properties, such as compaction and reduction of porosity. In addition, degradation of the litter leads to the suppression of soil microflora and humus formation processes under fire pits (Douglass et al., 1999). Increased recreational loads cause the oppression of trees (decrease in growth; the appearance of foci of diseases and the spread of pests; reduction in size and discoloration of needles, shoots; suppression of photosynthesis, respiration, transpiration and vital activity of roots). Trees are also susceptible to typical mechanical damage, such as pinching, splitting of trunks, trampling of roots, breaking of tops and skeletal branches. Individual trees can be cut down when equipping places for recreation and firewood harvesting. In addition, the bark of trees can get burned near bonfires.

Recreation leads to degradation of undergrowth, primarily small (height less than 0.5 m) and medium (0.5–1.0 m), as well as to a decrease in the density of shrubby undergrowth. In the initial period of loads, the undergrowth of different ages turns into the undergrowth of the same age, then the undergrowth and undergrowth are preserved by kurtins, and their viability decreases. It is also possible to change the collection of young trees, which indicates the danger of a future transition to another type of forest. It is obvious that at a certain stage of changes in forest ecosystems, erosion is observed, caused mainly by soil degradation under the influence of recreation. The relationship of soil erosion, runoff coefficient and slope steepness control the erosion process. The permissible limits of recreational loads that do not cause soil erosion are determined: the steepness of slopes up to 15° – 4.9 people. /ha; steepness from 15 to 20° – 2.1 people. /ha; steepness from 20 to 23 ° – 0.1 people / ha. Such a recreational load can minimize erosion processes. On slopes steeper than 23°, even a minimal recreational load activates the erosion process (Ivonin and Voskoboinikova, 2014; Shcheglo and Gorbunova, 2011).

The relevance of the topic is determined by the increasing demand for forest recreational resources of the West Kazakhstan region. As a result of long-term research (1981-2019), it was revealed that 630 species of vascular plants belonging to 72 families and 309 genera grow in the floodplain forests of the Ural River within the West Kazakhstan region (Ramazanova et al., 2022; Ramazanova et al., 2020). The largest families are *Poaceae* – 72 species (11.4%), *Asteracae* – 65 species (10.3%), *Fabaceae* – 38 species (6.0%), *Rosaceae* – 37 species (5.9), *Lamiaceae* – 36 species (5.7%), *Caryophyllaceae* – 35 species (5.6%), *Brassicaceae* – 29 species (4.6%), *Chenopodiaceae* – 25 species (4.0%), *Apiaceae* – 24 species (3.8%), *Liliaceae* – 24 species (3.8%), etc. (Darbayeva et al., 2021; Darbayeva et al., 2020). Thus, in the floodplain forests, the presence of widely distributed families, such as *Poaceae, Suregaceae, Scrophulariacae, Polygonaceae*, which are distributed throughout the floodplain of the Urals, can be traced. The presence of local subendemic families *Fagaceae, Betulaceae, Tiliaceae, Gentianaceae, Ulmaceae, Dryopteridaceae, Trapaceae, Thelypteridaceae* indicates the preservation of non-moral broad-leaved species in floodplain forests.

MATERIALS AND METHODS

In the course of field research, soil erosion survey is carried out, during which the contours of soils are distinguished by the degree of erosion and the degree of resistance to erosion. The detail of the survey is determined depending on the complexity of the soil cover, the intensity of erosion and the nature of the use of land for recreational purposes.

Soil erosion survey is carried out with the predominant laying of the profile. The total number of profiles, their frequency and the number of samples taken are determined by the nature of the manifestation of erosion: the number of digs increases when it is difficult to determine the degree of erosion (Shcheglov and Gorbunova, 2011).

Based on the morphological description of the profile, the degree of soil erosion is determined – weak, medium, strong. According to Sobolev's classification, eroded soils are divided into slightly washed, medium washed, strongly washed and very strongly washed soils. Slightly washed soils. These include soils that have no more than ½ horizon A washed away. The color of the surface layer of the soil does not differ from the unwashed one. Medium-washed soils. These include soils in which the horizon A is partially (more than half) or completely washed away; the soil surface has a brownish tint. Strongly washed soils. These include soils in which the AB horizon has been washed away, the surface has a brown color. Very much washed away soils. These include soils in which the sun horizon has been completely washed away, the surface

layer of brown color is characterized by a lumpy structure. According to the degree of soapiness, there are weakly washed (up to 20 cm), medium-washed (20-40 cm) and strongly washed (more than 40 cm). The resistance of soils to water erosion in the absence of plants or crop residues on them depends on the lumpiness of the upper layer. Lumpiness is the weight content of fractions larger than 1 mm in diameter in a layer of 0-5 cm, expressed as a percentage of the weight taken from this layer. The lower the lumpiness, the less resistant the soil is to erosion, all other things being equal (Table 1). The destruction of lumps to erosively dangerous sizes (less than 1 mm in diameter) depends on their connectivity, which, in turn, is due to the physico-chemical properties of the soil: granulometric composition, carbonate content, salinity, and others.

