

DAMAGE TO LANDSCAPE AND ITS EVALUATION AT THE GAIŽIŪNAI MILITARY TRAINING AREA

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Abstract. The military activity carried out by the occupation army in Lithuania inflicted an extensive damage to the environment. The Soviet Army upon retreating left enormous devastated areas, the damaged ground, destroyed forests, and the degraded flora. In the Gaižiūnai Military Area it is possible to distinguish various firing ranges of military training areas, tank training fields, demolition areas, and tracked vehicles areas. The training area has an artificially created terrain, the devastated forms of natural landscape, the compressed soil, and the mixed upper layer of soil. Sand erosion occurs in some places.

The strongly damaged territories exist in the Gaižiūnai Military Training Area (tracked vehicles areas, mortar firing area), these territories cover even 8% of the military training area. The strongly damaged areas account for 5% of the Gaižiūnai Training Area (ruins in the training areas 4, 13, the former workers' township), the averagely damaged areas in the Gaižiūnai Training Area constitutes only 1%.

Laboratory investigations showed that soil porosity rate in the tracked vehicles area, the small tank training field and the drifted sand desert "Sahara" is distributed unevenly. The approximate soil porosity rate is by 10 percent less than in the background territories. An evident effect of military facilities on the training area soil is observed.

When selecting the measures for soil protection against deflation, simulation of a situation was performed, building of enclosures across the prevailing direction of wind is recommended.

Keywords: military activities, military training area, landscape, soil, erosion, soil porosity.

1. Introduction

The military heritage of the Soviet Army in the training area consists of considerable damage caused to the environment, especially to landscape. Due to intensive economic activity of people, in certain territories the environmental condition becomes worse, nature harmony, formed throughout millennia, is devastated or strongly damaged. Considerable destruction and damage caused to natural landscape took place in the former Soviet Army training areas, and their consequences have survived until now [1, 2].

Impact of military activities on the soil. Military activities in the training area have an overall influence on the environment. The soil gets destroyed, compressed, damaged under artificial covers, artificial relief is created. During construction in the military territory agricultural works of enormous volumes are performed, especially if underground structures are built. In damaged areas, soil erosion is spreading, in some places of the military training area, deflation takes place.

The former demolition training field and tank training field are subject to the major physical impact. Here a soil layer of several metres in thickness gets mixed up due to demolition and equipment, a territory is turned into wasteland.

Intensive military nature utilisation predetermined deep damage to the surface, physical degradation of landscape. In the explored territories, damaged land is found numerously. Their major part is in the aerodromes, missile bases. The previously viable layer of surface soil is damaged under artificial covers.

Damage and disturbance to fauna and flora. The military activity inflicts damage on unique biotopes and protected territories. Alongside the military objects and their territories, plant communities, not characteristic of landscape, are formed. Tranquillity of animals is disturbed; their migration routes become violated. Military equipment in forests, shooting ranges and elsewhere inflict damage on animals.

Due to an anthropogenic impact, in military territories, after felling of forests and opening of plains, plants, alien to these places, started spreading here. In open fields, plants of dumping sites and plains (wormwood) began growing.

The military activity reduced the stability and resistance of animal populations, worsened their life, nutrition and reproduction conditions. In the military affected zones, animal populations, not resistant, not characteristic of Lithuania and short-term, are being formed, whereas typical animal populations important in terms of genetic fund protection are disappearing [3].

Object of investigation:

To identify landscape damage inflicted in the Gaižiūnai Military Training Area, damage types and scope, to evaluate soil porosity in the Gaižiūnai Military Training Area, and to perform numeral modelling of soil deflation.

