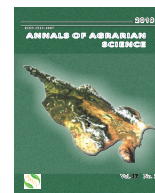




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The assessment and improvement of forest and agroecosystem services to promote ecotourism development (case study of Yenoqavan community, Republic of Armenia)

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ABSTRACT

The article, on the base of Yenoqavan community of Tavush region (Republic of Armenia) case study, analyzes and presents the importance of assessing the potential of certain forest and agroecosystem services in order to stimulate the development of ecotourism in the region. According to the results of the research, only the recreational and ecotourism services of community forest ecosystems accounts to 36 million AMD, but in 2019 only 55.6% or 20 million AMD were used from those services. Meanwhile, this value should be integrated in the general system of nature use and economy, aiming to re-direct the financial means for the forest and agro-landscapes improvement and protection. At the same time, the study revealed that unlike the ecotourism, agro-tourism is poorly developed, the main reasons for which are associated with degraded natural grasslands, low yields of arable lands, low productivity of livestock. The treatment means and measures are recommended in the study. The proposed improvement interventions can significantly increase the yield of fields and livestock productivity, also stimulate the development of ecotourism in the community.

Keywords: Forest ecosystem, agrocenos, production, recreational and ecotourism services, assessment, improvement.

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Background

Forest- and agroecosystem services provided direct and indirect contribution to human well-being based on the structure and functions of ecosystems.

Forest landscapes and agroecosystems provide a healthy environment for human living and economic activities, as well, as promote the development of human creative preferences [1, 2]. Forests have a positive impact on human health due to the release of volatile organic compounds by major forest tree species. They increase the amount of light oxygen ions in the atmosphere and weaken the intensity of solar radiation, reduce fluctuations in atmospheric pressure and temperature. The visual-auditory perception of forest and forest-agricultural landscapes has a beneficial effect on the human emotional and

psycho-physiological condition [3]. The forest is a multi-functional ecosystem, a source of many services, each of which plays a special role in ensuring the stability of this ecological system and generally contributes to the organization of nature protection and improving the well-being of people [4, 5]: Studies conducted in the Hrazdan region [6] have shown that the amount of organic carbon in the forest, sub-forest and adjacent (neighboring) pasture soils are 8.21%, 6.33% and 5.88%, respectively. Pastures are most exposed to erosion, then sub-forest. Transformation of the forest land into pastures in Jordan have increased erosion-from 540 kg / ha to 1110 kg / ha / year [7].

The agroecosystem is a complex ecological unit, that includes both abiotic and biotic components, which are mutually related and determine the cy-

cle of nutrients and energy flow in the system: The function of agrocenosis depends on the flow of energy and the circulation of materials in the components of the ecosystem structure, depending on the level of investment, which seriously determine the productivity, aesthetic and cultural values.

Forest and agricultural systems, along with biodiversity, balancing of environmental processes, making available genetic resources, provision of species habitats and food and fodder security, also provide intangible, spiritual and physiological benefits that people receive from these systems or as a result of interacting with them [8, 9]:

It follows that the well-being of society is also determined by natural capital, in particular, through ensured continuous flow of ecosystem services from forest- and agroecosystems. Therefore, any research aimed to assess and value forest and agroecosystem services is extremely important, actual and conditioned the overall development strategy of the region.

Material and Methods

The methodological basis for evaluating ecosystem services is the “Economics of ecosystems and biodiversity” (TEEB) [10]. TEEB was approved in 2007 as part of a joint effort of Germany and the European Commission. Based on the TEEB methodology, this study attempts to evaluate some forest- and agroecosystem services of the Yenokavan community in Tavush region that can contribute to the development of ecotourism.

The studies were carried out on the basis of analysis of field, visual, cartographic materials, analyses of production indicators, available opportunities for recreational and ecotourism services in Yenoqavan community, as well as analysis of the results of soil laboratory and agrochemical analyzes and calculations.

The calculation of available recreational and ecotourism services in Yenoqavan forest ecosystems is performed according to A.A. Yermakov methodology [11], the level of fertility of arable lands and grasslands, as well as the degree of degradation is done on the base of soil samples taken both from degraded and non-degraded spots. The content of macronutrients (NPK) in soil and in aqueous extract, the reaction of the environment (pH) are investigated. Soil analyzes are performed using the generally accepted methods described in the Guideline of agrochemical methods edited by B.A. Yagodin [12].

The degree of vegetation cover in natural grasslands (pastures, hayfields) is determined by taking into account the qualitative and quantitative composition of plants on one square meter [13]. The preliminary results of treatments of degraded pastures of the Yenokavan and neighboring Lusadzor communities conducting by the United Nations development program (UNDP) in the framework of the program “Mainstreaming sustainable land and forest management in mountain landscapes of North-Eastern Armenia” [14] also are used.

