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CHARACTERIZATION OF FOREST LANDSCAPES SPATIAL-TEMPORAL CHANGES BASED ON SOME INDICATORS
(case study of Ijevan Forest enterprise)

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The article deals with the issues of anthropogenic spatial-temporal changes in the forest cover of Tavush Region. In particular the case of Ijevan Forest enterprise is presented, the negative consequences of deforestation were identified and studied through the following indicators: changes in the forest area and species composition of the forest, fragmentation of the forest massives and changes in the forest boundary-lines, dynamics of landslides and mud-flows.

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***Keywords*:** spatial change, Ijevan Forest enterprise, fragmentation, species change, forest cover edge, landslides, mud-flows.

Introduction. The different studies and observations show that in the Tavush Region, starting from the Upper Quaternary period, there has been a continuous reduction of forest cover in both time and space.

In the Upper Quaternary, according to our studies, the forest cover was about 93.7% of the territory of the region. Later, as a result of increasing anthropogenic pressure and continuous aridification of the climate, the forest cover has been continuously reduced and currently accounts only for 51% of the territory of the Tavush Region [1, 2].

Materials and Method. The forest management plan of Ijevan forest enterprise (2020–2030), digital maps, and statistical data were used for the implementation of the research. Geographical-comparative and historical-comparative analysis, statistical, Geographic information systems (GIS) and spatial-temporal mapping methods were used in the work.

Research Results. Ijevan Forest enterprise inventory dataset for 1988, 2005 and 2017, including analysis of satelite imagies, has shown that forest clearings and corridors between forest stands have expanded significantly. In 1988, the total area of forest cover in Ijevan Forest enterprise was 24.177 *ha*, of which the forested area

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was 21.895 *ha*, the total stock of trees was 3 760 500 m^3. According to the 2005 inventory, as a result of logging, 2.270 *ha* of forest territories became anthropogenic clearings. Irregular logging was mainly carried out in forest neghborhood settlements and along forest roads [3].

In the period of 2005–2017, uncontrolled and non-legal felling continued in most of the forested areas of Ijevan forest enterprise, at the same time, felled, anthropogenic clearings with a small area were transformed into forested areas through natural regeneration (Fig. 1).

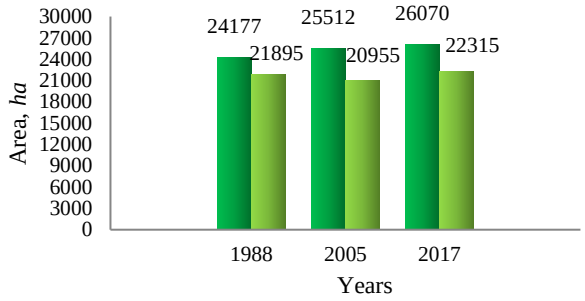

Fig. 1. The changes of total and forested areas in Ijevan Forest enterprise.

Despite the fact that an increase in the forested surface was observed, the total stock of forests decreased by 246 560 m^3 compared to 2005 (Fig. 2).

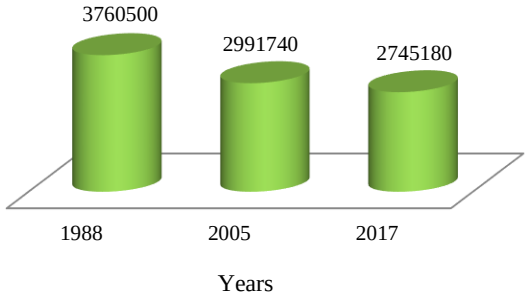

Fig. 2. The change of Ijevan Forest enterprise stock for 1988–2017 period in m^3.

In the last 20 years, as a result of selective tree felling, there has been a highly pronounced unwanted species change in the forested areas of Ijevan Forest enterprise, as a result of which the stands of beech, oak, ash and other valuable tree species have been replenished with *Carpinus orientalis*, *Carpinus betulus* L. and other low-value species. Hornbeam is ecologically flexible tree specie, unlike oak and beech. It is heat-loving, not sensitive to moisture and can grow and develop quickly without additional artificial intervention. Meanwhile, oak and beech perform an important ecological function by absorbing large amounts of carbon dioxide and regulating the climate.

