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Changes and Reclamation Ways of Agricultural Lands at the Artik City and its Neighboring Rural Communities

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ABSTRACT

The impact of floods and wastes of closed stone ore at the Artik city on its urban agricultural land areas and on those of neighboring rural communities has been studied in the current article. The study has revealed, that in conditions of global climate changes the soil of the mentioned communities have undergone serious degradation due to the adverse effect of the closed stone ore wastes and floods. Recommendations presented per communities have been already contributed by the EPIU, at the RA Ministry of Environment, while the surface reclamation activities for the meadows will start from May, 2020. The implementation of the mentioned activities will lead to the prevention of the soil degradation in the mentioned communities and to the increase of soil fertility by 30.0 %-45.0 %.

Introduction

Human economic activity, particularly mismanagement of natural resources, causes many negative phenomena in the natural environment, e.g. destroyed natural balance, poor sustainability in global ecosystem, deteriorated biodiversity and human living environment, unpredictable current and future processes in biosocial systems (due to global climate changes- tornadoes, floods, mudflows and desertification).

In Armenia only 7.0-7.5 thousand hectares of land area is operating under the conditions of stone residual materials. These wastes are constantly polluting the air, water and land areas of the mentioned settlements through the winds, hurricanes and flooding causing considerable damage to the vegetation and fauna of these regions.

The most commonly used stone material is Artik's tuff. Since 1928 the mechanized tuff mining has been implemented at the Artik mine site and more than 51 million cubic meters of tuff materials have been mined up to date, out of which only 30 %-40 % were used as a construction material and the other part was discharged into the environment as a waste (Gabrielyan, et. al, 2017, Galstyan& Mkrtchyan, 2013).

About 30.0-35.0 mln m^3 dumps discharged into environment throughout more than 90 years of continuous mechanized mining have become the reason of not only industrial "desert" formation with scarce weed vegetation but also resulted in stone dust and flood sediments due to improper exploitation of the mentioned stone mining sites. As a result the productivity of natural and agro-ecological systems considerably decreases: the intensity of photosynthesis conducted by plants is getting lower, air and water transparency of arable lands is becoming poorer, the content of humus is decreasing,

productivity of lands and livestock is depleting. (Galstyan, 2018, Galstyan, 2016).

Taking into account the aforementioned circumstances and the decision of climate change adaptation foundation board on the development of a complete document package for the program of "Artik city closed stone ore dumps and floods management" it was decided to carry out the following activities considering the phenomenon of global climate change and adaptation capacities of natural and agricultural landscapes: studying the status of arable lands, degraded pastures and hay lands of the Artik city, as well as Vardaqar, Harich and Nahapetavan rural communities affected by the dust and floods of stone ores; demonstrating these areas schematically and proposing a package of interventions that would improve the productivity of arable lands, pastures and hay lands, as well as livestock of the mentioned communities (Sayadyan, 1999).

Materials and methods

To explore the state of arable lands, pastures and hay lands of the Artik city, as well as that of Vardakar, Harich and Nahapetavan rural communities, to compare the degradation rate for the two periods, i.e. before and after mass land privatization in the RA (1991), as well as to determine the degree of stone ore dust influence on degradation we have performed visual, cartographic, field and laboratory researches on soil genetics and fertility. When determining the degree of degradation of natural grasslands we were guided by the requirements of the "Guidelines for the Preparation and Implementation of Sustainable Management Plans for Pastures and Hay Lands". Quantitative and qualitative composition of plant varieties per unit area of pastures and grasslands have been estimated, whereby the degradation rate of meadows in % on the background of non-degraded ones has been identified and calculated (Tovmasyan, 2015).

Soil samples were taken from community arable lands, pastures and hay lands to determine the content of humus, environmental reaction (PH) and available nutrients (NPK), then these indices were compared with the agrochemical indices of non-degraded or exemplary agricultural plots and the degradation rate (degree) of these lands were determined.

Laboratory analyses of soils were carried out by universal methods, which are based on the methods of agrochemical analyses described by B.A.Yagodin (Yagodin, et. al, 1989).

