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RESTORATION AND PRODUCTIVITY IMPROVEMENT OF DEGRADED FOREST ECOSYSTEMS

***Abstract:** Anthropogenic impacts on forest ecosystems lead to degradation of forest cover, changes in species composition, soil erosion, and reduced natural regeneration capacity. In many mountainous and foothill regions, illegal logging, uncontrolled grazing, and inappropriate land use practices have significantly weakened forest productivity. This article examines the main factors affecting forest degradation and proposes measures for restoring forest ecosystems and increasing their productivity. Special attention is given to reforestation, species selection according to ecological conditions, erosion control, and sustainable forest management. The restoration of degraded forests is essential for maintaining ecological balance, protecting biodiversity, and improving environmental stability.*

***Keywords:** forest ecosystems, productivity, restoration, reforestation, anthropogenic impact, erosion, biodiversity*

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ВОССТАНОВЛЕНИЕ И ПОВЫШЕНИЕ ПРОИЗВОДИТЕЛЬНОСТИ ДЕГРАДИРОВАННЫХ ЛЕСНЫХ ЭКОСИСТЕМ

***Аннотация:** Антропогенное воздействие на лесные экосистемы приводит к деградации лесного покрова, изменению видового состава, эрозии почвы и снижению способности к естественному возобновлению. Во многих горных и предгорных регионах незаконная вырубка лесов, неконтролируемый выпас скота и нерациональные методы землепользования значительно ослабили продуктивность лесов. В данной статье рассматриваются основные факторы, влияющие на деградацию лесов, и предлагаются меры по восстановлению лесных экосистем и повышению их продуктивности. Особое внимание уделяется лесовосстановлению, отбору видов в соответствии с экологическими условиями, борьбе с эрозией и устойчивому лесопользованию. Восстановление деградированных лесов имеет важное значение для поддержания экологического баланса, защиты биоразнообразия и повышения экологической стабильности.*

***Ключевые слова:** лесные экосистемы, продуктивность, восстановление, лесовосстановление, антропогенное воздействие, эрозия, биоразнообразие.*

Forests are among the most valuable natural ecosystems and provide important ecological, economic, and social benefits. They regulate climate, absorb carbon dioxide, produce oxygen, conserve biodiversity, protect water resources, and prevent soil erosion. Forests also supply timber, fuelwood, medicinal plants, and recreational opportunities.

In recent decades, many forest ecosystems have faced growing pressure from illegal logging, overgrazing, fires, agricultural expansion, urbanization, and unsustainable resource use [2,7,11,23]. These factors have reduced forest area and quality, causing fragmentation, loss of valuable species, lower productivity, and weaker ecological resilience.

Mountain and foothill forests are especially vulnerable. Loss of forest cover increases soil erosion, landslides, and water imbalance, while reducing the ability of

ecosystems to recover naturally. In such cases, restoration measures become necessary.

Forest productivity includes not only timber yield but also biodiversity conservation, climate regulation, soil and water protection, and long-term ecosystem services. Therefore, improving productivity means strengthening overall forest health and resilience [1-3,8,14,17].

Successful restoration requires natural regeneration, reforestation, suitable species selection, erosion control, and sustainable management based on local environmental conditions.

In Greater Caucasus, Lesser Caucasus, and Talysh Mountains, forest degradation has become an important environmental problem [24]. Restoring these forests is essential for biodiversity, water resources, and regional ecological balance.

This article examines the main causes of declining forest productivity and practical measures for forest restoration and sustainable management.

Forest productivity is influenced by a wide range of natural and human-induced factors. Productivity declines when forests lose their capacity for healthy growth, natural regeneration, biomass production, and ecological stability. In many regions, the combined effects of anthropogenic pressure, environmental degradation, and climate-related stress have significantly weakened forest ecosystems [4,7,12,17, 22-25]. Understanding these factors is essential for planning effective restoration and sustainable management strategies.

One of the primary causes of reduced forest productivity is illegal logging and uncontrolled tree cutting. The removal of mature and healthy trees decreases canopy cover, disrupts forest structure, and reduces seed sources needed for natural regeneration. Selective cutting of valuable species can also alter species composition and lead to the dominance of low-value or invasive vegetation. Repeated cutting without proper management often transforms dense forests into sparse woodlands or shrublands.

