

The Role of Azerbaijan's Forests in the 'Green' Economy

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Abstract

This article examines the theoretical foundations of the role of forests in the development of the green economy, as well as the concepts and nature of the green economy. In this context, the significance of forest resources within the ecological system was examined, and an analysis was carried out of the role of Azerbaijan's forests in the development of the green economy, including the current state of Azerbaijan's forest resources. In this context, particular attention was paid to the environmental role and economic significance of Azerbaijan's forests within the green economy. In addition, the paper analysed the main challenges facing Azerbaijan's forestry sector, explored ways of improving the use of forest resources within the framework of the green economy, and examined international experience of sustainable forest management. The article concludes by assessing the prospects for the development of forestry and providing practical recommendations for the development of a green economy in Azerbaijan's forestry sector.

Keywords: green economy, forest resources, ecological functions, economic significance, sustainable development, comparative analysis

1. Introduction

In recent years, particular attention has been paid in Azerbaijan to environmental protection, the sustainable use of natural resources, and the development of a green economy (OECD, 2022). Against a backdrop of climate change, increasing human pressure on natural ecosystems and the need to ensure the country's environmental security, the importance of forest resources as a key component of the state's natural capital is growing. Forests fulfil numerous environmental and socio-economic functions. They help to preserve biodiversity, regulate the water cycle in these areas, protect the soil from erosion, and contribute to the absorption of carbon dioxide and the creation of favourable climatic conditions. In addition, forests have considerable economic potential, serving as a source of timber and non-timber resources, as well as providing opportunities for the development of recreation and ecotourism.

Despite the relatively low level of forest cover in the country, Azerbaijan's forest resources are of great importance for ensuring the country's environmental sustainability. In past years, government programmes have been implemented to reforest, expand protective green spaces, and improve the forest management system. At the same time, problems persist relating to the degradation of certain forest areas, the consequences of climate change, and the need to improve the efficiency of forest resource use. The relevance of this research topic stems from the need to improve the efficiency of Azerbaijan's forest resource utilisation, to refine mechanisms for their protection and restoration, and to strengthen the role of the forestry sector in ensuring environmental sustainability and the development of a green economy.

The purpose of this study is to examine the role of Azerbaijan's forests in the development of the green economy and to draw up proposals for improving the use and conservation of forest resources. The object of the study is the forest resources of the Republic of Azerbaijan, while the subject of the research comprises the environmental and economic aspects of the use of forest resources within the framework of the green economy. The theoretical and methodological basis for the study was provided by the works of domestic

and international researchers in the fields of forestry, ecology, sustainable development, and the green economy, as well as official statistical data and regulatory and legal documents. The study employed methods including a review of the scientific literature, statistical and comparative analysis, a systems approach, generalisation, and logical analysis. The practical significance of this work lies in the possibility of using the findings and the recommendations developed to prepare measures aimed at improving the system for the protection, restoration, and sustainable use of forest resources in the Republic of Azerbaijan.

2. Discussion

The concept and essence of the green economy: In the current context of global economic development, the concept of the green economy is becoming particularly relevant, as it aims to ensure the sustainable development of society whilst making rational use of natural resources and preserving the ecological balance. The rise of environmental problems, climate change, environmental pollution, and the exhaustion of natural resources have become the main reasons why many countries have shifted to a new model of economic development based on environmental safety and the principles of sustainable use of natural resources. The term 'green economy' became widely used in the late 20th and early 21st centuries. The concept gained particular significance following the work of international environmental organisations and United Nations programmes. The United Nations Environment Programme, UNESCO, and the Food and Agriculture Organization have made a significant contribution to the development of this concept, emphasising the need to transition to sustainable development and an environmentally sound economy. According to UNEP's definition, the green economy is an economic system that promotes improved well-being and social justice whilst reducing environmental risks and the depletion of natural resources. The main aim of the green economy is to achieve economic growth without harming the environment (United Nations Environment Programme, 2011). The development of a green economy is linked to the need to tackle global environmental challenges. Among the most serious of these are climate change, land degradation, the loss of biodiversity, deforestation, air pollution, and the depletion of water resources. In this regard, the international community is placing great emphasis on the development of environmentally-oriented sectors of the economy, the rational use of natural resources, and the introduction of technologies that reduce the negative impact on the environment.