Humus content was determined upon I.V. Tyurin`s method with the help of phenylanthranilic acid through titration method, CO_2 (carbonates) - through gaz measurement method (calcimeters) with 10 % hydrochloric acid application. The soil solution reaction (PH) was determined through electro-potentiometric method, the total nitrogen was determined through Kjeldahl method, and the easyly hydrolysed nitrogen – with the methods of I.V. Tyurin and M.M.Kononov. The content of the mobile phosphorus was determined according to the methods of Arrhenius and Machigin, and that of the exchangeable potassium - by means of Maslova's methods.

Results and discussions

Upon the results of the complex survey it has been found out that mountainous-meadow (9.3 thous. ha), meadow-steppe (3.5 thous. ha) and black-soil (31.5 thous.ha) types are involved in 44.3 thousand hectares of the overall land areas at Artik region, that are mainly formed on the background of weathered substances of andesite-dacites and tuffs (soil-formation maternal substances), where according to the studies of R.A. Edilyan and others (1990) 4 % -6 % humus is accumulated in the black soils and the moisture capacity is relatively lower. In arable lands, especially on the slopes, the humus content is lower than in virgin lands; depending on the degree of erosion, the aspect of the slope and their usage character the humus content varies from 3.0 %-3.5 %, in individual places up to 5.0 %-6.0 % (Hayrapetyan, 2000, Melkonyan, et. al, 2004. Atlas of soils of Armenia, 1990).

According to the referenced researchers, in the black soil areas the soil reaction is mainly neutral and the PH fluctuates within 7 value. The arable lands have been deprived of good structure as a result of non-regular cultivation and are generally characterized by weakly viscous or powder-forming strains. Before the last decade of the 20th century these lands were rich in total nitrogen (0.15 %-0.35 %), phosphorus (0.15 %-0.26 %) and potassium (1 %-2 %), but now they are poorly and moderately provided with available nitrogen and phosphorus, and well provided with potassium.

As a result of the laboratory analysis of soil samples taken from the administrative areas of the Artik city, Vardaqar, Harich and Nahapetavan rural communities, it was found out that the environmental response (PH) in the Artik urban community and Vardaqar rural community is 7.5-7.6 (low alkaline), and in the arable lands of Harich and Nahapetavan communities PH equals to 7.1-7.3 i.e. the environment response (PH) fluctuates from neutral to low alkaline domains (Table 1). In the mentioned arable lands, the content of humus per communities varies between 2.6 %-3.3 %, and the content of easily hydrolyzed nitrogen and available phosphorus is negligible, respectively, between 2.0 mg-2.9 mg and 1.9 mg-3,6 mg in 100 g soil i.e. they are poorly provided with the mentioned elements and averagely provided with potassium, i.e. the content of potassium in 100 g soil is 23.0 mg-29.0 mg.

Comparing the current agronomic and agrochemical indices of the mentioned arable land areas with the similar indices fixed in the 1990s of the 20th century and with those of the non-degraded arable lands in these communites, it should be noted that those areas of arable lands that were closer to Artik's tuff stone ore, have been subjected to deep degradation as a result of the negative impacts caused by wastes, heavy rainfalls, flood sediments and global climate change. Thus these areas have been singled out per communities and marked out on the large-scale maps with the recommendations of the needed reclamation works.

Table 1. Average agrochemical indicators of arable land areas in communities*

Community	Soil sampling depth, cm	Humus, %	Connected CO_2, %	General nitrogen, %	PH Water extract	The amount of available nutrients (mg) in 100 g soil		
						N	P_2O_5	K_2O
Artik	0-25	2,9	0,75	0,14	7,5	2,7	2,9	28,0
Vardaqar	0-25	2,7	0,81	0,15	7,6	2,9	1,9	27,0
Harich	0-25	2,6	0,27	0,13	7,1	2,0	3,1	29,0
Nahapetavan	0-25	3,3	0,62	0,16	7,3	2,8	3,6	23,0
Non-degraded arable lands	0-25	4,2	0,83	0,26	7,1	5,52	4,81	32,0

Table 2. Average agrochemical indicators and number of plant stems per 1 m^2 in pastures and hay lands of the communities*

