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DAMAGE ASSESSMENT CAUSED BY ILLEGAL AMBER MINING FOR THE STATE IN THE VOLODYMYRETS DISTRICT OF THE RIVNE REGION

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Setting a problem

The problem of the spread of disturbed lands as a result of illegal amber mining in recent years has become threatening. «Amber fever» covers almost the entire north-western part of Ukraine with an area over 14.6 thousand square kilometers [1]. Illegal mining of amber causes irreparable damage to the environment and leads to significant losses of land resources. Illegal mining of amber causes negative environmental and socio-economic impacts. At present, the law does not regulate the issues of extraction of minerals from manifestations that are not of industrial significance, individuals and small business entities, so the proceeds from such activities are not available to budgets of all levels [2].

On the territory of the Rivne region large-scale works on illegal amber mining are conducted within the limits of Rokytnivsky, Dubrovytsky, Volodymyrets, Zarychnensky and Sarnensky districts. Complex operational monitoring of the development of disturbed lands in these territories is not carried out, which leads to a lack of information about the scale of these processes and prevents the establishment of real amounts of pecuniary damage caused to the state.

Presentation of the main material of the problem

Rivne region accounts for about 6% of the world's stock of amber. The scale of the disaster reaches not only the width of the hectares in the fields and in the woods, but also in the depths of the earth. According to official data [3], the area of disturbed lands was 8.8 hectares (0.0004% of total territorial area) in the Rivne region in 2011, and it is already 2192.1 hectares (0.1093% of total territorial area) in 2014. There is no information on the area of disturbed land in subsequent years. Due to the lack of up-to-date information on the area of disturbed lands in general and, taking into account the continuous processes of increasing them as a result of illegal amber extraction, it is impossible to comprehensively assess the damage caused by these processes throughout the entire region.

The activity associated with the illegal mining of amber negatively affects the environmental components such as soil, vegetation, water, atmospheric air and subsoil. Particular attention deserves the problem of land degradation as a result of removing the fertile layer, breaking the integral structure of the soil, littering the land. The consequences are, as a rule, loss of humus, macro and microelements, the destruction of the upper fertile soil layer, and the strengthening of wind and water erosion. If we talk about vegetation, then the nature of the impact is a violation of the integrity of the grass cover and the illegal destruction of tree nurseries. Unauthorized uncontrolled use of surface and groundwater leads to disturbance of the hydrological regime of the territory and reduction of groundwater level. There is a violation of the geological structure of the territory, the mineral resources are lost, which leads to deformation of the earth's surface, damage to mineral deposits, which completely excludes or substantially limits the possibility of their further exploitation [2, 4].

In most cases, the territory where unauthorized extraction takes place are in constant use of forest enterprises, in the lease of mining and processing enterprises and agricultural enterprises, as well as in the property of citizens, territorial communities and the state.

The Law of Ukraine «On the protection of the natural environment» (article 69) provides for the reimbursement of unearned profits for the time necessary for the restoration of the quality of the natural environment, reproduction of natural resources to a condition suitable for use on the intended purpose. In its turn, the Land Code of Ukraine (article 207) provides for compensation for losses caused by deterioration of the quality of the land due to the negative influence caused by the activities of citizens or legal entities.

Analysis of the latest investigations and publications, which are related to solving this issue

It is worth noting that researches that were directly related to this topic were practically absent in Ukraine until 2015 [2]. However, the expansion of the scope of activities associated with the unauthorized extraction of amber attracted the attention of scientists to this problem. The main aspects of assessing the impact of anthropogenic activities connected with the illegal extraction of amber on the environment are covered in the writings of such scientists as Nadtochy P. P., Tymochko T., Myslyva T. M., Slobodian O., Filipovich V. E., Yakovliev Ye.O., Korniyenko V. and others. Questions of the economic assessment of the amount of damages inflicted by the state as a result of illegal amber extraction are considered in detail by Nadtochy P. P. [2] and Filipovich V. E. [1, 5].