2. Territory description

The Gaižiūnai Military Training Area is located close to Rukla – Gaižiūnai settlements, in a wooded sandy plain. The Gaižiūnai Rukla Military Training area is situated in the plateau of the lower reaches of the rivers Nemunas and Neris, Pravieniškės–Užusaliai microdistrict. The Pravieniškės–Užusaliai microdistrict covers the plain of the lower palmiform depression, located in the Nemunas and

Neris intervalley. The greater part of the microdistrict is covered with sands, lying on striped clays. In watersheds, a sandy, somewhat wavy plain is very marshy and forms a landscape of large-waved boggy sandy plain. The microdistrict sites the Didžiojo Raisto marsh, which emerged after bogging up of several lakes and its spreading over the surrounding dry lake.

In the western part, where limnoglacial loamy soils are not covered either with sands or gravel, considerable areas in watersheds are occupied by the woody landscape. Approaching the rivers Nemunas and Neris, the plain is broken by erosion [4].

In the eastern and southern part, the military training area passes over to the training territory where various tactical and other exercises take place. In the south, this territory borders the Polaraistis thelmological reserve; the eastern border of the training territory goes across the coast of the river Lomena and takes about 40% of the Lomena landscape territory. In southwest, the military training area borders the huge woody territory, with marshy areas in some places. In the northwest part, the Gaižiūnai military area reaches the approaches of the town Rukla, in the northwest – the Gaižiūnai settlement with the railway stations.

Several small rivers are flowing through the military training area: Ruklėlė, Verkstinė, Lankis, Glitinė, several lakelets are found here. In the outskirts of the military training area there are marshy areas; in the central part, huge open areas of drifted sand, reminding the dune landscape, are found [5].

The Gaižiūnai Military Training Area is the object of multi-profile military exercises, consisting of shooting fields, tank training fields, the former demolition military training areas, and other military training territories. The destination of the military training area predetermined the type of environmental damage. The greatest damage was inflicted on relief and soil. In the territory, after destruction of the surface, soil erosion and deflation increase.

The following parts are mostly affected by the military activity: tank training field, the tracked vehicles area, and the drifted sand desert "Sahara". The paper deals with landscape (soil) damage in this territory.

3. Investigation methods

Research of mechanical damage was conducted in separate territories, used for military needs according to their destination: shooting ranges, tracked vehicles area, the former settlement, etc. In each territory, evaluation was given of the area, damage time (by Soviet or Lithuanian army), type and a degree of damage: damaged weakly, averagely, strongly, and very strongly. Relief damage was also assessed: digging off or building of hills, diggings of various types, deepening, etc. In separate territories, a type and scope of plant damage is evaluated: damage inflicted by vehicles running not by roads, intensive trampling down, running over the grass plantations, compression or other damage inflicted on plants or destruction. The damaged area is established visually, the completely ruined area is equalled to 100% damage (see Table 1).

Building up of territories with buildings of various destination, covering of surface with a concrete or asphalt cover, ruins, construction waste, etc. were analysed according to the time of object building (installation), condition, and the area occupied. The smaller damaged area

was established by measuring it with the measuring reel, whereas larger areas visually and by using precise maps of the locality.

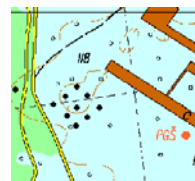


Fig 1. Diagram of soil probe-taking sites

Soil porosity research was performed to evaluate mechanical soil damage of anthropogenic origin. It is based on the fact that porosity reduces when the soil is destroyed or compressed [6]. Soil probes for porosity research were taken from the depth of 25-30 cm, distance between probes being 10 m, according to the diagram prepared in advance (See Fig 1).

Probes taken from the soil were investigated by the method of saturation in the environmental chemical laboratory. The total sand porosity and porosity rate is determined by using the saturation method.

In quantitative terms the porosity is expressed by the relation of all pores of rocks and cracks (V_p) and the total volume of the probe (V_b).

$$n = \frac{V_p}{V_b}; \quad (1)$$

where n -rock porosity. Then porosity rate e is calculated:

$$e = \frac{n}{1 - n}. \quad (2)$$

Model porosity was considered soil porosity in the military training area where mechanical damage opportunities are least [7].