Forest resources are one of the most important components of the green economy. Forests fulfil a wide range of functions, including climate regulation, water conservation, soil protection, public health and recreation. Furthermore, forests play a significant role in reducing the concentration of carbon dioxide in the atmosphere and ensuring the environmental sustainability of natural ecosystems. In today's world, forests are regarded not only as a source of timber but also as a vital component of a country's environmental security. The sustainable use of forest resources helps to maintain the natural balance, prevent soil erosion, protect water resources, and improve the quality of the environment. The concept of the green economy is closely linked to the concept of sustainable development. The principles of sustainable development were set out in the 1987 report by the UN World Commission on Environment and Development, 'Our Common Future'. According to this concept, the development of society must ensure that the needs of the present generation are met without compromising those of future generations (OECD, 2017). Within the framework of the green economy, the main focus is on the conservation of forest ecosystems, the expansion of forest areas, the restoration of degraded land, and the improvement of the effectiveness of environmental policy. Many countries are implementing special programmes to restore forests, reduce deforestation and promote environmentally sustainable forestry. For Azerbaijan, the development of a green economy is of particular importance, as the country's natural resources play a key role in ensuring environmental sustainability and socio-economic development.

In recent years, Azerbaijan has been placing great emphasis on environmental protection, the restoration of forest areas, and the implementation of environmental programmes. The transition to a green economy not only helps to improve the state of the environment but also contributes to the creation of new jobs, the development of ecotourism, an increase in the country's investment appeal and the strengthening

of environmental security. In this respect, the sustainable use of forest resources is becoming one of the most important aspects of the state's environmental policy. Consequently, the green economy represents a modern model of sustainable development based on the rational use of natural resources, the preservation of ecological balance, and the creation of favourable living conditions for the population. In this system, forests are the most important natural resource, ensuring environmental stability, climate stability, and the conservation of biodiversity.

The importance of forest resources in the ecological system Forest resources are one of the most important components of the natural environment and play a significant role in maintaining ecological balance. Forests fulfil numerous environmental, climatic, water conservation, sanitary-hygienic, and socio-economic functions. In today's world, the importance of forests is growing significantly in the face of global environmental challenges, including climate change, environmental pollution and land degradation. One of the main functions of forests is to regulate climatic processes. Forests influence temperature patterns, air humidity, the amount of precipitation, and the circulation of air masses. Forests absorb carbon dioxide and release oxygen, thereby helping to reduce the concentration of greenhouse gases in the atmosphere. In this context, forests are regarded as a vital natural mechanism for combating global climate change. The ability of forests to sequester carbon is of particular importance. Through photosynthesis, trees absorb carbon dioxide from the atmosphere, which helps to reduce the negative impact of human activity on the environment. According to international environmental organisations, the conservation and restoration of forests are among the most effective ways of reducing carbon dioxide emissions. Forests play an important role in protecting the soil from erosion. The root systems of trees stabilise the soil, prevent the topsoil from being washed away, and reduce the risk of landslides. Forests are of particular importance to mountainous regions, where erosion processes are most intense. For Azerbaijan, this issue is particularly relevant given the country's complex terrain.

According to research carried out by Azerbaijani scientists, forests play an important role in water conservation. According to Q. Sh. Mammadova and K. S. Asadova, Azerbaijan's forest ecosystems play a key role in preventing erosion and conserving biodiversity (Məmmədov & Əsədov 2010). They regulate surface water runoff, help to maintain soil moisture, and prevent the onset of drought conditions. F.A. Amirov's works emphasise that forests have a significant impact on the hydrological regime of an area and help to conserve water resources. Furthermore, forest ecosystems prevent waterlogging and regulate groundwater levels (Məmmədov, 2004). An important function of forests is the conservation of biodiversity. Forests provide a natural habitat for a large number of plant, animal, and microorganism species. The degradation of forest ecosystems leads to a decline in the populations of many species of flora and fauna, a disruption of the natural balance, and a deterioration in the environmental situation. Azerbaijan is characterised by a rich biodiversity, thanks to its variety of climatic conditions and natural regions. The country is home to broad-leaved, mixed, and relict forests, which are of great ecological importance. The beech forests of the Greater Caucasus and the woodlands of the Talysh region are of particular value (Яхьяев & Абиев 2015; Hasanov et al., 2017). Forests also fulfil a public sanitary-hygienic function. They purify the air of dust, toxic substances, and harmful gases, reduce noise levels, and improve the quality of the environment. In urban and suburban areas, forests help create a favourable microclimate and has a positive impact on public health. The recreational functions of forests are of great importance. Forest areas are used for recreation, tourism, and public health. The development of eco-tourism not only contributes to the conservation of natural areas but also enhances the economic efficiency of forest resource use.