Unsolved parts of the general problem

In works [1,2,5] calculation of losses inflicted by the state as a result of unauthorized extraction of amber is carried out within the framework of environmental legislation on the following indicators:

- unauthorized use of mineral resources;
- unauthorized occupation of the land parcel;
- use land not for specific purpose;
- littering the land parcel, as well as storing waste there without special permission;
- removal of a fertile soil layer without special permission.

When calculating these indicators, appropriate methods [6,7,8] are used. However, the definition of certain

parameters in accordance with these methods requires not only field surveys on the ground, but also accurate data on the volume of mining operations. It is clear that in the conditions of illegal extraction it is impossible to obtain such information, and sometimes even conduct in-kind field observations.

Also, when assessing the damage to the state as a result of unauthorized extraction of amber, consideration should be given to the possibility of reimbursement of losses caused by deterioration of the quality of the land due to the negative impact caused by the activities of citizens or legal entities stipulated in art. 207 of the Land Code of Ukraine.

Setting the task of the problem

The purpose of the work is to estimate of damage and loss assessment caused by illegal amber mining for the state and to analyze the anthropogenic impact of this activity on the state of land resources of the Volodymyrets district of the Rivne region.

Due to the lack of complex operational monitoring of the development of disturbed lands due to illegal amber mining, the estimate of damage and loss assessment can be determined only for specific land parcel. The subject of the study will be disturbed lands that were discovered as a result of inventory of land [9] on the territory of the Canynytsya village council of Volodymyrets district, with a total area of 11,5825 hectares.

Displaying the main material of the problem

There are 358 deposits of minerals and underground waters in Rivne region, that are represented by 18 species, 121 of them are developed. Amber deposits are concentrated in the northern regions and are represented by 4 explored deposits of amber: «Klesivske», «Vilene», «Volodimirets Shidnuy», «Zolote» («Dubivka» and «Virka»).

The «Klesivske» and «Volodimirets Shidnuy» have been used for industrial mining amber deposits. Nowdays, only 3 enterprises have special permits for the use of subsoil for amber mining: State Enterprise «Burshtyn of Ukraine» – «Klesivske» deposit, Ltd. Centre «Soniachne remeslo» for the amber mining «Volodimirets Shidnuy» deposit and Ltd. «RED.MET» – «Zolote» deposit.

The Volodymyrets district of the Rivne region is located in the Dubrovyts'k-Volodymyrets amber region zone of the Pripyat amber basin. This zone, in the form of a strip of width 18-40 km, is extended from the south-west to the north-east As a result of the erosive incision in the central part of the zone, it is divided into two separated massive fields, which spatially correlate with the areas of development of the Dubrovytsky and Volodymyritsky amber deposit. The massive of the amber deposits is 5.0-9.5 m, and the depth of their occurrence on average is 10.5-16.5 m. The total power and depth of the amber deposits of the area increase in the western and south-western directions [10].

In the Volodymyrets district of Rivne oblast, the total amber stock is estimated at 100 thousand tons, which predominantly lie in sandy and sandy-clay soils at depths up to 15 meters. It is sufficient for research and introduction of mining technologies on an industrial scale.

Promising areas for amber mining include Volodymyretska, Virkivska, Politsey-Malyi Zholudsk, Ivanchynsk, Remake-Kidrinsk, Rafaliv-Kannonitskiy. The Volodymyrets and Virkiv amber areas are the most knowledgeable at the stage of search and search-and-appraisal works. In their boundaries the main promising objects are manifestations: Dubovsky, Volodymyrets East, Zhovkini, Kanonitsky, Virkivsky [10].

Illegal amber mining undermines the ecosystem of the region and is a significant loss for the rural and forestry area. Due to the illegal amber mining the area of the destroyed forest is constantly increasing. The extraction of amber by means of a pump method dehydrates the system of artificial melioration and changes the level of ground water, causing considerable damage to the ground waters of the district. The ground blasting with water jets leads to water logging of the territory and changes in soil moisture balance. At the agricultural land in places of amber extraction there are observed processes of wind and water erosion. It lead to a decrease in the capacity of the humus horizon, nutrient reserves, loss of soil structure and increased soil drought.

Another area problem is the illegal mining of amber on the nature reserve fund lands and other environmental protection purposes. Problems also arise in animals that fall into the formed pits and can not go away from there.