4. Experimental results

During research it was established that military activities in the military training area have an overall impact on the environment. Soil is destroyed, compressed and damaged under artificial covers, artificial relief is formed. Soil erosion becomes spread in the damaged areas, in some places of the military training area, intensive deflation occurs.

At this moment, military activities are carried out, using the same training areas of the Soviet Army: shooting ranges, tracked vehicles training fields, etc. Transformation of new territories for military needs is not determined in the military training area. Temporary military campsites are most often set up in the same places. After training, the environment is put to order.

Research showed that *trenches* during tactical training are most often dug up in the forest among the trees. After completion of training, trenches are filled up, the territory of exercises is put to order. It was determined that when digging up trenches tree roots are damaged. If damage is considerable, trees become dry. *Tracked vehicles training exercises* are also conducted in territories specially designated for that purpose. Tracked vehicles are running along the same routes (Territory 3), the same shelters and camouflage places for equipment are used. Because of

frequent driving along the same places, the training area soil is run through in some places by deep ruts.

Table 1. Mechanical damage of training fields in the Gaižiūnai Military Training Area in percentage.

Territory	Territory No.	Mechanical damage %
Tracked vehicles route	3	100
Training field 3	4	2 - 3
Training field 6	7	2 - 3
Training field 2	5	1 - 40
Training field 1	6	1
Training field 7	8	1
Former worker's township	12	60
Ruins in training field 13	10	55
Ruins in training field 4	11	50
Mortar firing training area	1	80
Territory near the antitank weapon shooting range	2	5 (southern part)
		80 (northern part))
Demolition areas	9	95

Plant-covered areas are damaged by military facilities (ran over, compressed), trees and bushes are broken and damaged. Grass plantations are damaged by 100%.

Demolition areas are selected in depressions. During demolitions, large pits are made, soil is mixed up, plants are damaged and destroyed.

Grenade launching areas are installed in remote places, territories are fenced. At the demolition sites, there is a sand cover. Military exercises of this type have no considerable effect on the environment.

The mortar firing area (Territory 1) in the Gaižiūnai Military Training Area is arranged in the huge waste ground of drifted sand near the aerodrome, in the former shooting and mortar firing training area. Firing is carried out to targets arranged at various distances. Exercises of that type are conducted in the part of the training area, the landscape of which is damaged since of old.

