



ANTHROPOGENIC TRANSFORMATION OF VEGETATION IN SOUTHERN TAJIKISTAN: CURRENT STATE, MAIN DRIVERS AND ECOLOGICAL CONSEQUENCES

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ANNOTATION

Purpose of the study. To assess the current state of vegetation in Southern Tajikistan under anthropogenic pressure and to identify the main drivers and ecological consequences of vegetation transformation.

Material and methods. The study was carried out in Southern Tajikistan during 2015-2024. The work was based on route-field surveys, geobotanical descriptions, herbarium analysis, comparative-historical assessment, and vegetation mapping. More than 400 geobotanical descriptions of the ecological state of vegetation were recorded, and archival materials from 1950-1970 were used for comparative analysis.

Research results. It was established that the most severely disturbed vegetation types in Southern Tajikistan are semi-savannas, juniper woodlands, and tugai communities. Biodiversity imbalance was identified in semi-savannas - 65%, shrub communities - 45%, and juniper woodlands - 60%. In areas of overgrazing, ecosystems were degraded on more than 30% of the territory, while grass productivity decreased from 20-25 c/ha to 10-12 c/ha. Tugai vegetation in the Vakhsh River basin is in a particularly critical condition: from 110 thousand ha, only 24 thousand ha have remained. Anthropogenic transformation is associated with agricultural expansion, overgrazing, logging, mining, salinization, and settlement construction.

Conclusions. Anthropogenic factors have become the leading drivers of vegetation degradation in Southern Tajikistan. The obtained results justify the need for ecological monitoring, vegetation restoration, rational land use, and targeted conservation measures in the most disturbed ecosystems.

KEYWORDS. Southern Tajikistan, vegetation, anthropogenic transformation, semi-savanna, tugai vegetation, juniper woodlands, overgrazing, degradation, ecological monitoring, biodiversity.

TOPICALITY

The problem of anthropogenic transformation of vegetation has become especially acute in arid and semi-arid regions, where plant communities are highly sensitive to long-term human pressure. Southern Tajikistan is one of the most economically important regions of the republic, where agricultural development, grazing, mining, and settlement expansion are intensively progressing. Under such conditions, vegetation cover experiences structural and floristic changes that lead to ecosystem instability, decline in productivity, and loss of biodiversity [1-5].

In recent decades, the transformation of natural vegetation in Southern Tajikistan has been determined not so much by natural succession as by direct and indirect human impact. The reduction of natural habitats, fragmentation of communities, simplification of species composition, and xerophytization of hydrophilous vegetation indicate a serious ecological shift. Therefore, assessment of the current state of vegetation and identification of the most vulnerable plant formations are highly relevant for biodiversity conservation and sustainable management of natural resources [6-9].

PURPOSE OF THE STUDY

To evaluate the anthropogenic transformation of vegetation in Southern Tajikistan, identify the most disturbed plant communities, and determine the main ecological consequences of long-term human impact.

RESEARCH MATERIALS AND METHODS

The research was conducted in Southern Tajikistan during 2015-2024. The study covered model territories of the Khatlon region and a number of districts characterized by different natural and economic conditions. The methodological basis included route-field observations, geobotanical descriptions, comparative-historical analysis, herbarium revision, and ecological-cartographic assessment. Vegetation studies were carried out during the growing season, mainly from March to May. More than 400 geobotanical descriptions reflecting the current ecological condition of vegetation were recorded. In addition, archival descriptions from the Department of Botany and Dendrology of the Tajik National University for 1950-1970 were used to compare past and present states of plant communities. The study also included analysis of herbarium



collections from scientific institutions of Tajikistan. Based on the obtained data, a map of the ecological condition of vegetation in Southern Tajikistan was compiled.

RESEARCH RESULTS

Long-term monitoring conducted in Southern Tajikistan demonstrated that anthropogenic transformation affects nearly all major vegetation types of the region, although its intensity varies considerably among ecosystems. The reliability of the obtained findings is supported by a broad empirical base, including field investigations carried out in 2015-2024, analysis of herbarium collections, more than 400 geobotanical

descriptions, and more than 600 validated geobotanical records used for comparative ecological assessment.

The study showed that the most severely disturbed vegetation types of Southern Tajikistan were semi-savannas, juniper woodlands, and wetland-associated plant communities. A pronounced imbalance of biodiversity and community structure was observed under the influence of agricultural expansion, settlement and industrial construction, overgrazing, untimely collection of fruits and seeds, and the use of woody plants for domestic and energy needs. The main quantitative indicators of anthropogenic disturbance in the principal vegetation types are presented in Table 1.