Table 1. Classification of soils by degree of resistance to erosion (Shcheglov and Gorbunova, 2011) Degree of stability

Degree of stability	The content of physical clay in %
Strong	Over 20
Average	20–10
Weak	less than 10

Determination of the percentage of clumping of the soil is carried out as follows: the average sample is taken from at least 5 points for each layer. The weight of the sample is 1.5–2 kg. Sieving is carried out in the field through a closed sieve with holes of 1 mm after bringing the sample to an air-dry state. The basis for the grouping of soils of various granulometric composition in terms of resistance to erosion is the percentage of physical clay.

Assessment of the recreational load of the territory on a landscape-dynamic basis consists of the following stages:

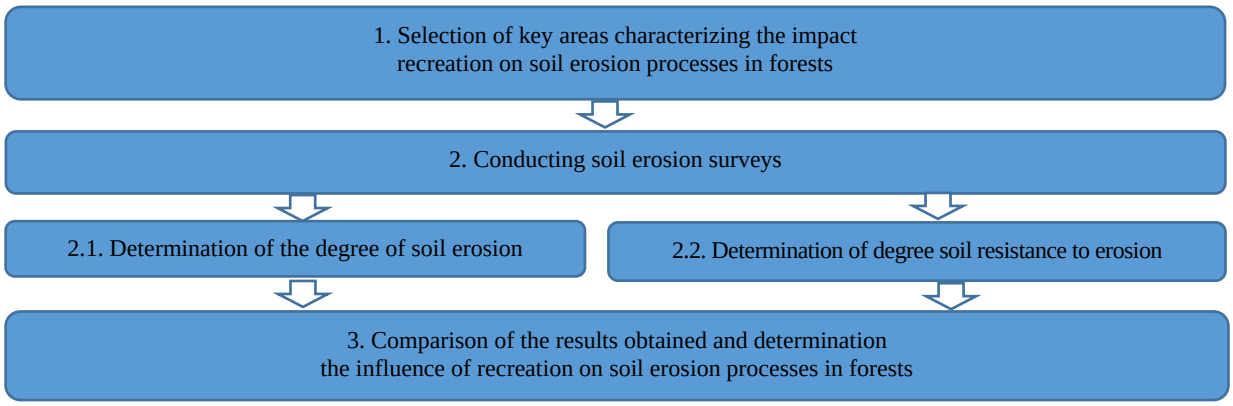

Figure 1. Flowchart «Determination of the influence of recreation on the processes of soil erosion in forests» (Source: Authors)