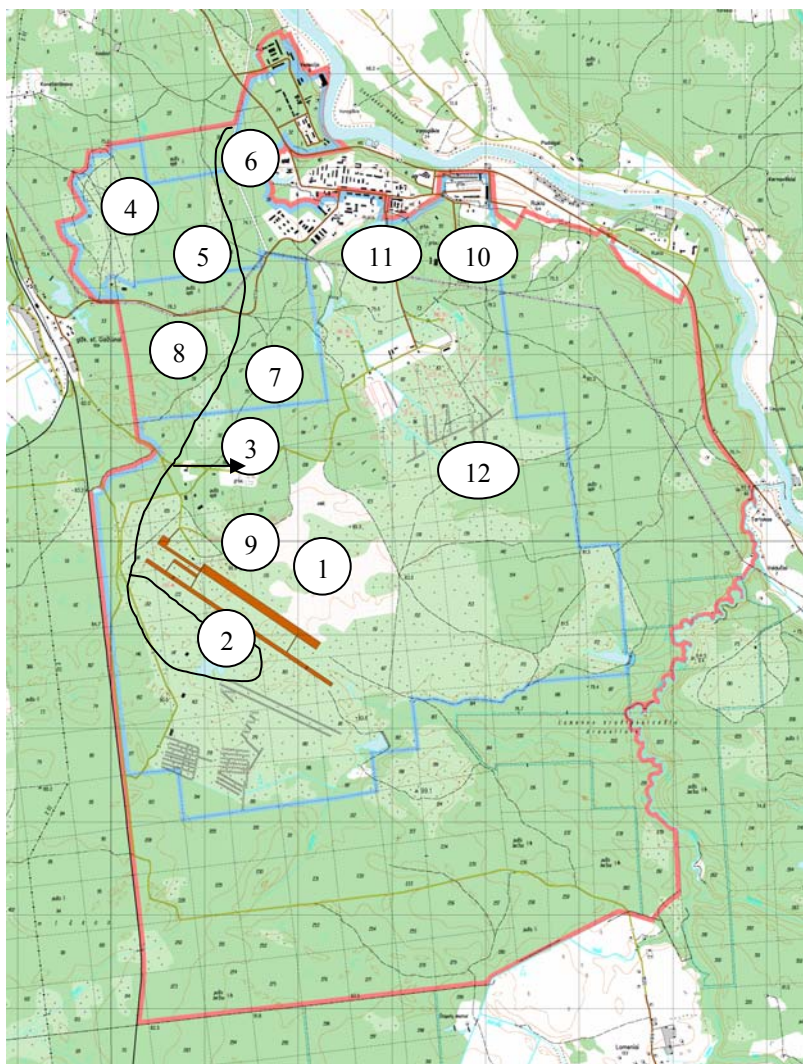


Fig 2. Training fields of the Gaižiūnai Military Training Area (numbers according to Table 1)

Buildings not used, ruins. In the military training areas, there are old destroyed and completely devastated buildings, which became construction waste, the entire areas are contaminated with various ruins and construction waste. These ruderal zones with the devastated environment not only worsen the aesthetical value of landscape, but also completely destroy or strongly damage the soil in large areas. In some territories, plants characteristic of wasteland grow, bushes grow in the ruins.

Relief is greatly changed in some places, deep pits remained up to 1.5-2 m of excavated sections. In the outskirts of the territory, old trenches, built hills and other relief changes remained. The entire territories are very strongly damaged mechanically.

After conducting laboratory research of soil porosity in the Gaižiūnai Military Training Area, it was established that the training area is not uniform in terms of soil porosity. This is seen from the distribution of porosity rate according to the place of probe-taking (Fig 3; 5). Soil porosity rate fluctuates from 0.3 to 0.38.

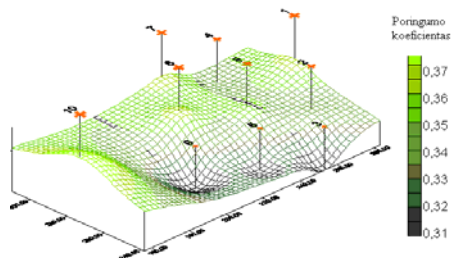


Fig 3. Distribution of soil porosity rate in the tracked vehicles route

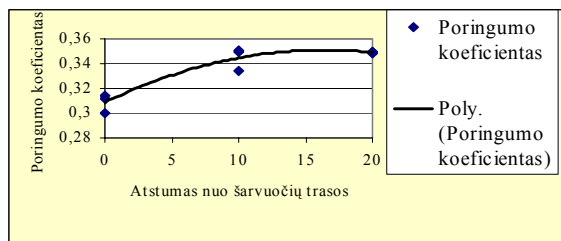


Fig 4. Dependence of soil porosity on the distance to the tracked vehicles route

Investigation showed that in the military training territories of intensive use – the tracked vehicles route and training fields – the soil porosity is reduced as compared to the background one (background probes were taken from the forest nearby where no tracked vehicles are driven).

The soil porosity rate is indicated in the figure. The research data obtained (Fig 3) make it possible to assert that soil is most considerably damaged (compressed) in points 3, 6, and 9. Probe-taking sites 3, 6, and 9 are located in the tracked vehicles route. Other probes are taken from the territory situated near the route. Thus, in places where tracked vehicles are running constantly, soil porosity is changed (reduced) most of all. Porosity of the soil near the tracked vehicles route is higher than in the route, but it does not reach the background level.

Background probe is taken in the forest near the tracked vehicles route (probe 10), where mortar military vehicles do

not run. The background soil porosity rate is higher than the porosity rate in the tracked vehicles route by approximately 16%.