In today's world, forests are becoming increasingly important as a key element of sustainable development and the green economy. The sustainable use of forest resources helps to ensure environmental safety, improve the quality of life for the population, and create the conditions for sustainable socio-economic development. For Azerbaijan, the conservation of forest ecosystems is of strategic importance. Despite the country's relatively low level of forest cover, forests play an important role in maintaining ecological balance, preventing land degradation and protecting natural resources. In recent years,

programmes have been implemented in the country to restore forest cover, carry out afforestation, and protect particularly valuable natural ecosystems (НОВИКОВ, 2005).

Significant attention is being paid to the reforestation of the liberated territories of Karabakh. The implementation of reforestation measures helps to improve the environmental situation, prevent soil erosion, and preserve the region's natural potential. Forest resources are therefore a vital component of the ecological system and play a key role in ensuring sustainable development. The ecological functions of forests are of great importance for maintaining the natural balance, improving the quality of the environment and developing Azerbaijan's green economy.

The current state of Azerbaijan's forest resources. Azerbaijan's forest resources constitute the country's most important natural asset; however, their quantitative and qualitative characteristics indicate the need for a systematic approach to their management and restoration.

According to data from the State Statistics Committee of Azerbaijan, the total area of the forest reserve is approximately 1.213 million ha, of which around 1.037 million ha are directly covered by forest, corresponding to a forest cover of approximately 11.8% (Azərbaycan Respublikasının Dövlət Statistika Komitəsi, 2024). By way of comparison, the average forest cover across Europe is around 32%, which highlights a significant gap and the potential for reforestation. The spatial distribution of forests is extremely uneven. The highest concentration of these — accounting for around 95% of the total forest area — is found in the mountainous regions of the Greater Caucasus, the Lesser Caucasus and the Talysh Mountains (Azərbaycan Respublikası Ekologiya və Təbii Sərvətlər Nazirliyi, 2024; Əmirov, 1997). At the same time, in the arid, flat regions that make up a significant part of the country's territory, the area covered by forest is minimal. This imbalance poses serious environmental risks: low-lying areas lack natural protection against wind erosion and soil salinisation (Əliyev, 2002).

The species composition of Azerbaijan's forests is diverse and is determined by vertical zonation. The Hircanian forests of the Talysh Zone are of particular scientific and conservation value — these are relict broad-leaved forests dating from the Tertiary period, which have survived thanks to the region's unique microclimate. They are included on the UNESCO World Heritage List and represent a unique biogeographical phenomenon. An analysis of trends in forest cover over the last decade indicates a positive trend towards an increase in forested area in Azerbaijan. According to figures from the State Statistics Committee, in 2025 the area of forest covered 1,213.7 thousand ha of the forest reserve.

Despite the government's reforestation measures, the current rate of forest cover expansion is not yet sufficient to fully offset the effects of past periods of forest ecosystem degradation. In this regard, further increasing the scale of reforestation work remains one of the key priorities of the government's environmental policy (Azərbaycan Respublikasının Dövlət Statistika Komitəsi, 2024). This indicates that the expansion of forest cover is proceeding at a slow pace and has not yet fully compensated for the historical losses to the forest stock.