The community’s crop and livestock production data are taken from the community administration, and the qualitative and quantitative indicators of soils are taken from the Soils Atlas of RA [15,16]. The study used available scarce publications related to forest and agroecosystem services of the Tavush region [17-19].

Research results

Yenokavan community is located in the north-east of Armenia, in Ijevan region (Tavush marz). The total area of the community is 1564.2 hectares, the distance from Ijevan city is 10 km, from Yerevan - 150 km. The population of Yenoqavan community is 585 people, the number of households is 184 [20-24].

The terrain of the community is mountainous and is characterized by complex topographical conditions. The relief is characterized by vertical and horizontal dissection, which significantly affects the productivity of agricultural lands and the efficient management of agriculture. Despite this circumstance, erosion processes are not intensively developed, which mainly is due to the presence of forest cover. Some activity of erosion processes has been observed in the recent 15 years due to unregulated tree felling’s carried out by the residents of the community.

The community is provided with electricity and drinking water. The community used to have a centralized gas supply 3 decades ago, but now it is not the case, due to which the residents use portable gasbags. In winter, the heating is carried out by wood-burning stoves. In the settlement, some houses (35.7%) have sewage disposal systems, which, without cleaning passes short distance and directly discharged into the river.

The community’s economy is entirely based on agriculture, mainly is provided with a fodder base and pastures, but horticulture is very risky, as pe-

riodically is exposed to hail and frost. The major growing crops are wheat, barley, cabbage, etc.

The community residents have cattle, and some of them (54.0%) apiary. The community annually produces 300 tons of milk, 20 tons of meat, one ton of honey and 1.3 tons of wool.

Below is presented the land balance of Yenoqavan community (Table 1).

During the last 10-15 years, due to the intensive exploitation of the forests the ecological balance of forest ecosystems has been disturbed and one of its important feature- self regeneration ability- is lost. As a result only 12,2% or 17,8 ha of total forest area has reliable regeneration potential thanks to available natural seedlings (5-8 thousand per ha). But the regeneration of forests took place through non-value bale hornbeam and oriental hornbeam species. The 76% or 111,0 ha area out of total forest cover has 1000-2000 regeneration seedlings per ha, that has group allocation [5, 16].

According to sociological surveys (July-august, 2019), the main source of heating in the community is firewood. One household uses a minimum of 10 and a maximum of 15 m³ firewood per year. The demand for firewood in the community is annually 2300 m³ of storage mass (184 x 12.5 cubic meters or 1600 m³ of condensed mass). According to the Yenoqavan forest management plan draft from 2019, the annual demand for firewood in the community is estimated at 2,000 cubic meters.

We have calculated the cost of 2600 hectares of forest production, from which the villagers get firewood, ecosystem service- located both in the community and in the 10 km radius of Yenoqavan. The total annual net growth of the mentioned area is 3900 m³ (1.55 m³ per hectare) and the amount of annually available firewood will constitute 1360-1365 m³ (35% of annual growth), out of which 1020 m³ (75%) is available for use. The annual available for use amount of firewood from the 146 hectares of forest of Yenoqavan community is 60 m³. As a re-

sult, the cost of both the community and 10 km radius forest production service will make 3 million 240 thousand. AMD (1020 m³ + 60 m³ x 3000 AMD), or the demand of Yenoqavan population for liquid fuel-wood will be satisfied only by 65%. Therefore, serious steps need to be taken to find alternative sources of fuel-wood to meet the population's demand.

The importance of Yenoqavan and neighboring forest ecosystems is crucial from the perspective of estimating the spatial distribution and yield of forest fruits and berries. According to the results of a study conducted in 2017-2018 [18] only in the Ijevan region (the territory of the planned Ijevan state sanctuary), forest fruit and berry species occupied an area of 969.4 hectares, the total amount of the harvest was estimated as 96750 kg, of which 37.7%-cornelian cherry, 21.2%- blackberries and 20.4%-nuts.

One of the most important forest ecosystem service is carbon storage. According to studies, on average, 1 hectare of forest in RA provides 111-188 tons of carbon annual accumulation, which ensures the fertility of agricultural lands, contributes to food security [17]. The accumulated reserves of forest carbon for the 2600 hectare forest area located in the 10 km radius of Yenoqavan will make about 40,000 tons of carbon storage..

Together with forest production (timber, non-timber) services, it is extremely important to have an idea of the recreational and ecotourism opportunities of the community forest economy, to calculate the cost of those services. In general, historical-cultural and natural monuments, landscape diversity, favorable climate, springs, high biodiversity potential are important conditions for the development of the recreational sector, which can play an important role in the socio-economic development of the region and the country to improve the living standards of the population. From this point of view, the area of Yenoqavan is very remarkable, which is rather attractive after its famous rocky landscapes, table-like

Table 1. *Yenoqavan community land balance (01.01.2019), ha*

Community total area, ha	Including					
	Arable land	Pastures	Grass land	Non-used areas	Shrubs	Forest area
1564,2	229	484,4	391	234	80	146

peaks, mountain-forest and mountain-steppe natural and agricultural landscapes. For ecotourism, the areas of “Lastiver” waterfall, “Tandzut” caves, as well as the historical-cultural heritage of St. Gregory’s Church (12th century) and “Cyclops” castles have been used for decades.