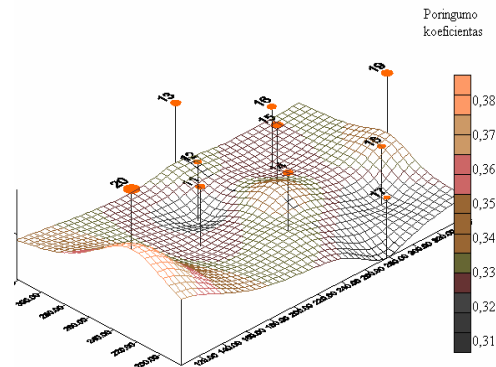


Fig 5. Distribution of soil porosity rate in the tank training field

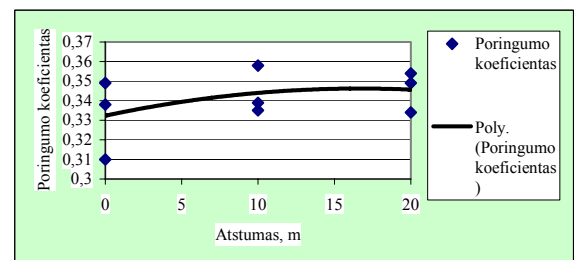


Fig 6. Change of soil porosity in the tank training field

In the large tank training field where tracked vehicles are running not so intensively, the decrease of the soil porosity rate is considerably lower (9%).

Comparing two military training territories (tracked vehicles route and the large tank training field), it is possible to state that soil porosity is directly dependent on the intensity of running of military vehicles. The highest reduction of soil porosity is observed in the tracked vehicles route where tracked vehicles are running constantly.

Knowing from literature data that porosity in eroded soils gets reduced and studying the central part of the Gaižiūnai Training Area “Sahara”, it is possible to make a presumption that that soil in this part of the training area is affected by deflation. Reduction of the porosity rate (3%) is observed as compared to the model probe; thus, it is possible to affirm that eolian denudation occurs in this area and it is characterized by drifting of small particles of the ground, thus the reduction of the porosity rate. In the territory areas where settlement of fine sand particles (eolian accumulation) occurs, the increase of the soil porosity rate (3.5%) is observed.

Since there are no trees in the central military training area (only sporadic bushes are growing), the territory is not protected from wind and with the western and southwestern winds prevailing, soil erosion occurs.

5. Numeral modelling of soil reduction deflation

Basing on the literature data, we may assert that one of the most simplest and reliable measures for reduction of wind velocity and prevention of the blowing out of soil and deflation are antiwind obstacles.

The protective bands of trees, with dense and low crowns of deciduous and coniferous trees, grown with bushes on the sides, covering bare tree trunks in the middle, are the most effective in protecting from wind.

Using the previously conducted research on the effect of transverse obstacles on the change of wind velocity and distribution of the wind flow [8, 9, 10], we calculated and

visually depicted the effect of obstacles on the distribution of sand particles, i.e. at what distance the wall reduces effectively the wind velocity and how sand particles, meeting on their way an obstacle, are distributed, with the application of the computer mathematical modelling program PHOENICS. Height of the formed plantation band is 1.3 m.