An increase in the area of disturbed lands as a result of illegal amber mining can be researched on the example of the Canynytsia village council of Volodymyrets district.

The illegal work on amber extraction on this territory began to operate in 2015. Through «solar stones» has caused irreparable damage to the environment, especially to agricultural lands. At that time, the area of technogenically disturbed lands was 120 hectares. There are about 3 hectares of forest (fig. 1).

Fig. 1 The fragment of the territory of the Canynytsya village council of Volodymyrets district in 2015

On the basis of geological and economic evaluation of amber deposits in the «Kanonichi» parcel [11], the technical feasibility of the development of the deposit and the feasibility of its industrial development was established. In this regard, dissatisfaction from the local population is growing. Residents of the villages of Kannonichi and Dubovka do not rule out the possibility of sabotaging and blocking the industrial production of amber by legal means on the basis of a special permit. They themselves are engaged in the illegal amber mining of in these lands. This situation indicates an aggravation of social tensions within the territorial community and does not promote the development of legal methods for extracting amber and proceeds to budgets of all levels.

At present, the area of disturbed lands due to illegal amber mining is about 150 hectares, including the area of disturbed lands of the forest fund reaches 15 hectares. This testifies to the fact that illegal works are continuing, and with this the area of disturbed lands increases (fig. 2).

Fig. 2 The fragment of the territory of the Canynytsya village council of Volodymyrets district in 2017

The introduction of a mechanism for compensation of damage and loss caused to the state, landowners and land users through the illegal amber mining can serve as a deterrent for chaotic amber extraction and the sustained growth of disturbed lands. However, due to the illegal nature of this activity, it is sometimes impossible to establish from whom to charge these damage and losses. Implementation of this mechanism in the land administration system should be carried out taking into account the specific conditions of this activity.

We consider in detail the calculation of damage and losses for disturbed lands that were found on three parcels due to the inventory of land in the territory of the Canynytsya rural council of Volodymyrets district [9]. According to the current data of the state statistical reporting on quantitative land registration and distribution of land owners, land users and lands, these land plots are recorded in agricultural land (agricultural land - arable land) and belong to land in state ownership [9] (table 1).

Table 1

Explication of land in state ownership on the territory of the Canynytsia rural council of Volodymyrets district

№ parcel	Cadastral number	Land name	Area, ha
1	5620884900:03:031:0207	arable land	6,2635
2	5620884900:03:031:0208	arable land	23,8316
3	5620884900:03:023:0195	arable land	79,8648
Total, ha			**109,9599**

Identified lands that are suitable for further use in agriculture and that are disturbed lands due to illegal amber mining taking into account the state of the soil, the condition of the existing use of land, the availability of restrictions on use (table 2).

It has been established that 11.5825 hectares of land of the Canonitsky village council are disturbed due to amber extraction. These lands are not suitable for further use in agriculture and can not continue to be used for their intended purpose. In order to further their efficient use, it is necessary to carry out a series of measures aimed at restoration of soil cover, to carry out the reclamation of disturbed lands.

Table 2

Explication of disturbed lands of the parcels in state ownership on the territory of the Canynytsia rural council of Volodymyrets district

№ parcel	Land name	Area, ha	of them, ha	
			lands that are suitable for further use in agriculture	disturbed lands due to illegal amber mining
1	arable land	6,2635	5,1234	1,1401
2	arable land	23,8316	18,0008	5,8308
3	arable land	79,8648	75,2532	4,6116
Total		**109,9599**	**98,3774**	**11,5825**

Parcel number 1 is located in the south of the Dubivka settlement and has an area of 6.2635 hectares. The disturbed lands amount to 1.1401 hectares. Plot number 2 borders with the parcel number 1 and is located in the south of the village Dubivka near the forest. The total area of the plot is 23.8316 hectares. The disturbed land is 5.8308 hectares (fig. 3).

Fig. 3 Plan of boundaries of land plots №1 and №2

Parcel number 3 is located in the north-east of the village Canonichi near the pond. It has an area of 79.8648 hectares, of which the disturbed lands are 4.6116 hectares (fig. 4).

