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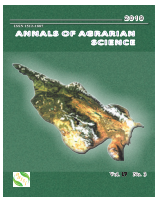

Assessment of ecological condition of Kosh stone pit adjacent agrocenoses and the improvement measures

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A B S T R A C T

The article analyzes and presents the results of the impact studies of the Kosh stone pit on the productivity of the agro-ecological systems of the Kosh, Ujan and Avan communities in the Ashtarak district of the Republic of Armenia. Studies have shown that under the influence of tuff quarry dust, scrap, among other anthropogenic factors, decreased the productivity of natural agro-cenoses in the adjacent communities of the stone pit (Kosh, Ujan), deteriorated the photosynthetic capacity of plants, decreased air permeability reduced humus and macro-food-elements amounts, while no significant negative impact was observed on the productivity of agro-cenosis in the Avan community, which is essentially away from the stone pit. At the same time, it was substantiated that in order to mitigate the negative impact of the stone pit on the agro-cenosis of the adjacent surrounding communities and to increase the fertility of the soils, it is necessary to carry out fertilization works with mineral-organic fertilizers, and perennial grasses in grasslands sowing works according to the degree of land degradation and prescribed improvement measures.

Keywords: Stone pit, Agricultural systems, Productivity, Organic fertilizers, Improvement measures, Communities.

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Background

Human economic activity, especially misuse of natural resources, causes many negative phenomena in the environment, as a result of which the balance of nature is disturbed, the state of the biota and its bio-genic habitats is weakened, the current and future processes in natural social systems become unpredictable.

In the territory of the Republic of Armenia, 7.0 - 7.5 thousand ha of land is occupied only under the waste of stone materials (tuff, basalt, etc.). These wastes, as a result of winds and tornadoes, as well as heavy rains and floods, constantly pollute the air, water and land areas of the settlements, causing significant damage to the natural and agricultural systems in the surrounding areas, reducing their productivity, significantly affecting biodiversity, particularly on conservation of individual endemic animal and plant species [1].

There are many stone pits with different colors of tuff in Armenia, where more than 92 million m3 of tuff has been extracted since 1928 [2,3].

The Kosh tuff stone pit, where ore mining was carried out in the 55s and 60s of the last century, has been mechanized since 1969. Over the past 50 years, about 15.3 million m3 of tuff has been extracted, 37% of which has been used as masonry, and the rest - 63% or 9.6 million m3 as waste, dumped into the environment in the form of scrap and dust [2, 4]: The mentioned wastes, as a result of unwise exploitation of the quarry, not only caused the formation of industrial deserts, where only certain species of weeds (lice, thorns, etc.) grow scarcely, but also caused formation of floods and sediments due to mixture of dust from the quarry and heavy rains. As

a result, the productivity of natural agricultural systems decreases, the yield of horticulture fields and the productivity of livestock decreases. Therefore, any study aimed at identifying the negative effects of the stone pit to identify measures to improve them is relevant to the requirements of the regional development strategy plans.

Materials and methods

A task was set to study and assess the land degradation in the Kosh quarry adjacent Kosh, Ujan and Avan communities productivity of the agricultural systems due to waste generation from mine exploitation. In particular the following tasks were fulfilled:

a) The level of degradation of agricultural lands (arable lands, natural pastures) in Kosh, Ujan and Avan communities, adjacent to the quarry, over the last three years.

b) Develop a system of measures to mitigate the land degradation and increase their productivity.

c) Develop recommendations to the farmers of the communities on the possible application ways of the developed measures.

To study the condition of arable lands, pastures and grasslands of the mentioned rural communities, to make comparative analyses with the data of the non-degraded areas of those systems, as well as to determine the degree of their degradation due to the quarry activity, we performed visual, cartographic [5,6] and laboratory study, as well as the results of agricultural activities for the last three years to determine the impact of the quarry, conditioned by the distance, on the economic efficiency of the agricultural activities of the communities through the comparison of crop yields.