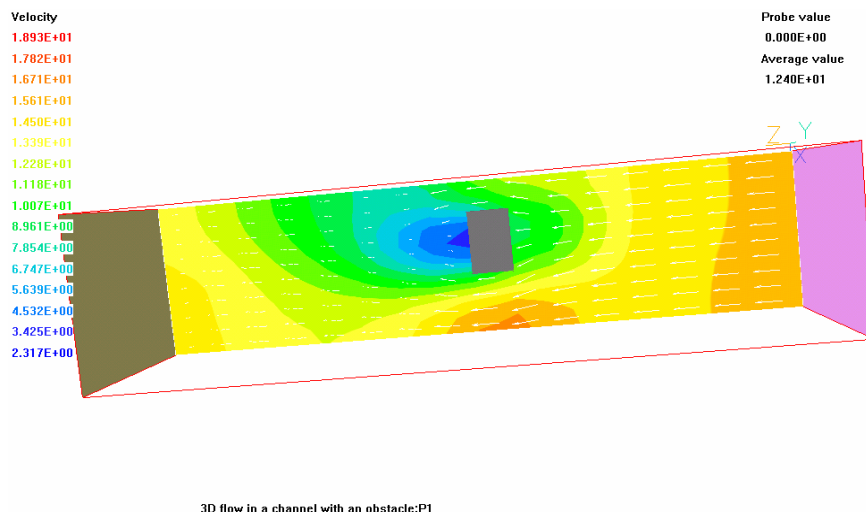


Fig 6. Decrease of the velocity due to the protective walls

Due to the protective tree band near the wall, wind velocity decreases from 15 m/s to 10m/s. And beyond the wall even up to 3.5 m/s. With wind velocity at 5 m/s, due to the protective tree bend, it reduces to 2.5 m/s. However, when at a height of 2 m beyond the protective band wind velocity increases to 3.4 m/s and thus rising higher increases.

0.1 mm and larger sand particles at the wind velocity of 15 m/s, when raised from the ground, moves together with the air flow. After planting the protective band of trees, part of these sand particles settles down, part of them remains in the air.

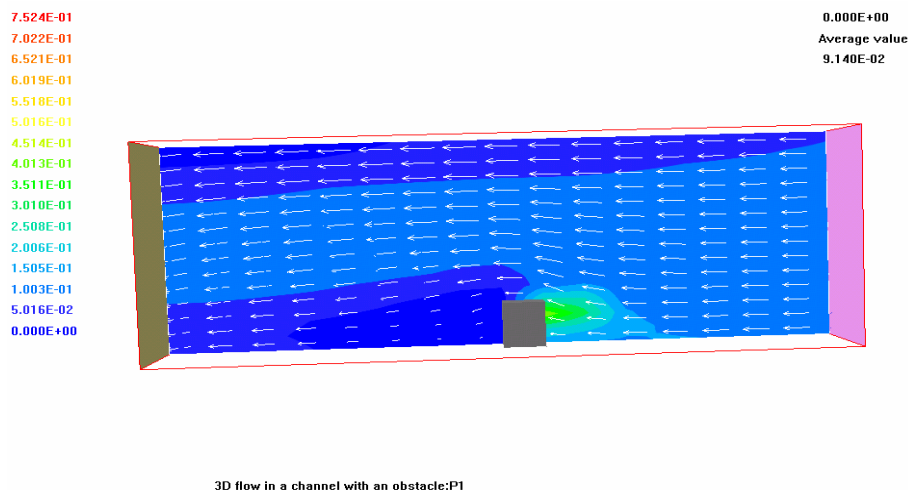


Fig 7. The distribution of large sand particles (0.1mm) in the graphic view

It was established that sand particles of 0.05 mm and smaller settle down on the earth surface with greater difficulty. Their higher concentration will be observed in upper layers of air. Therefore the planted band of trees will influence the settlement of these particles.

The formation of the recommended protective plantations when adjusted to the Gaižiūnai Military Training Area infrastructure and their implementation would help to prevent further soil erosion.

6. Conclusions

1. In the military training area, ruderal territories, not used and damaging landscape, destroyed buildings, and trenches are left from the Soviet period. Some territories contain rubbish. After demolition, in the training area, pits are formed, damage is inflicted on plants and soil.
2. While evaluating damage caused to landscape, deep ruts of tracked vehicles that completely damaged plants deserve special attention. After conducting soil porosity research, the

clear soil density zones, coinciding with the mortar vehicles routes, are established.

3. Comparing the research results of these zones with background probes, the evident deviation of soil porosity (0.30 – 0.36) is seen, this showing the marked effect of military facilities on soil and plants growing in it.

4. The mortar facilities have a great impact on (degrade) soils, therefore tactical exercises should be conducted only in permanent places, specially designed for exercises.