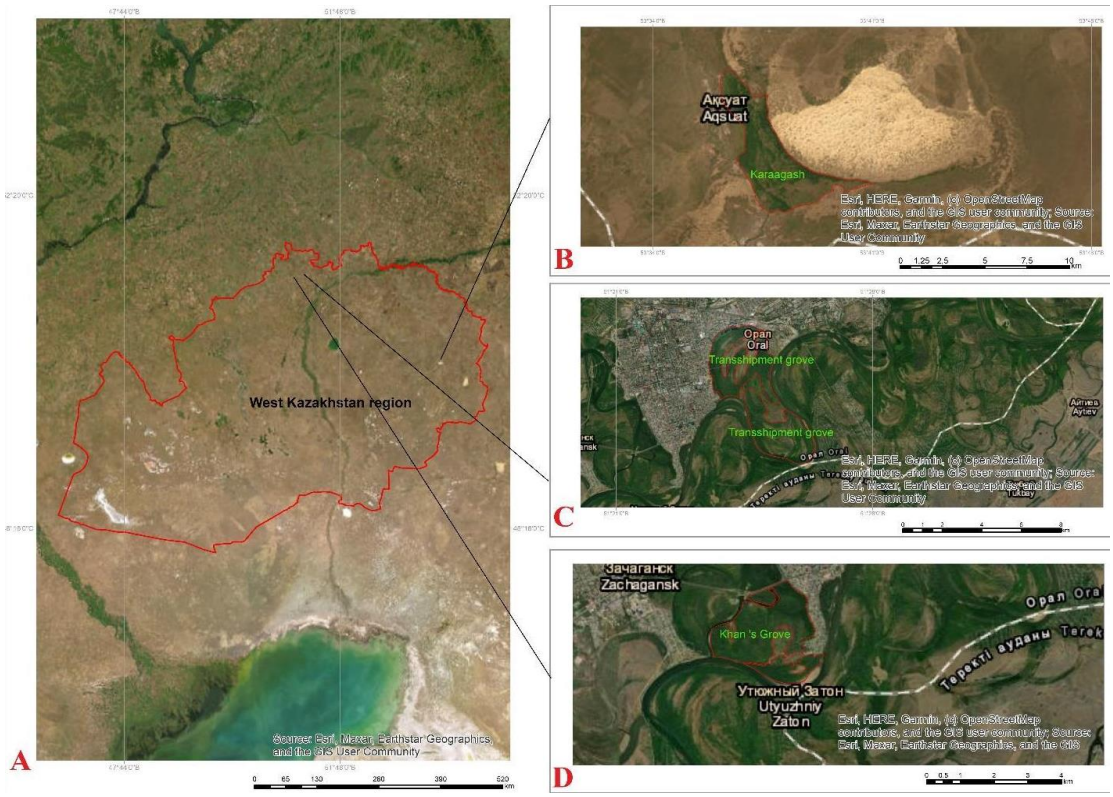

Figure 2. Forests of the West Kazakhstan region (Source: Author, created in the ArcGIS 10.8 program using the National Geographic World Map, Maxar, 2023) A) West Kazakhstan region; B) Karaagash Forest; C) Transshipment Grove forest; D) Khan Grove Forest

RESULTS DISCUSSIONS

The following woodlands were selected as objects of studying the influence of recreation on the processes of soil erosion in the forests of the study region: Karaagash, Transshipment grove and Khan's grove (Figure 2).

Khan's grove is a pine forest located at the junction of the Ural and Shagan rivers. In total, it occupies 256 hectares. The transshipment grove, with the old Ural riverbed (686.5 hectares), 40% of the forest area of which was lost due to private forest fires, lack of proper care and sanitation. Karaagash-a forest area of about 7 thousand hectares, located in the upper reaches of the Buldurta River, is a refuge for northern forest species. Various types of birch and aspen trees have been developed here. The main characteristics of the studied woodlands are presented in Table 2.

Table 2. Characteristics of research objects

Woodlands	Coordinates	Number of observation points	Slope steepness, in degrees	Breed	Mother breed	Age, years	Number of barrels, pcs. / ha
Karaagash	50.319041, 53.634890	3	1,9	*Ulmus*	Fine - grained sandstones	78	81
Transshipment grove	51.207332, 51.409667	4	3,21	*Betula, Populus tremula*	Clay shales and sandstones	120	215
Khan 's Grove	51.179611, 51.365102	3	3,18	*Pinus*	Fine-grained sandstones and shales	130	205

Based on the morphological features of the profiles of the selected woodlands, the degrees of soil erosion were determined according to the method described above. There are 3 profiles laid in the Karaagash forest, the location of the profiles is determined depending on the intensity of recreational development. The study showed that the soil of two out of three of them belongs to the category of slightly washed soils, where no more than ½ horizon A has been washed away. The color of the surface layer of these soils does not differ from the unwashed one.

Figure 3. Forest «Khan 's Grove» (Source: the research was conducted by the authors in «Khan 's Grove», summer, 2023)