Soil samples were taken from community arable lands and natural grasslands. The content of humus, environment reaction (pH), available nutrients (NPK) were determined in the samples. These indicators were compared with similar indicators of non-degraded or considered agricultural land types. As well as the production data of 3 years were taken from the three communities located at different distances from the stone pit (Kosh, Ujan, Avan) through the comparisons revealed the impact of the quarry activity on the results of agricultural production received by those communities.

Laboratory analyzes of soils were performed by universal methods, which are given in manual of methods of agrochemical analysis, edited by B.A. Yagodin [7].

The hummus was determined by Turin method, with the help of phenyl andranyl acid, vie a titration method, The reaction of the soil solution pH was determined by the electropotentiometric method, the total nitrogen was determined by Kjeldal, and the easily hydrolyzable nitrogen was determined by I.V. Turin and M.M. Kononova methods. The content of mobile phosphorus was determined according to Arenius and Machigin, and the exchange potassium was determined by Maslova's methods.

Research results

Analyzing the agrochemical parameters of the lands of Kosh, Ujan and Avan communities located at different distances from Kosh quarry, it became clear that in the arable lands and natural grasslands of communities immediately adjacent to the quarry are more severely degraded (Kosh, Ujan) by mine waste (dust, rubble), than similar land areas of Avan community, located 21-25 km from the quarry (Table 1). Thus, if the humus content in the pastures and arable lands of Kosh community adjacent to the quarry was only 0.8 and 1.6%, the content of available nutrients (NPK) in pastures were only 2.2, 2.8 and 26 mg per 100 grams of soil, in arable lands -3.2, 5.2 and 27 mg, than at a distance of 10 km from the Kosh stone pit mine, east of Kosh community, in Ujan community the same land type pastures and arable lands, the mentioned indicators have better values than in Kosh community. However, the same could not be said about Avan community, which is located 21 km north-west of Kosh stone pit mine: despite the lands of mentioned communities are less degraded, both the humus content and the nitrogen, phosphorus-potassium levels are higher than the similar indicators in the pastures and arable lands of Kosh and Ujan communities, they are almost close to the agrochemical indicators of the non-degraded soils of the region (Table 1). Due to the activity of the mine, studying of the average yields of agricultural crops grown in Kosh, Ujan and Avan communities over the last three years (2017-2019), comparing the distances of communities from the Kosh stone pit mine, reavealed that near the mine or in the nearest communities, the yield of agricultural crops and orchards is less than the yield of similar

crops grown in the community lands farther away from the mine [8].

Thus, if in the Kosh community, which is near to Kosh stone pit area, the average yield of grain (autumn wheat) was 24.6 c / ha, plum - 34.2 c / ha, green bean - 57.5 c / ha, apple - 128.5 c / ha, in the Ujan community, which is 11 km away from the mine, the average yield of the same crops were- 26.2 c / ha of autumn wheat, 62.5 c / ha of green beans, 63 c / ha of stone-fruits, 62.4 c / ha of grapes, 156.8% of apples. c / ha, while farmers and individual peasants of Avan community, located 21-25 km away from Kosh mine, provided higher yields from the same crops in 2017-2019 than in Ujan community - almost 26-50% higher than near the mine located Kosh community.

Table 1. *Structure of the land fund, agrochemical indicators of arable lands and pastures of the communities adjacent to the Koshi quarry**

Community name and distance from the mine	Total land. ha	Arable land, ha	Perennial planting, yes	Grasslands, ha	Pastures, ha	Land-use types	Sample depth, sm	Humus content,%	pH in aqueous extract	Available nutrient content, mg per 100 g of soil		
										N	P_2O_5	K_2O
Kosh 1.5- 2,5 km	690	152	32	-	194	arable land	0 - 20	1.6	8.0	3.2	5.2	27.0
						pasture		0.8	8.2	2.2	2.8	26.0
Ujan 9.5- 11 km	1948	328	82	6	918	arable land		1.8	7.7	3.6	5.0	29
						pasture		1.1	7.6	3.7	3.0	30
Avan 21- 25 km	1300	448	162	2	245	arable land		2.2	7.4	4.8	6.3	32
						pasture		1.5	7.2	3.9	4.8	33
Non-degraded	-	-	-	-	-	arable land		2.4	7.3	5.6	6.4	34.0
						pasture		1.8	7.1	5.4	6.9	33.0