Fig. 4 Plan of boundaries of land parcel №3

First, we will calculate the damage incurred to the state due to illegal amber mining in these areas.

For calculate the amount of damages for unauthorized use of the minerals, a method was used to determine the amount of damages caused to the state due to the unauthorized use of minerals [6]. In order to determine the amount of damages, use the following formula:

$$D = \sum_{i=1}^{k} \left(P_i \times N \times V_i \right), \qquad (1)$$

where D – the damage incurred to the state due to the unauthorized use of minerals, UAH;

P_i – the base damage rate in the shares of the minimum wage;

V_i – volume of illegally extracted minerals, kg;

N – the size of the minimum wage, UAH.

According to the method [6], to determine the volume of illegally extracted minerals V_i, the direct measurements of linear dimensions of length, width and height are performed directly at the place of extraction, calculating the

volume through the product of linear sizes using the appropriate measuring instrument, which has a metrological confirmation. For amber, such an approach is not entirely effective, since the volume of formed vortex does not correspond to the volume of amber extracted in this place. Another problem in determining volumes of illegally extracted minerals is inaccessibility for field surveys of most illegal place of extracted.

In work [2], the amount of compensation for damage caused to the state as a result of the unauthorized use of minerals is calculated provided that the volume of extracted amber will be 2 kg per day, and production will last 30 days.

We are proposed to determine the volume of illegally extracted minerals based on amber stocks in the area.

According to the geological report «Search and appraisal works on amber within the section «Canonichi» of Volodymyrets district of Rivne region» [11] the total stocks of amber category C2 in the quantity of 15970 kg and perspective resources of category P1 in the amount of 34154 kg were calculated. According to the special permit No. 3504 dated February 3, 2009, for the use of the subsoil, the approximate area of the plot «Canonichi is 1958 hectares.

Based on the data provided, one can calculate approximate stocks of amber in the range of 1 hectare. Approximate reserves for this deposit amount to 25.6 kg / ha. Thus, the estimated volume of illegally extracted minerals in the researched plots with a total area of 11.5825 hectares is 296.5 kg.

The base damage rate in the shares of the minimum wage for amber is 1.42 kg. The minimum wage as of January 1, 2018 is 3723 UAH. [12]. The results of calculations are shown in the table 3.

Table 3

The calculate of the damage incurred to the state due to illegal amber mining

Indicator	Parcel №1	Parcel №2	Parcel №3
Area, ha	1,1401	5,8308	4,6116
P_i	1,42		
N, UAH	3723		
V_i, kg	29,19	149,27	118,06
D, грн	154299,42	789131,70	624127,01
Total	**1567558,13 UAH**		

Since the disturbed lands due to illegal amber mining on the territory of the Canynytsya village council relate to agricultural land of state property, carrying out works on illegal amber mining on these lands testifies to the unauthorized occupation of land plots. The amount of damage caused as a result of unauthorized occupation of a land plot is determined for all categories of land (except for residential and public land) by the method of determining the amount of damage due to unauthorized occupation of land, the use of land not for specific purposes, the removal of a fertile soil layer without special permission [7] with the following formula:

$$\mathrm{D_o} = \mathrm{P}_s \times N_p \times K_f \times K_i, \qquad (2)$$

where D_o – the damage due to unauthorized occupation of the land, UAH;

P_s – area of the unauthorized occupied land, ha;

N_p – average annual income, which can be obtained from land use by purpose, UAH / ha;

K_f – coefficient of functional use of land;

K_i – coefficient of indexation of the normative monetary valuation of land equal to the product of indexation coefficients of the normative monetary valuation of land for 2007 and subsequent years, which are determined in accordance with the Procedure for the indexation of monetary valuation of land [7].

The average annual income, which can be obtained from land use by purpose in the Rivne region is 746 UAH / ha. The coefficient of functional use of land is 1.

The coefficient of indexation of the normative monetary valuation of land is 2,38.

The results of calculations are shown in the table 4.