Overgrazing by livestock is another major factor affecting forest ecosystems, especially near settlements and mountain villages. Grazing animals damage young seedlings, compact the soil, and prevent the successful regeneration of trees and shrubs [18,20,22,23]. Continuous grazing pressure can eliminate understory vegetation, reduce biodiversity, and accelerate soil erosion. In many degraded forest belts, the absence of natural regeneration is directly linked to uncontrolled grazing.

Soil erosion and land degradation severely reduce forest productivity, particularly on steep slopes and deforested lands. When tree cover is removed, rainfall and surface runoff wash away fertile topsoil rich in organic matter and nutrients. Exposed soils become shallow, dry, and less capable of supporting tree growth. In advanced stages, parent rock may become exposed, making afforestation increasingly difficult.

Forest fires, whether natural or human-caused, can destroy vegetation cover, seed banks, wildlife habitats, and soil microorganisms. Frequent fires prevent the development of mature forest stands and may permanently alter ecosystem structure. In dry climatic regions, repeated fires can convert forests into grasslands or shrub-dominated landscapes.

Unsuitable land use change also contributes to declining productivity. Conversion of forest lands into agricultural fields, roads, settlements, or industrial zones reduces forest area and fragments habitats. Fragmented forests often suffer from edge effects, reduced species diversity, and weakened ecological resilience. Smaller isolated forest patches are more vulnerable to drought, pests, and human disturbance.

Pests and diseases can significantly damage forest stands, especially when ecosystems are already weakened by drought or poor management. Insect outbreaks, fungal infections, and pathogen spread may reduce tree growth, cause mortality, and decrease timber quality. Monoculture plantations are often more vulnerable to large-scale pest problems than mixed forests.

Climate change has become an increasingly important factor affecting forest productivity. Rising temperatures, irregular precipitation, prolonged droughts, and extreme weather events place stress on trees and reduce growth rates. Changes in climate may also shift species distribution ranges, increase fire risk, and create favorable conditions for pests and diseases. Sensitive mountain forests are particularly vulnerable to these changes.

Loss of biodiversity can further reduce forest productivity. Diverse forests are generally more resilient and efficient in nutrient cycling, pest resistance, and adaptation to environmental stress. When species diversity declines, ecosystem functions weaken, and productivity may become unstable over time.

Finally, poor forest management practices such as lack of monitoring, weak law enforcement, absence of reforestation planning, and insufficient community involvement often worsen existing problems [3,7,9]. Sustainable productivity cannot be achieved without effective governance, scientific management, and long-term conservation strategies.

In conclusion, declining forest productivity usually results from the interaction of multiple factors rather than a single cause. Addressing these threats requires integrated solutions that combine protection measures, ecological restoration, sustainable use of resources, and climate adaptation planning.

Strict control of forest boundaries and protection from illegal activities are essential. Preventing unauthorized logging and restricting grazing in vulnerable areas help forests recover naturally.

Low-value, curved, and damaged tree stands should be gradually replaced with productive and ecologically valuable species. Corridor planting methods and canopy management can improve stand structure.

In severely degraded lands where natural regeneration is impossible, forest plantations should be established. Species selection must consider soil fertility, moisture conditions, altitude, and slope exposure.

Selecting suitable tree species is a key factor in successful forest restoration and productivity improvement. Species should be chosen according to climate, altitude, slope, soil fertility, moisture, and degradation level. Wrong species often lead to poor survival, slow growth, and unsuccessful reforestation.

In dry and degraded areas, drought-resistant species should be prioritized because they tolerate harsh conditions and gradually improve soil quality. Later, native species can be introduced as conditions recover.

For foothill and rocky slopes (500–600 m), Eldar pine and Crimean pine are suitable due to tolerance of drought, wind, and poor soils. Their roots also help control erosion.

In middle mountain belts, Scots pine, Crimean pine, and mixed pine plantations are effective for restoring degraded lands. In upper mountain zones, Scots pine, wild pear, and birch perform well under cooler and wetter conditions.

Where soils are fertile, native broadleaf species such as oak, beech, alder, walnut, and chestnut should be included because they provide high ecological and economic value.

Mixed-species plantations are usually better than monocultures, as they are more resistant to pests, drought, and climate change while supporting biodiversity. Using local seed sources also improves adaptation and survival.

Proper species selection helps achieve higher productivity, stronger resilience, and long-term forest recovery.