Table 1. Degree of anthropogenic disturbance of the main vegetation types of Southern Tajikistan

Vegetation type	Disturbance of Biodiversity/Community Balance, %	Main Interpretation
Semi-Savannas	65	Highest disturbance among the reported zonal vegetation types
Shrub Communities (Shiblyak)	45	Marked restructuring of community composition
Juniper Woodlands	60	Severe degradation of woody mountain ecosystems
Wetland Vegetation	45	Considerable disturbance of humid and marsh-related communities
Mean Calculated Disturbance Across Reported Vegetation Groups	53.8	Indicates generalized regional vegetation imbalance

As shown in Table 1, the highest level of anthropogenic disturbance was recorded in semi-savannas and juniper woodlands, where the degree of transformation reached 65% and 60%, respectively.

One of the leading causes of ecosystem degradation was intensive grazing by large and small livestock. In overused pasture areas, degradation affected more than 30% of the studied territory. At the same time, grass stand productivity

declined from 20-25 c/ha to 10-12 c/ha, which corresponds to an absolute reduction of 10-13 c/ha and an approximate relative decrease of about 50-52%. According to midpoint calculations, productivity decreased from 22.5 c/ha to 11.0 c/ha, representing a decline of 51.1%. These changes were accompanied by the periodic disappearance of valuable species from community composition, including at least 150 rare and endangered taxa. The principal indicators of pasture ecosystem degradation are summarized in Table 2.

Table 2. Quantitative Indicators of Pasture Degradation Under Overgrazing

Indicator	Reference condition	Disturbed condition	Absolute change	Relative change
Share of Degraded Territory	-	>30%	-	-
Grass Stand Productivity, c/ha	20-25	10-12	-10 to -13	about -50.0 to -52.0%
Grass Stand Productivity, Midpoint Estimate, c/ha	22.5	11.0	-11.5	-51.1%
Valuable species lost from communities	-	>=150 rare and endangered species periodically disappear	-	

As shown in Table 2, overgrazing caused marked degradation of pasture ecosystems, accompanied by a nearly twofold reduction in grass productivity and periodic loss of valuable plant species.

A particularly critical ecological situation was documented in tugai ecosystems of the Vakhsh and Kafirnigan river basins. The ongoing xerophytization of mesophilous and mesohydrophilous tugai communities promoted the disappearance of marsh and meadow-marsh phytocoenoses, especially on sandy soils with low water retention capacity. In

general, 45% of wetland vegetation in Southern Tajikistan was found to be disturbed under anthropogenic influence. The most catastrophic transformation was recorded in the Vakhsh River basin, where the area of tugai vegetation decreased from 110 thousand ha to only 24 thousand ha. This corresponds to an absolute loss of 86 thousand ha and a relative reduction of 78.2%, meaning that only 21.8% of the former tugai area has remained. The quantitative characteristics of this process are presented in Table 3.



Table 3. Transformation of tugai and wetland vegetation in Southern Tajikistan

Indicator	Historical/Reference Value	Current Value	Absolute Change	Relative Change
Disturbed share of wetland vegetation in Southern Tajikistan, %	-	45	-	-
Tugai area in the Vakhsh River basin, thousand ha	110	24	-86	-78.2%
Remaining tugai area in the Vakhsh River basin	100%	21.8% of former area	-78.2 percentage points	-78.2%

As shown in Table 3, the degradation of tugai vegetation was especially severe in the Vakhsh River basin, where the total area decreased by 78.2%, indicating a catastrophic contraction of this ecosystem.

Additional regional observations confirmed that anthropogenic transformation also affected other woody and shrub formations. Turkestan maple forests occupy about 25 thousand ha, but these communities are described as strongly disturbed. Walnut stands

are also substantially degraded, with the disturbance level reaching up to 50%. Mesophytic shrub communities, particularly rosaries, occupy more than 45 thousand ha, yet their productivity remains very low at about 0.4 c/ha, indicating a low-yield secondary vegetation type. Shiblyak communities cover about 260 thousand ha and have a productivity range of 3-10 c/ha, while pistachio formations with Regel maple and almond occupy more than 70 thousand ha. These additional quantitative indicators are presented in Table 4.

Table 4. Additional regional indicators characterizing ecosystem disturbance

Ecosystem/formation	Quantitative characteristic	Interpretation
Turkestan Maple Forests	about 25 thousand ha	Large area, but strongly disturbed
Walnut Stands	disturbance up to 50%	Severe degradation of mesophytic woody ecosystems
Rosary Formations	>45 thousand ha	Wide distribution of secondary shrub communities
Productivity of Rosary Formations	0.4 c/ha	Very low productivity
Shiblyak Communities	260 thousand ha	One of the most widespread transformed vegetation types
Productivity of Shiblyak	3-10 c/ha	Moderate but highly variable forage value
Pistachio Formations with Regel Maple And Almond	>70 thousand ha	Regionally important woody-shrub vegetation complex

As shown in Table 4, even relatively widespread vegetation formations are characterized by marked structural degradation, low productivity, and reduced ecological stability under long-term anthropogenic pressure.