Table 4

The calculate of the damage incurred to the state due to unauthorized occupation of the land plots

Indicator	Parcel №1	Parcel №2	Parcel №3
P_s, ha	1,1401	5,8308	4,6116
N_p, UAH / ha	746		
K_f	1		
K_i	2,38		
D_o, UAH	2024,22	10352,47	8187,80
Total	**20564,50 UAH**		

The amount of damage caused by the use of land not for specific purposes is calculated according to the method of determining the amount of damage due to unauthorized occupation of land, the use of land not for specific purposes, the removal of a fertile soil layer without special permission [7] by the formula:

$$\mathrm{D_p} = P \times 0{,}33 \times \left(N_p + N_f \times K_r\right) \times K_o \times K_i, \qquad (3)$$

where D_p – the damage caused by the use of land not for the specific purpose, UAH;

P – the area of the land plot, which is used not for the specific purpose, ha;

0,33 – coefficient for calculating the share of average annual income;

N_p and K_i have the same meaning as in formula (2);

N_f – annual average additional income received as a result of actual use of land;

K_r – coefficient used to take into account the regional difference in the formation of the average annual income received from the actual use of land not for the specific purpose;

K_o – coefficient, which used for taking into account the environmental value.

The average annual income received as a result of actual use of the land under open development of minerals for agricultural lands is 18024 UAH / ha.

Coefficient used to take into account the regional difference in the formation of the average annual income received from the actual use of land not for the specific purpose in the Rivne region is 1,01.

For the parcel number 3, a coefficient is used to take into account the environmental value, such as the protection zones along the power lines – 1,5.

The results of calculations are shown in the table 5.

Table 5

The calculate of the damage incurred to the state due to the use of land not for specific purpose

Indicator	Parcel №1	Parcel №2	Parcel №3
P, ha	1,1401	5,8308	4,6116
N_p, UAH / ha	746		
N_f	18024		
K_r	1,01		
K_i	2,38		
K_o	-	-	1,5
D_p , UAH	16968,70	86782,82	102955,25
Total	**206706,77 UAH**		

The amount of damage caused by the removal of the fertile soil layer without a special permit is determined by the method of determining the amount of damage due to unauthorized occupation of land, the use of land not for specific purposes, the removal of a fertile soil layer without special permission [7].

To determine the amount of damage caused by the removal of a fertile soil layer without special permission, use the following formula:

$$D_s = P \times N_g \times K_i, \quad (4)$$

where D_s – the damage caused as a result of removal of soil cover without special permission, UAH;
P – area in which the removal of the fertile soil layer was detected, ha;
Ng – standard losses from destruction of soil cover, UAH / ha;
K_i – has the same meaning as in formula (2).

The standard losses from the destruction of soil cover for Rivne region – 15843 UAH / ha. The results of the calculations are given in table 6.

Table 6

The calculate of the damage incurred to the state due to removal of the fertile soil layer without special permission

Indicator	Parcel №1	Parcel №2	Parcel №3
P, ha	1,1401	5,8308	4,6116
N_g, UAH / ha	15843		
K_i	2,38		
D_s, UAH	42989,00	219858,13	173886,56
Total	**436733,68 UAH**		

The amount of damage due to littering of lands is determined by the method of determining the extent of damage caused by pollution and contamination of land resources due to violations of environmental legislation [8] by the formula:

$$D_L = A \times Б \times M_{VL} \times P \times K_L \times K_d \times K_E, \quad (5)$$

where D_L - the total damage from littered land, UAH;
A – the specific costs for the elimination of consequences of littering land, the value of which is equal to 0.5;
B – the conversion coefficient; it is equal to 10 if the land is littered by household, industrial and other waste.
M_{VL} – normative monetary value of the land affected by litter, UAH / ha;
P – area of the littered land plot, ha;
K_L - coefficient of the littering land plot; it is depend on the degree of littered by its waste;
K_d – coefficient of waste danger;
K_E – coefficient of ecological and economic land plots value.

Normative monetary valuation of agricultural land outside the settlements of the Volodymyrets district for arable land is M_{VL} = 13501 UAH / ha.

As a result of amber extraction, the destruction of the upper fertile soil layer, the clogging of the land by sand, and the crown of lower ground horizons of the soil profile is observed. After the activities of the diggers and the work of the motor pump on disturbed lands there are remnants of tree plantations, pollution land with non-toxic waste. For the researched parcels, the estimated volume of waste is 20-50 m^3. It is corresponds to 4 levels of littering of the land. Then the coefficient of the littering land plot is K_L = 2,5. The coefficient of waste danger is K_d = 1.00.