5. Soil porosity investigations show that soil porosity rate increases in those territories where sand particles are drifted and accumulation of sand particles occurs.

6. It was established that a very important factor, having an effect on the trajectory of a sand particle, is its size. Big sand particles (0.1 mm) are lifted from the ground with more difficulty but they settle down more quickly. Small sand particles (0.05 mm and smaller) are lifted even when wind is not strong (5 m/s).

7. Building of obstacles across the direction of prevailing winds would be an effective measure for soil protection against deflation in the military training areas.

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KRAŠTOVAIZDŽIO PAŽEIDIMAI IR JŲ VERTINIMAS GAIŽIŪNŲ KARINIAME POLIGONE

Santrauka

Okupacinės kariuomenės Lietuvoje vykdyta karinė veikla padarė didžiulę žalą aplinkai. Išeidama sovietų kariuomenė paliko milžiniškus nuniokotus plotus, pažeistą gruntą, sunaikintus miškus, degradavusią augaliją. Gaižiūnų kariniame poligone galima išskirti įvairių karinio mokymo teritorijų šaudyklų, tankodromų, sprogdinimo teritorijų, šarvuočių trasų. Poligone sukurtas dirbtinis reljefas, suardytos natūralios kraštovaizdžio formos, suspaustas dirvožemis, sumaišytas viršutinis žemės sluoksnius. Vietomis paplitusi smėlio erozija.

Stipriai pažeistų teritorijų yra tik Gaižiūnų kariniame poligone (šarvuočių trasa, sunkiųjų kulkosvaidžių šaudymo poligonas), šios teritorijos sudaro netgi 8% poligono ploto. Stipriai pažeistos teritorijos sudaro Gaižiūnų poligone 5% (griuvėsiai 4, 13 mokymų laukuose, buvęs darbininkų miestelis), vidutiniškai pažeistos teritorijos Gaižiūnų poligone sudaro tik 1%. Laboratoriniai tyrimai parodė, kad dirvožemio poringumo koeficientas šarvuočių trasoje, mažajame tankodrome ir pustomo smėlio dykumoje „Sacharoje“ pasiskirstęs netolygiai. Apytiksliai dirvožemio poringumo koeficientas yra 10 procentų mažesnis nei foninėse teritorijose. Pastebimas aiškus karinės technikos poveikis poligono dirvožemiui.

Parentant dirvožemio apsaugos nuo defliacijos priemonės, atliktas situacijos modeliavimas, rekomenduojamas užtvartų statymas skersai vyraujančios vėjų krypties.

Raktažodžiai: karinė veikla, karinis poligonas, kraštovaizdis, dirvožemis, erozija, dirvožemio poringumas

НАРУШЕНИЕ ИЗОБРАЖЕНИЯ И ИХ ОЦЕНКА НА ВОЕННОМ ПОЛИГОНЕ ГАИЖУНАЙ

Резюме

Выходящая Советская армия оставила огромные пространства с нарушенной экологией, это леса и растения, разрушенный грунт. На военном полигоне Гаижунай можно выделить разные территории по типу военного учения. Это стрельбище, танкодром. На полигоне создан искусственный рельеф, разрушены натуральные формы ландшафта, утрамбованная почва, смешанный верхний слой земли. Местами распространена эрозия песка. Лабораторные исследования показали, что коэффициент плотности поверхности почвы на трассе танков, на маленьком танкодроме и в пустыне „Сахара“ различны. Коэффициент плотности поверхности почвы на полигоне в 10% меньше, чем в естественных окрестностях. Очень поврежденные территории на военном полигоне Гаижунай (трасса танков, полигон перестрелки пулеметов) составляет даже 8% общей площади полегона. Меньше поврежденные - 5% (площади обучения бывший городок рабочих), посредственно поврежденные территорий на полигоне составляет только 1%.

Подбирая, меры защиты почвы от эрозии, смоделированы ситуации, предложено ставить заборы.

Ключевые слова: полигон, ландшафт, эрозия, коэффициент плотности