Figure 1. Geographical distribution of forests in Azerbaijan

Figure 1 shows the geographical distribution of Azerbaijan's forest areas. As can be seen from the map, forests cover around 11-12% of the country's territory and are distributed unevenly. The largest areas of forest are concentrated in the mountainous regions of the Greater Caucasus in the north-east of the country, the Lesser Caucasus in the west and south-west, and the Talysh Mountains in the south-east. In lowland and semi-arid regions, the forest cover is considerably lower due to the characteristics of the terrain, climatic conditions, and precipitation patterns. This distribution of forest resources determines their vital role in preserving biodiversity, protecting soils from erosion, regulating the water balance, and maintaining the ecological sustainability of Azerbaijan's natural ecosystems. Furthermore, the fact that forests are concentrated mainly in mountainous areas enhances their importance in preventing landslides, mudslides, and other adverse natural phenomena.

Table 1. Trends in CO₂ emissions in Azerbaijan (2018–2021)

Year	CO ₂ emissions (million tonnes)	Change (%)
2018	33,7	—
2019	34,2	+1,5
2020	32,5	-4,9
2021	35,1	+8,0

Source: World Bank Data, 2022 [40].

As shown in the data in Table 1, despite a temporary decline in carbon dioxide emissions in 2020, linked to the reduction in economic activity during the COVID-19 pandemic, this figure rose to 35.1 million tonnes as early as 2021, an increase of 8% compared with the previous year. This indicates that the country's economy remains dependent on sectors linked to the consumption of fossil fuels and highlights the need to step up measures to reduce the carbon footprint on the environment.

Forest ecosystems play a vital role in achieving climate targets, as they act as natural carbon sinks. Through photosynthesis, forests store carbon in their woody biomass, soil and forest litter, thereby helping to reduce the concentration of greenhouse gases in the atmosphere. According to estimates by the Food and Agriculture Organisation of the United Nations (FAO), one hectare of mature broadleaf forest is capable of absorbing an average of between 2 and 5 tonnes of CO₂ per year. Based on these figures, offsetting the increase in emissions recorded in 2021 alone would require a significant expansion of the areas set aside for reforestation.

Consequently, increasing the area of forest cover should be viewed not only as an environmental protection measure but also as an important tool for implementing green economy policies and fulfilling Azerbaijan's international commitments in the field of combating climate change. In this context, afforestation programmes, improving the effectiveness of the protection of existing forests, and the introduction of modern methods for monitoring the carbon balance of forest ecosystems take on particular significance (Global Forest Resources Assessment, 2020).

An analysis of trends in CO₂ emissions shows that the development of the forestry sector can make a significant contribution to reducing the negative impact on the climate and enhancing the country's environmental sustainability. However, in order to achieve a tangible impact, it is necessary to further expand the scale of reforestation work and improve the forest resource management system.

Table 2: Key ecological functions of forests

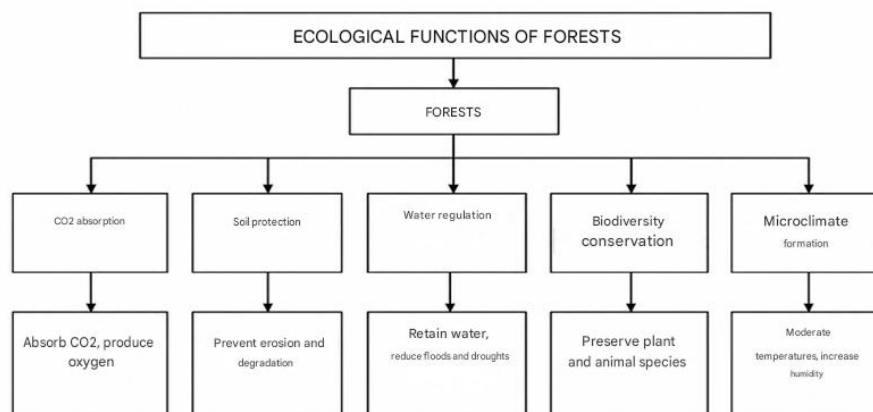


Table 2 sets out the main ecological functions of forests. As can be seen from the diagram, forests play an important role in absorbing carbon dioxide, which helps to mitigate the effects of climate change. Furthermore, they protect the soil from erosion, regulate the water balance of the area, and help to preserve biodiversity. Another important function of forests is to create a favourable microclimate. The combination of these functions ensures that ecological balance is maintained and that natural ecosystems develop sustainably.