Table 1

Carbon sequestration by the main dominant tree species during 1 year [4]

Predominant type of tree	Carbon sequestration *t /ha*
Oak	355
Carpinus betulus L.	324
Beech	305
Pine tree	264
Degraded forest	249
Other	239

It is clear from Tab. 1 that oak-dominated stands have a high carbon sequestration capacity. In particular, the absorption of carbon in 1 year by an oak-dominated forest with an area of 1 *ha* is 355 *t*, a beech-dominated forest is 305 *t*, a *Carpinus betulus* L. is 324 *t*, a pine tree is 264 *t*, and a degraded forest is 249 *t* [4]. From these statements, it can be concluded that the prevention of the reduction of the forest stand surfaces dominated by oak, beech, and pine trees, as well as their expansion, is of a vital importance.

In 1988 according to the 2017 inventory data, the total area of stands dominated by beech, which is estimated to be 56% of the forested area, decreased by 3254 *ha* or by 27.6%, the total area of oaks, the 2nd in reserve, decreased by 557 *ha*, and the stands of *Carpinus betulus* L. increased by 3556 *ha*, *Carpinus orientalis* by 1562 *ha* (Fig. 3) [3].

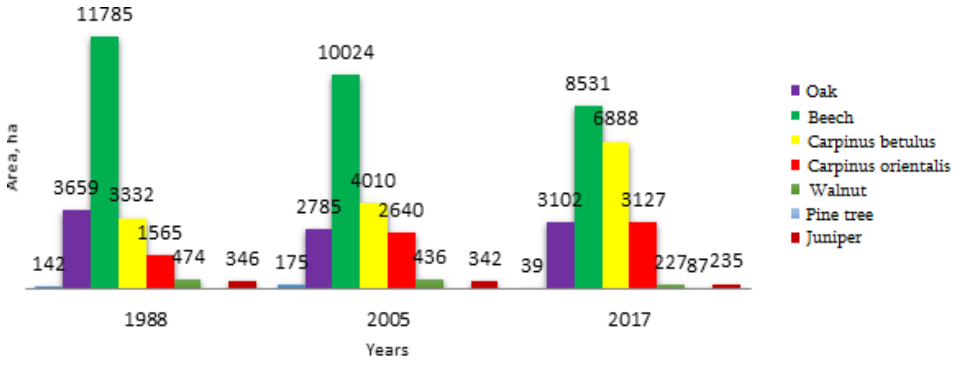

Fig. 3. The change in the areas of dominant tree species in Ijevan Forest enterprise.

Irregular deforestation has significantly changed the forest cover of Ijevan Forest enterprise, which has led to the increase of forest fragmentation and the complexity of the external boundary lines [5, 6]. Based on the 2005 and 2017 satellite images for Ijevan Forest enterprise, we classified and grouped the forest stands according to the coverage areas and performed a comparative analysis in the GIS.

The analysis of Tab. 2 shows that the number of forest stands with a small area increased in 2017 compared to 2005, as a result of which their contours became more complex. The number of forest stands with an area of 5 *ha* and smaller increased by 31, those with an area of 1 *ha* and smaller increased by 110.4%, and those with an area of 1.1–5.0 *ha* increased by 25.1%. Both the number and the border of

those with 5–100 *ha* area have been significantly reduced. In particular, 5.1–10.1 *ha* was reduced by 17, and 10.1–100 *ha* – by 26. Their margins were reduced by 41.5% and 11.2%, respectively. It is clear from the table that the number of forests with an area of 100.1–200 *ha* has increased by 19, and their borders have increased by 33.6%.