Soil erosion is one of the most serious results of forest degradation, especially in mountainous areas. When forest cover is removed, soil becomes exposed to rain, wind, and runoff, causing loss of fertile topsoil, reduced productivity, landslides, and river sedimentation.

Forests help prevent erosion naturally. Tree roots stabilize the soil, forest canopies reduce rainfall impact, and leaf litter improves water infiltration while slowing runoff. Therefore, restoring forest cover is one of the most effective ways to control erosion.

In degraded areas, afforestation and reforestation should be priority measures. Planting trees and shrubs adapted to local conditions helps stabilize slopes and restore soil fertility. Fast-growing species may provide early protection, while native species ensure long-term sustainability.

Steep slopes, riverbanks, and landslide-prone zones need special attention. Methods such as terracing, contour planting, check dams, and vegetative barriers can be combined with forest planting to reduce runoff and trap sediments.

Controlling grazing, preventing illegal logging, and establishing protected forest zones are also important. Erosion control brings ecological and economic benefits by protecting soils, farmland, infrastructure, and water quality.

The restoration and sustainable management of forest ecosystems are especially important in mountainous regions, where forests protect soil, regulate climate, and preserve water resources. In many parts of the republic, forests have been degraded by illegal logging, overgrazing, agricultural expansion, and unsustainable use of natural resources.

In the Greater Caucasus, valuable beech and mixed forests have often been replaced by shrubs and sparse vegetation, increasing erosion and landslide risks. Forest restoration here is essential for slope stabilization, flood prevention, and watershed protection.

In the Lesser Caucasus, forests are fragmented and degraded. Reforestation should focus on reconnecting forest patches, increasing biodiversity, and improving soil fertility.

The Talysh Mountains contain unique humid forests rich in endemic species. Restoration is important for conserving biodiversity, regulating local climate, and maintaining water resources [15,17, 23-25].

Forests near villages face pressure from fuelwood collection and grazing. Therefore, community-based protection, alternative energy sources, and environmental education are necessary.

Forest restoration also provides economic benefits through ecotourism, sustainable wood production, medicinal plants, and rural employment, supporting both ecology and regional development.

Forest degradation negatively affects ecological regulation, landscape balance, and biodiversity conservation. Therefore, priority actions should be directed toward forest restoration, productivity enhancement, and sustainable management. Combining natural regeneration with artificial reforestation and strong protection measures can ensure the long-term recovery of forest ecosystems. The future of forestry depends not only on ecological planning but also on economic and social support systems.

References:

1. Aslanova S. Subalpine Meadow Vegetation of Talish Highlands of Azerbaijan //Бюллетень науки и практики. – 2024. – Т. 10. – №. 2. – С. 38-46.
2. Aslanova S., Ecology. //ASPU. Baku. P-347. – 2025.
3. Aslanova S., Asadova B. Flora and fauna of Azerbaijan //ASPU. Baku. P-347. – 2023.
4. Atamov V. V., Cabbarov M., Gurbanov E. The pytosociological characteristics of ecosystems of mountain of Talysh Region of Azerbaijan //Asian Journal of Plant Sciences. – 2006. – Т. 5. – №. 5. – С. 899-904.
5. Chazdon R. L. Beyond deforestation: restoring forests and ecosystem services on degraded lands //science. – 2008. – Т. 320. – №. 5882. – С. 1458-1460.
6. Ciccarese L., Mattsson A., Pettenella D. Ecosystem services from forest restoration: thinking ahead //New forests. – 2012. – Т. 43. – №. 5. – С. 543-560.
7. Elshad K. et al. BIOLOGICAL SCIENCES //Annali d'Italia №. – 2024. – Т. 58. – №. 3.
8. Gurbanov E. M. Systematics of higher plants //Baku: BGU. – 2009. – Т. 429.