Yenoqavan recreation area was built in 2004–2005, at first it was a horse race, after that cottages were built thanks to the large flow of people. In 2008–2009, the construction of cottages began and became an active recreation area. In 2015 the “Yell Extreme” park was opened, which includes a zip line consisting of 5 lines with a total length of 135–750 m. There are climbing classes, rope park, off road tour, horse riding, and baseball areas.

The recreation area can currently accommodate 110 people a day. The cottage had 9,500 inhabitants in 2019, and the total number of visitors was 17,500. According to statistics, 49% of visitors were from Armenia, 51.0% from abroad - Russia, Spain and Germany. The recreation area is 25 hectares, where a restaurant complex has been built and operates. Based on the existing recreational and ecotourism opportunities in the Yenoqavan forest ecosystems and the number of annual visitors (2019), we have calculated these services according to the methodology proposed by A.A. Yermakov [11]. According to the availability of tourist resources, the coefficient of accommodation of tourists and the demographic capacity of the territory, as well as the values of the coefficient of recreation in green zones and the entry fee (500 AMD) are multiplied. Thus, if the number of visitors was 17,000, the coefficient of organizing recreation in green zones is 1.2, the coefficient of accommodation of vacationers is 1.12, and the entrance fee is 500 drams / person, then in 2019 recreational and ecotourism service cost:

$$17000 \times 500 \times (1,2+1,12) = 19 \text{ mln.720 thous. AMD}$$

Meanwhile, the demographic capacity of the area is $31000 \times 500 \times (1.2 + 1.12) = 35 \text{ million } 960 \text{ thousand. AMD}$: Thus, out of about 36 million AMD total recreational and ecotourism services of Yenoqavan forest ecosystem in 2019, about 20 million AMD services or 55.6% of the potential only we were used. In order to carry out the proper organization of ecotourism, it was carried studies to assess the state of agro-cenosis and their productivity of Yenokavan community: on agricultural lands- arable lands, pastures, to determine the level of fertility of grasslands, to reveal the need for crop yields to develop the agro-tourism potential.

As a result of complex studies, it was found out that in the administrative territory of Yenokavan community, mainly mountain forest, meadow-steppe and gray-meadow, in some parts brown soils are spread, which are mainly formed on basaltic rocks and andesitadacitic tuffs. According to R.A. Edilyan and others [22] studies in the mentioned soil types of that community, where the humidity is relatively high, accumulates 4.2–5.9% humus. According to the authors, the content of humus in arable lands, especially on slopes, is less than in virgin soils, depending on the location of the slope, the degree of erosion, the nature of their use. The content of humus diverse from 3,3–4,1 to 4,8% [6]. In the soil types of the administrative area of the community, the reaction of the soil solution is mainly in the areas close to neutral and the pH fluctuates in the range of 6.7–7.1. Due to irregular cultivation, the arable lands have lost their good structure and mainly are expressed with medium-grained, dust-grain structure. Until the last decade of the last century, these soils were rich in total nitrogen (0.16–0.26%), phosphorus (0.14–0.21%) and potassium (1.1–1.9%), but they were weak and moderately supplied with available nitrogen, mediocre with phosphorus, and good with potassium exchange. In general, the studied lands, being in a moderate and mild natural-climatic zone, had sufficient natural fertility and before the privatization of lands (1991), were favorable for obtaining a higher crop yield [2].

Within the framework of the goal, the laboratory tests of soil samples taken from agricultural lands of Yenokavan administrative area revealed that the environmental reaction in the arable lands of the community is 7.5–7.7 (weak alkaline), the humus content fluctuates between 3.0–3.6%. The content of easy hydrolyzable nitrogen and available phosphorus in 100 g of soil varies between 2.4–3.1 and 3.5–3.98 mg, respectively, and these elements are poorly provided, and the content of potassium in 100 g is 27.0–30.0 mg. Comparing the agrochemical indicators of the current state of the community arable lands with the similar indicators of the 90s of the 20th century, it is noted that the parts of the administrative territory that have been subjected to unsystem cultivation over the years, due to various negative natural and human-made factors, were allocated and marked on the cadastral map of the community and treatment measures for 60 ha were prescribed (Table 2). Similar studies conducted in pasture and haylands of the community found that the content of available nutrients and humus in

comparison with non-degraded areas significantly decreased (table 2): So, if the humus content in the soil was 4.4% in non-degraded pastures and 4.9% in haylands, then this indicators decreased in degraded pastures and haylands respectively by 3.8% and 4.1%. Degraded areas of hayfields and pastures of the community compared to non-degraded areas had decrease in the 100 g soil content of nitrogen, phosphorus and potassium: in hayfields- by 1.3; 2.2 and 3.0 mg and in pasture lands- 1.6; 2.7 and 2.3 mg respectively.