Table 2

Fragmentation of the forest cover of Ijevan forest enterprise and the change of the contours for the 2005–2017 period

Forest area, *ha*	Number of woodlands, 2005	Number of woodlands, 2017	Changing forest areas, 2005–2017	Forest border-line, 2005, *km*	Forest border-line, 2017, *km*	Forest border-line change 2005–2017, *km*
1 or <	32	48	16	10.5	22.1	11.6
1.1–5	95	110	15	83.9	105	21.1
5.1–10	41	24	–17	72.2	42	–30
10.1–100	126	100	–26	652.8	579.6	–73.2
100.1–200	97	116	19	892.2	1192.1	299.9
200.1–300	6	5	–1	78	67.7	–10.3

Among the natural factors of the change of the forest landscapes of the region, the climatic factor had a decisive influence. During the last 100 years, an increase in the average annual air temperature by 2–30°C leads to an increase in the lower limit of the spread of the forest by 150–200 *m*, as a result of which the upper limit of the spread of the post-forest steppe zone also rises upwards and occupies larger areas on large slopes. Which, together with unsustainable forest use, creates more favorable conditions for mud-flows and the expansion of eroded areas. The meadow-steppe landscape zone above the forest zone expands into the sub-alpine zone, where the few areas occupied are further reduced. According to the "Third National Report on Climate Change", the number of dangerous meteorological phenomena (hail, frost, strong wind, heavy precipitation, drought) has increased in the Republic of Armenia. Moreover, in Tavush Region during 1980–2012 period, the number of cases with heavy rains increased, which contributes to the occurrence of mud-flows and landslides. In general, the average penetration value of southern cyclones that form heavy rainfall in Armenia has increased by 24% [7, 8].

Aghstev Valley is especially distinguished by the intensity of landslides. The most dangerous is the Hovk Landslide, which is in the stage of active development. Enokavan Landslides are located on the left slope of Sarnajur, near Getahovit village, 1.5 *km* long, 350–500 *m* wide. During the last 20 years, the settlements of Aghstev Valley are regularly flooded. The valleys of Aghstev Haghartsin and Paghgur tributaries are known for intense mudslides. Here, there are a number of anthropogenic factors contributing to mudslides, the first of which is the accumulation of crops and garbage in the mud valleys and mud channels passing through settlements. There is also an unaccountable construction of riverbeds, which becomes the cause of catastrophic consequences during a certain period of the phenomenon's activity. In particular, this is the situation in Getahovit and Haghartsin settlements. Another important factor is the intensive deforestation that surrounds the floodplains. Forests absorb precipitation, reducing surface runoff and increasing groundwater flow.

During the spring flood of Agstev, which begins in mid-March, reaches its maximum in May and lasts until mid-July, 60–70% of the flow passes. The average duration of the phenomenon is about 110 days [9]. The peak costs of spring floods in Agstev sometimes reach catastrophic proportions. 2006 as a result of the sharp spring flooding of Aghstev, the frontal part of the landslide adjacent to Haghartsin village was flooded and collapsed, which, damming the riverbed, changed the direction of the current, destroyed some parts of the interstate highway, invaded the low-lying coastal zone of the village, causing great damage to residential houses and houses. In the region, the maximum costs of the Aghstev basin with catastrophic consequences are observed once every 5–7 years [10].

Below is presented the forest cover and forestry of Tavush Region (Fig. 4) [11].