** Considering that there are no or almost insignificant grasslands in the studied communities, no studies were conducted in such areas.*

The average yield of autumn wheat in Avan community was 39.5 c / ha, green beans - 87.0 c / ha, cherry - 124.6 c / ha, apple - 197.0 c / ha (Table 2).

The results of agricultural activities are different in the communities at different distances from the mine; the farther from the mine, the higher yield of crops are observed and on the contrary, if this or that community is closer to Kosh quarry, than the yield of crops grown in that community is much lower. By the way, such a pattern was observed when determining the level of degradation and soil fertility, especially the content of humus and mobile nutrients (NPK) in the pastures of those communities, especially in rural-side areas.

Thus we can definitely conclude that under the influence of Kosh quarry dust and scraps, among other anthropogenic factors, decreases in natural (in this case pastures, because in these communities there is almost no natural grassland) and agricultural systems' productivity is observed. Also water and air permeability of arable lands is worsened, humus content and generally field yield, as well as pasture use efficiency is decreasing.

Table 2. *Sown areas of main agricultural crops and yield data in Kosh, Ujan and Avan communities of Ashtarak*

Communities	Crops	Occupied areas, ha			The actual collected harvest, c				The average yield for three years, c / ha
		2017	2018	2019	2017	2018	2019		
Kosh	Autumn Wheat	20	17	20	492	418.2	492		24.6
	Green bean	5	4	6	287.5	230.0	345.0		57.5
	Plum	5	5	5	170	173	170		31.2
	Apple	4	4	4	518	514	510		128.5
	Cucumber	5	3	6	564	582	576		123.0
Ujan	Autumn wheat	50	57	55	1310	1493.4	1441		26.2
	Green bean	6	8	8	372	504	500		62.5
	Plum	141	141	143	8883	8980	8786		63.0
	Apple	6	6	6	950	930	942		156.8
	Grapes	62	62	62	3731	4030	4028		63.4
	Potato	18	12	18	2340	1660	2240		130.0
Avan	Autumn what	29	35	40	1146	1462	1501		39.5
	Green bean	7	8	8	696	690	615		87.0
	Cherries, plums	41	41	42	5230	5208	5010		124.6
	Apple	53	54	54	10608	10508	10144		197.0
	Walnut	4	4	5	247	196	198		49.3

Therefore, taking into account the low level of fertility of the arable lands of the communities, as well as the negative impact of Kosh quarry functioning on the agronomic productivity (agro-cenosis productivity) of neighboring communities (Kosh, Ujan), especially on the agricultural crops, we propose to apply the following mixtures of organic and mineral fertilizer in Kosh community.

1. Combining the norm of 5-8 t / ha of biohumus or organomix with 60 (N60P60K60) kg / ha norm of nitrogen, phosphorus and potassium active substance.
2. For the fertilization works in arable lands in Ujan community use 70-75% of the fertilization norm proposed for the Kosh community, and in Avan community -up to 50% of the proposed norms for the Kosh community.
3. In order to increase the content of humus and available nutrients, the density and composition of vegetation per unit area, in the degraded pastures of Kosh, Ujan and Avan communities- it is necessary to carry out the following surface improvement works,

- Fertilize with the rotten manure at the rate of 10-15t / ha and 30 kg / ha of NPK measure and collect stones.
- Carried out sowing with the seeds of perennial herbs with the folloing norms in the communities: in Kosh- 20 kg/ha, in Ujan - 15 kg / ha and in Avan of 9-10 kg/ha

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