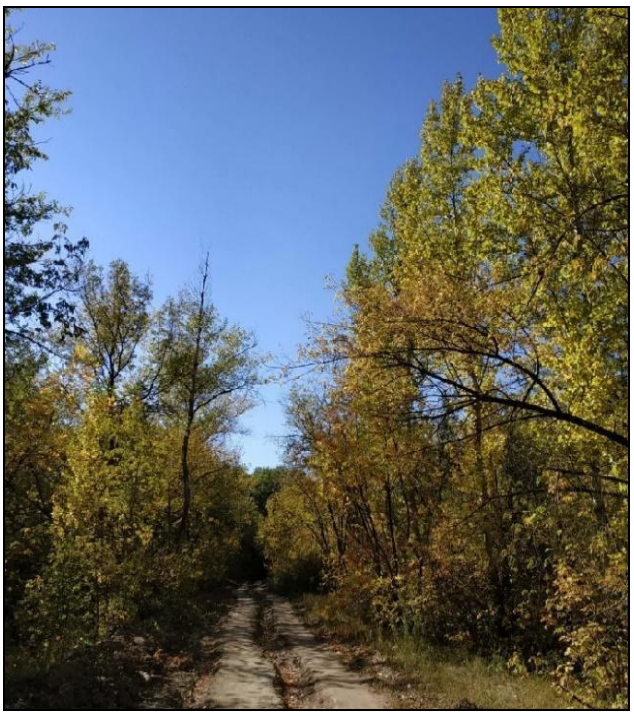

Figure 4. Forest «Transshipment grove»(Source: the research was conducted by the authors in «Transshipment grove», summer, 2023)

Soil control at one point belongs to the category of medium-washed soils, where the horizon A is completely washed away, and the soil surface has a brownish tint. Studies show that the average content of physical clay in the soils of the Karaagash forest is 3.2% and have a low degree of resistance to erosion processes. There are four profiles in the Transshipment Grove forest area, which are located depending on the intensity of recreational development. The results of the study showed that the soil in two of these profiles belongs to the category of slightly washed soils, in which flushing occurs no more than half the depth of horizon A. The surface layer of slightly washed soils does not differ in color from non-flushed soils. The remaining two profiles belong to medium-washed soils, where more than half of the horizon A has been washed away and the surface has a brownish color. The average content of physical clay in the soils of the Transshipment Grove forest is 11.3%, and the soils have an average resistance to erosion processes.

Three soil profiles were studied in the Khan's Grove forest, which were established depending on the degree of recreational use. From the study it became clear that two of these profiles belong to the category of soils with a strong

degree of flushing, where the horizon AB is washed away, and the surface has a brown color. In one of the points of the Khan's Grove forest, the soil belongs to the category of medium-washed soils, where the horizon A is partially washed away, and the soil surface has a brownish color. Studies show that the average content of physical clay in the soils of this forest area is 3.9%, which indicates their low resistance to erosion processes.

Depending on the physical and geographical features in all the forests selected for the study, the slope steepness is up to 15 degrees and in relation to the permissible limits of recreational loads that do not cause soil erosion should not exceed 4.9 people/ ha, can reach 15-18 people/ha. Khan's Grove attracts a large number of visitors and has an extensive network of paths, making it a popular holiday destination. However, due to the intensive use of this forest area for recreational purposes, significant changes are occurring in the natural soil cover. In addition, woodland components such as low-density sandstones and shales are not resistant to erosion. But this indicator in the Khan's grove in the summer period exceeds 2-3 times. In the rest of the studied woodlands does not exceed the established norm.

CONCLUSION

Based on the above, we can say that the forest landscapes of the West Kazakhstan region are affected by recreational activities, which are growing and leading to a change in the natural environment. Studies conducted in 2023 showed that heavily washed soils are the soils of the Khan's Grove forest, where the AB horizon is washed away, the surface has a brown color. Khan's grove, which is located in the vicinity of the city of Uralsk, is a popular place for recreation with a large number of visitors and an extensive network of paths. The influence of recreational load on this forest area leads to significant changes in the natural mosaic of living ground cover. In addition, the components of the forest, such as fine-grained sandstones and shales, are not resistant to erosion processes. Studies show that the total area of paths and trampled areas in pine plantations directly depends on the attendance of these arrays.

The fine-grained sandy soils of the Karaagash forest are slightly washed. The vegetation cover consists of various grass groupings, including many types of weeds. Currently, the Karaagash forests are less susceptible to recreational load compared to the Khan Grove and the Transshipment Grove. However, the array is used as a place for the removal of household and construction waste. The soils of the Karaagash forest have low resistance to erosion processes.

Forest landscapes are becoming susceptible to the negative impact of recreational activities, which can have serious consequences for green areas, especially those located near reservoirs. An increase in the recreational load and the steepness of the slopes leads to degradation of the forest floor and grassy cover. The remnants of these materials move downhill under the influence of visitors, and the soil surface becomes denser. As a result, the porosity coefficient of the topsoil is reduced, which leads to a deterioration of its water permeability and an increase in surface runoff. Studies show that the runoff coefficient, the air-dry mass of the forest litter and the porosity coefficient are interrelated. An increase in the runoff coefficient correlates with a decrease in the air-dry mass of the forest litter and the porosity coefficient.

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