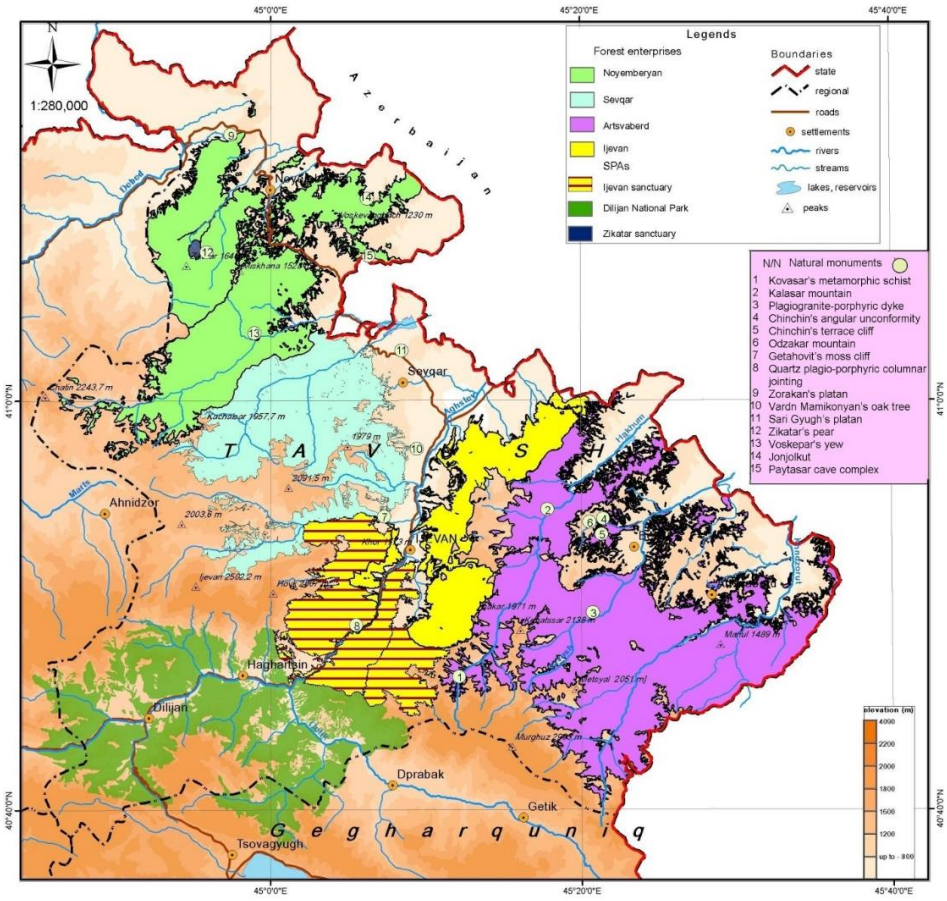

Fig. 4. Forests and nature monuments of Tavush Region.

Conclusion. During 1988–2017, the analysis of the changes in the forest stands of Ijevan Forest enterprise shows that the increase in the fragmentation of the forest stands and the changes in the boundaries have led to the reduction of biodiversity, the weakening of the climate-regulating and water-regulating functions of the forest, contributing to the intensification of erosion, landslide and mud-flows phenomena. The year-by-year replacement of moisture-loving tree species with

heat-loving tree species indicates the aridification trends of forest landscapes in Tavush Region of the Republic of Armenia.

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Հ. Յա. ՍԱՅԱԴՅԱՆ, Է. Ա. ՎԱՐԴԱՆՅԱՆ

ԱՆՏԱՌԱՅԻՆ ԼԱՆԴՇԱՖՏՆԵՐԻ ՏԱՐԱԾԱԿԱՆ ՓՈՓՈԽՈՒԹՅՈՒՆՆԵՐԻ ԲՆՈՒԹԱԳՐՈՒՄԸ ՈՐՈՇ ԻՆԴԻԿԱՏՈՐՆԵՐԻ ՄԻՋՈՑՈՎ
(Իջևանի անտառտնտեսության օրինակով)

Ամփոփում

Հոդվածում անդրադարձ է կատարվում Տավուշի մարզի անտառածածկի բնամարդածին տարածաժամանակային փոփոխությունների հարցերին:

Մասնավորապես, Իջևանի անտառտնտեսության օրինակով, անտառազրկման բացասական հետևանքները բացահայտվել և ուսումնասիրվել են հետևյալ ինդիկատորների միջոցով՝ անտառածածկ տարածքի և անտառի տեսակային կազմի փոփոխություն, անտառի ֆրագմենտացիա և եզրագծի փոփոխություն, սողանքային և սելավային երևույթների դինամիկա:

О. Я. САЯДЯН, Е. А. ВАРДАНЯН

ХАРАКТЕРИСТИКА ПРОСТРАНСТВЕННЫХ ИЗМЕНЕНИЙ ЛЕСНЫХ ЛАНДШАФТОВ С ИСПОЛЬЗОВАНИЕМ НЕКОТОРЫХ ИНДИКАТОРОВ (на примере лесного хозяйства Иджевана)

Резюме

В статье рассматриваются вопросы антропогенных пространственно-временных изменений лесного покрова Тавушской области. В частности, на примере Иджеванского лесного хозяйства были выявлены и изучены негативные последствия вырубки лесов по следующим индикаторам: изменение лесной площади и породного состава леса, фрагментация леса и изменение контуров, динамика оползней и селей.