9. Gurbanov E., Aslanova S. Phytocenoses found in grassy mountain-meadow soils in the subalpine zone of Talish //Proceeding Book of 3rd International Conference on Scientific and Academic Research ICSAR. – 2023. – T. 1. – №. 2. – C. 81-84.
10. Gurbanov, E., & Aslanova, S. Average annual productivity of the Thymuseta-vicaetum-festucosum formation, distributed in summer pasture field No. 8" Turkesoba"(AZERBAIJAN). *Norwegian Journal of Development of the International Science*, 2024- 126.
11. Gurbanov E., Aslanova S. COMPARATIVE ANALYSIS OF THE FLORA OF THE ABSHERON PENINSULA AND THE OIL-CONTAMINATED FLORA OF AZERBAIJAN //Deutsche internationale Zeitschrift für zeitgenössische Wissenschaft . . . № 92 2024 VOL. – 2024. – C. 16.
12. Gurbanov E., Aslanova S. Study of the Area, Environmental Conditions of the" Binagadineft" NGCI Mines in the Absheron Peninsula of the Republic of Azerbaijan, and Study of Vegetation-Soil Cover Contaminated by Oil and Oil Products //Advanced Studies in Biology. – 2025. – T. 17. – №. 1. – C. 11-17.
13. Gurbanov E., Aslanova S. VEGETATION OF ALPINE MEADOWS AND ALPINE CARPETS OF THE TERRITORY OF THE REPUBLIC OF AZERBAIJAN //German International Journal of Modern Science/Deutsche Internationale Zeitschrift für Zeitgenössische Wissenschaft. – 2025. – T. 11. – №. 3.
14. Gurbanov E., Aslanova S., Ibrahimov S. The Alhagieto-Salsoletum-Artemisiosum fosmation group at the SiyazanNeft NQCI mine //AS-Proceedings. – 2023. – T. 1. – №. 3. – C. 17.
15. Hüttl R. F., Schneider B. U. Forest ecosystem degradation and rehabilitation //Ecological Engineering. – 1998. – T. 10. – №. 1. – C. 19-31.
16. Kurbanov E., Aslanova S. National-Economic Significance of the Vegetation Cover of Atropatene (within the Republic of Azerbaijan). – 2024.
17. Sharma A., Tracy J., Panwar P. Ecological restoration of degraded forests for achieving land degradation neutrality //Land degradation neutrality:

Achieving SDG 15 by Forest management. – Singapore : Springer Nature Singapore, 2022. – С. 191-204.

18. Youssef N. A. et al. Antioxidant enzymes, fluctuating asymmetry and morphological changes of urban trees as an ecological indicator of heavy metal stress //International Journal of Pharmaceutical Science and Health Care. – 2013. – Т. 3. – №. 1. – С. 1-18.

19. Yusifova, A., Asadova, B., & Aslanova, S. Plants, Human Health And Civilization. *Norwegian Journal of Development of the International Science*, 2024-136, 6-10.

20. Гурбанов Э. М., Асланова С. Ш. Новые местонахождения некоторых видов растений в горной части Ленкорани //Географическая среда и живые системы. – 2013. – №. 2. – С. 21-24.

21. Гурбанов Э., Асланов С., Сафарова А. КЛИМАТИЧЕСКИЕ УСЛОВИЯ ГОРНОЙ ЧАСТИ ТАЛЫША //German International Journal of Modern Science/Deutsche Internationale Zeitschrift für Zeitgenössische Wissenschaft. – 2024. – №. 90.

22. КУРБАНОВ Э., АСЛАНОВА Ф. СКАЛЬНО-ОСЫПНАЯ РАСТИТЕЛЬНОСТЬ АТРОПАТАНСКОЙ ПРОВИНЦИИ (В ПРЕДЕЛАХ АЗЕРБАЙДЖАНСКОЙ РЕСПУБЛИКИ) //ANNALI D'ITALIA. – №. 60. – С. 13-16.

23. Эльшад К., Асланова С. ИСТОРИЯ И ЗНАЧЕНИЕ ИЗУЧЕНИЯ ФИТОМЕЛИОРАЦИИ НЕФТЕЗАГРЯЗНЕННЫХ ЗЕМЕЛЬ В АЗЕРБАЙДЖАНЕ //German International Journal of Modern Science/Deutsche Internationale Zeitschrift für Zeitgenössische Wissenschaft. – 2024. – №. 80.

24. Эльшад К., Санубар А. ЭКОЛОГИЧЕСКАЯ КЛАССИФИКАЦИЯ ПОЧВЕННО-РАСТИТЕЛЬНЫХ ТЕРРИТОРИЙ, ЗАГРЯЗНЕННЫХ МИНЕРАЛИЗОВАННЫМИ ВОДАМИ НА АПШЕРОНСКОМ ПОЛУОСТРОВЕ //German International Journal of Modern Science/Deutsche Internationale Zeitschrift für Zeitgenössische Wissenschaft. – 2024. – №. 75.