The coefficient of ecological and economic agricultural lands value is K_E = 1.0. The results of calculations are given in table 7.

Table 7

The calculate of the damage incurred to the state from littering agricultural land due to illegal amber mining

Indicator	Parcel №1	Parcel №2	Parcel №3
А	0,5		
Б	10		
M_{VL} , UAH/ha	13501		
P, ha	1,1401	5,8308	4,6116
K_L	2,5		
K_d	1		
K_E	1		
D_L, UAH	192406,13	984020,39	778265,15
Total	**1954691,66 UAH**		

The total amount of the damage incurred to the state due to illegal amber mining extraction on agricultural lands of state ownership on the territory of the Canynytsya village council of Volodymyrets district was UAH 4186254.74.

Article 207 of the Land Code provides for the reimbursement of losses caused by deterioration of the quality of the land due to the negative influence caused by the activities of citizens or legal entities. The loss assessment in agriculture caused by deterioration of land quality is determined in accordance with the Procedure for determining losses in agriculture and forestry to compensation [13] by the formula:

$$V_L = (1 - K) \times N_L \times P, \quad (6)$$

where V_L – the value of losses, ths. UAH;
K – coefficient of reduction of productivity of the land, which is determined on the basis of data of agrochemical certification of land plots;
N_L – normal standard losses, UAH / ha;
P – area of the land plot, ha.

In the Rivne region, for arable land, the standard losses of agricultural production is 121.1 thousand UAH / ha.

Illegal amber mining leads to degradation of soil and destruction of the fertile layer. On the abandoned places of extracted remains only sand, because during the «golden stone» extraction, the thin humus layer of the soil is mixed with the main mass of sandy and sandy soils. It is very difficult to restore their fertility, because the processes of

soil formation are very slow [4]. Under these conditions, it can be assumed that the coefficient of reduction of productivity of the land is 100%. The results of the calculations are given in table 8.

Table 8

Calculation of losses in agriculture caused by deterioration of land quality due to illegal amber mining

Indicator	Parcel №1	Parcel №2	Parcel №3
P, ha	1,1401	5,8308	4,6116
N_L, UAH/ha	121100		
K	100 %		
V_L, UAH	138066,11	706109,88	558464,76
Total	**1402640,75 UAH**		

The total amount of agricultural production losses caused by the deterioration of land quality due to illegal amber mining on agricultural land of state ownership in the Canonitsky village council of Volodymyrets district will be UAH 140,262,407.75.

Conclusions

1. At present, the greatest problem of increasing the area of disturbed land in the Rivne region is the development of minerals, such as illegal amber mining. The analysis of disturbed land resulting from amber mining in the Volodymyrets district has shown that the soil cover and vegetation in the areas of amber extraction are completely destroyed, and it takes decades to restore them.

2. The total amount of damages inflicted to the state as a result of illegal amber mining (UAH 4186254.74) and agricultural production losses caused by deterioration of land quality due to illegal amber mining (UAH 140,268,407) are insufficient to compensate for damage to the environment and conduct reclamation of land from the restoration of disturbed lands to the previous state or at least to an ecologically safe permissible state possible in such conditions.

3. For the implementation of the mechanism for compensation of damages and losses caused by illegal amber mining to the land administration system at the local level, it is necessary to give local governments the right to issue permits for the development of local amber deposits with the proper record keeping of diggers. Also, give them additional control functions in the field of land and environmental legislation. Provide funds received for recultivation and restoration of disturbed lands.

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Damage assessment caused by illegal amber mining for the state in the Volodymyrets district of the Rivne region

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The development of disturbed lands as a result of illegal amber mining in the Volodymyrets district of Rivne region has been analyzed. The article proposes estimate of damage caused by illegal amber mining for the state on state-owned agricultural land in the Canynytsia rural council of Volodymyrets district. The loss assessment in agriculture caused by land degradation a result of illegal amber mining are determined.