Overall, the obtained results indicate that anthropogenic transformation in Southern Tajikistan is expressed not only in floristic simplification but also in reduced productivity, shrinking areas of ecologically valuable vegetation, habitat fragmentation, and progressive replacement of native species by degraded secondary communities. These findings confirm that current vegetation change in the region has both structural and functional dimensions and requires long-term ecological monitoring and scientifically grounded conservation measures.

DISCUSSION

The results demonstrate that vegetation degradation in Southern Tajikistan has a complex and cumulative character. Anthropogenic transformation is not limited to the reduction of vegetation area, but also includes changes in floristic composition, productivity, ecological functions, and landscape connectivity. Semi-savannas and juniper woodlands are particularly sensitive because their recovery is slow under arid climatic conditions. Tugai ecosystems are even more vulnerable due to hydrological disturbances, reduced water availability, and land-use change in river valleys.

The decrease in grass productivity and the loss of ecologically valuable species indicate not only a floristic problem but also a broader environmental and economic issue. Degraded pastures reduce fodder potential, disturbed riparian ecosystems lose protective and hydrological functions, and transformed forest-shrub communities become less effective in preventing erosion and stabilizing slopes. Therefore, the ecological consequences of anthropogenic vegetation change directly affect agriculture, livestock breeding, water balance, and long-term regional sustainability.

The study confirms that modern vegetation dynamics in Southern Tajikistan should be considered within the framework of continuous ecological monitoring and landscape-based management. The compiled ecological map and comparative analysis with historical materials provide a practical basis for identifying priority zones for restoration and conservation.

CONCLUSION

Anthropogenic transformation of vegetation in Southern Tajikistan has reached a scale that threatens the stability of major plant communities. The most disturbed ecosystems are semi-savannas, juniper woodlands, and tugai vegetation. Overgrazing, agricultural expansion, logging, mining, salinization, and settlement construction act as the main drivers of degradation. The sharp decline in productivity, the shrinking



of natural habitats, and the loss of floristic diversity justify the need for scientifically based conservation measures, restoration programs, and rational use of plant resources.

LITERATURE

1. Williams B.A., Venter O., Allan J.R., et al. Change in Terrestrial Human Footprint Drives Continued Loss of Intact Ecosystems. *One Earth*. 2020;3(3):371-382. doi:10.1016/j.oneear.2020.08.009.
2. Lewin A., Murali G., Rachmilevitch S., et al. Global evaluation of current and future threats to drylands and their vertebrate biodiversity. *Nature Ecology and Evolution*. 2024;8(8):1448-1458. doi:10.1038/s41559-024-02450-4.
3. Pärtel M., Tamme R., Carmona C.P., et al. Global impoverishment of natural vegetation revealed by dark diversity. *Nature*. 2025;641(8064):917-924. doi:10.1038/s41586-025-08814-5.
4. Luo Q., Li S., Wang H., Cheng H. Mapping Human Pressure for Nature Conservation: A Review // Remote Sensing. - 2024. - Vol. 16, No. 20. - Art. 3866.
5. Han W., Zheng J., Guan J., et al. Assessment of Vegetation Drought Loss and Recovery in Central Asia Considering a Comprehensive Vegetation Index. *Remote Sensing*. 2024;16(22):4189. doi:10.3390/rs16224189.
6. Rahmonov O., Szypuła B., Sobala M., Islamova Z.B. Environmental and Land-Use Changes as a Consequence of Land Reform in the Urej River Catchment (Western Tajikistan). *Resources*. 2024;13(4):59. doi:10.3390/resources13040059.
7. Nowak A., Świarszcz S., et al. Conspectus of the vegetation types of Tajikistan and adjacent areas with special focus on phytosociological classes. *Acta Societatis Botanicorum Poloniae*. 2024;93:191675. doi:10.5586/asbp/191675
8. Ma S., Li W., Tojibaev K.S., Turginov O., Yang W., Ma K. Regionwide and Nationwide Floristic Richness Reveal Vascular Plant Diversity in Central Asia. *Plants*. 2024;13(16):2275. doi:10.3390/plants13162275.
9. Schulz C., Kleinschmit B. Monitoring the Condition of Wetlands in the Syr Darya Floodplain - How Healthy Are the Tugai Forests in Kazakhstan? *Forests*. 2023;14(12):2305. doi:10.3390/f14122305.