Community	In pastures							In hay lands						
	Humus	Connected CO_2, %	PH in Water extract	Available nutrients in mg/ 100g soil			The number of stems on $1m^2$	Humus	Connected CO_2,	PH in Water extract	Available nutrients in mg / 100g soil			The number of stems on $1m^2$
				N	P_2O_5	K_2O					N	P_2O_5	K_2O	
Artik	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vardaqar	2,9	0,82	7,6	3,1	2,7	27,0	290	3,1	0,99	7,0	5,9	6,4	33,0	784
Harich	3,1	0,79	7,5	3,0	2,9	30,0	270	3,3	0,82	7,6	2,9	3,1	29,0	300
Nahapetavan	3,2	0,76	7,5	2,9	3,2	29,0	284	5,4	0,98	7,2	6,2	6,1	32,0	765
Non-degraded	4,9	1,04	7,1	5,4	5,0	34,0	800	5,3	1,02	7,0	6,1	6,3	33,0	892

**Composed by the authors*

By conducting similar studies in the pastures and hay lands of the mentioned communities, it has been found out that the content of nutrients and humus available in the pastures of Vardaqar, Harich and Nahapetavan and also those of the Harich haylands has decreased as compared to non-degraded areas (Table 2). Thus, if the humus content in the non-degraded pastures was 4.9 %, in the hay lands - 5.3 %, then in the degraded pastures this index was 2.9 % in Vardaqar, 3.2 % in Nahapetavan and in the Harich pasturelands it was 3.1 %, while in individual grasslands it made 3.3 %. The content of nitrogen, phosphorus and potassium in degraded pastures, as compared to non-degraded ones, has dropped respectively by 2.6 %, 46.0 % and 20.6 % in Vardaqar; 44.4 %, 47.8 % and 11.8 %, in Nahapetavan. The decrease of NPK in Harich pastures was 46.3 %, 42.0 % and 13.0 % and in the hay lands - 52.5 %, 50.8 % and 12.1 % respectively.

The study of pasture and vegetation cover in the mentioned communities has shown that if in case of non-degraded pastures there are 800 stems on 1 m^2 and 892 ones - in hay lands, then in degraded and strongly degraded pastures of Vardaqar community there are 290 plant stems on 1 m^2 and in Nahapetavan its number makes 284, while in Harich degraded pastures the number of plant stems on $1m^2$ is 270 and in hay lands - 300. At the same time, studies have revealed that almost no degradation has been observed in the hay lands of the communities of Vardaqar and Nahapetavan, where the number of plants is 784 n / m^2 respectively.

Conclusion

Thus, as a result of studies, it has been revealed that 300 hectares of arable land areas, 190 hectares of pastures and 15 hectares of hay lands in Artik city and the neighboring Vardaqar, Harich and Nahapetavan rural communities have been subjected to deep degradation due to the impacts of floods and closed stone ore at Artik city, as well as other anthropogenic activities (Table 3).

Table 3. The degraded agricultural lands to be reclaimed*

N.	Community	Degraded land area, ha		
		Arable land	Pasture	Hay land
1	Artik	132	-	-
2	Vardaqar	28	55	-
3	Harich	60	70	15
4	Nahapetavan	80	65	-
Total		300	190	15

**Composed by the authors*

So, it is recommended to implement the following activities to reclaim the abovementioned land areas:

1. Implementation of an effective fertilization system (Organomix 1 t / ha + $N_{100}P_{90}K_{90}$) for the fertility increase of the community arable lands and organization of deep ploughing for the loosening of compacted middle soil stratum.

2. Application of fertilization system (organomix 1 t/ha + $N_{50}P_{50}K_{30}$) in the degraded pastures and hay lands.

3. Sowing perennial plants (fescue, clover, sainfoin) with 16 kg/ha dose.

4. Prohibiting pasture use for 1-2 years in the reclaimed pasturelands.

Recommendations made on the degraded arable lands per communities have been already contributed by the Environmental Projects Implementation Unit, at the RA Ministry of Environment, while the surface reclamation activities for the meadows will start from May, 2020. The implementation of the mentioned activities will lead to the prevention of the soil degradation in the mentioned communities and to the increase of soil productivity by 30.0 %-45.0 %.

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