After studying the state of vegetation cover in community hay lands and pastures, it turned out that if there are 876 stems in non-degraded pastures and 826 stems in hay lands, then in the degraded hay lands of the community the number of plant stems is 407 pieces/m², and in degraded pastures this indicator is 469 pieces/ m² (Table 2).

Thus, as a result of research, it was revealed that 60 ha of arable land, 57 ha of hay lands and 92 ha of pasture territories are under the influence of various anthropogenic pressures and have undergone deep degradation. It is necessary, where it is possible, to organize superficial treatment activities:

a) to increase the fertility of degraded arable land, annually add to the soil 1.5-3.0 t/ha organ mix and 60 kg/ha of mineral fertilizers- nitrogen, phosphorus and potassium (N₆₀P60K₆₀),

b) application of the fertilizer system in degraded hay lands and pastures: organomix 1 t / ha + (N50P50K50).

c) Organize mixed herbs sowing of perennial grasses (clover, fescue, hedgehog, cockshead) at the dosage of 15-18 kg / ha in degraded and deforested grasslands and limit the grazing at least for one year. Within the UNDP program are performed surface improvement of 137ha of degraded pastures during 2019-2020 in Yenoqavan community [14]. Continued implementation of these activities in the community's degraded arable lands, pastures and hay lands will support to increase the community's agricultural culture, improve soil fertility, increase crop and livestock products, and contribute to the overall development of the region, particularly ecotourism development.

Conclusion and recommendations

Summarizing the results of the assessment of forest and agroecosystems production, recreational and eco-tourism services, we have reached the following conclusions:

1. Services for providing firewood of Yenoqavan and its surrounding 10 km forest area sum up at 3 million 240 thousand AMD, of which in Yenoqavan the cost of firewood is 180 thousand AMD, and in 10 km radius forest area - 3 million 60 thousand AMD.

2. The total capacity value of the recreational and ecotourism services of the community forest is 36 million AMD, of which, however, in 2019 only 55.6% or 20 million AMD were used.

Table 2. Agrochemical indicators and the number of plant stems per m² of arable lands, pastures, grasslands in the administrative territory of Yenokavan community

Land cover condition and sampling depth, sm	Arable lands						Pastures							Hayfields						
	Humus, %	Related to CO ₂ , %	pH in water traction	Available nutrients, mg 100 g in soil			Humus, %	Related to CO ₂ , %	pH in water traction	Available nutrients, mg 100 g in soil			Number of stems per m2, pcs ,	Humus, %	Related to CO ₂ , %	pH in water traction	Available nutrients, mg 100 g in soil			Number of stems per m2, pcs .
				N	P ₂ O ₅	K ₂ O				N	P ₂ O ₅	K ₂ O					N	P ₂ O ₅	K ₂ O	
Degraded, 0-25	3,7	0,47	7,6	4,1	3,8	29,5	3,8	0,7	7,5	2,6	3,4	29,0	469	4,1	0,74	7,7	4,6	3,8	30,0	407
Non-degraded , 0-25	4,3	0,69	7,0	5,7	6,6	32,0	4,4	0,9	6,9	5,9	5,1	35,0	876	4,9	1,0	7,1	5,9	6,0	33,0	826

3. In order to increase the culture of agricultural activities carried out by the residents of the community, to improve the level of soil fertility, to create an abundance of crops and livestock products, in order to give a boost to agrotourism, it is necessary to carry out surface improvement works in degraded agricultural systems. In the arable lands every year should be applied 1.5-3.0 t / ha organomix and nitrogen, phosphorus and potassium 60 kg / ha dosage ($N_{60}P_{60}K_{60}$) per of active substance. Organize the improvement of degraded pastures and grasslands through application of mineral and organic fertilizers: organomix with norm 1 t / ha + ($N_{50}P_{50}K_{50}$) and mixed sowing of perennial herbs (clover, fescue, hedgehog and cockshead with norm 15-18 kg/ha). Prohibit grazing in the improved natural grasslands for at least one year.

4. Yenoqavan forest and agroecosystems production, recreation and ecotourism services have serious value and they should be integrated in the general system of nature use. At least 25-30% of the received incomes should be directed to the improvement of forest and agro-landscapes conservation and improvement.

5. Taking in account the rather high value of forest and agroecosystem services, it is necessary to set up the regular accounting and evaluation scientific studies system and to establish a division with Ministry of Environment to coordinate studies and monitoring of ecosystem services.

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