The state of the forest resources in the liberated territories of Karabakh and Eastern Zangezur deserves particular attention. According to various estimates, between 30 and 40% of the forest cover in the area was destroyed or seriously damaged as a result of years of occupation and military operations (Azərbaycan Respublikası Ekologiya və Təbii Sərvətlər Nazirliyi, 2023). The government has begun implementing large-scale reforestation programmes in the region, but full recovery will take decades.

An assessment of the current state of Azerbaijan's forest resources highlights three key issues: a low overall level of forest cover compared with European standards; spatial disparities in forest distribution; and insufficient rates of reforestation against a backdrop of rising greenhouse gas emissions. Addressing these issues is a prerequisite for the transition to a green economy.

An analysis of the ecological role of Azerbaijan's forests: Forests play a multifaceted ecological role; however, for Azerbaijan, with its specific geographical and climatic conditions, each of these functions is of particular, and often vital, importance. Unlike countries with high forest cover, where forests are taken for granted, in Azerbaijan, every hectare of forest cover bears a heavy environmental burden.

Climate control function. The forests of the Greater Caucasus act as a natural climatic barrier, protecting the country from Arctic air masses in winter and tempering the summer heat. Studies show that

in the forested areas of Azerbaijan, the average annual air temperature is 1.5–2.5°C lower, whilst humidity is 10–15% higher than in treeless areas at the same altitude (Məmmədov, 2004).

The Girkhan forests create a unique subtropical microclimate in the south-east of the country, without which the survival of many relict species would be impossible.



Figure 2. Degradation of forest cover and the risk of soil erosion. (Qusar District, mid-mountain terrain)

Figure 2 shows areas with sparse forest cover and partially denuded slopes. This state of forest ecosystems indicates a decline in tree cover and a weakening of their protective functions. The reduction in forest cover leads to increased erosion, higher surface runoff, a deterioration in the water regime of the affected areas, and a reduction in the stability of the soil cover. Furthermore, the degradation of forest stands has a negative impact on biodiversity, as it leads to a reduction in the natural habitats of many plant and animal species.

Forests play a particularly important role in the mountainous regions of Azerbaijan, where they help to protect the soil and regulate water flows and prevent landslides, mudslides, and other dangerous natural phenomena. A reduction in forest cover may lead to a deterioration in the ecological condition of the area and a decline in the ability of natural ecosystems to withstand human impact and the effects of climate change.

The example given clearly illustrates the importance of preserving existing forest areas and implementing effective reforestation measures. The rational use of forest resources, the strengthening of measures to protect them, and the expansion of efforts to restore degraded areas are essential for ensuring environmental sustainability and preserving Azerbaijan's natural potential.

Carbon sink. In today's world, the carbon sink function has taken on a strategic economic dimension. According to estimates based on the FAO methodology, the total amount of carbon sequestered in Azerbaijan's forests is approximately 180–220 million tonnes of CO₂ equivalent [29]. This implies that the degradation and destruction of forest resources will result not only in environmental losses but also in economic ones: in the context of the global carbon market, this volume has a very specific value. According to reports by the FAO and UNEP, forest restoration is one of the key mechanisms for reducing greenhouse gas emissions and can be regarded as a 'green' financing instrument (FAO, 2006; FAO, 2012; UNEP, 2011, UNEP, 2021).

Soil-protecting function. Soil conservation is of critical importance for the country's mountainous regions. According to Azerbaijani researchers in the field of forest ecology, the rate of water erosion on treeless mountain slopes is 15–20 times higher than that in forested areas (Məmmədov, 2004). This problem is particularly acute in the Lesser Caucasus, where intensive deforestation over the past decades has led to the degradation of the soil cover across large areas.

Water conservation function. Azerbaijan's rivers, which feed both inland reservoirs and flow into the Caspian Sea, have their source in the forested mountain ranges. Scientific data clearly indicate a direct

correlation: in catchment basins with high forest cover (over 40%), river flow is more consistent, flood peaks are 20–30% lower, and low-water levels (minimum water flow) are 15–25% higher compared with deforested basins (Əmirov, 2003). Given the growing shortage of fresh water forecast for the South Caucasus by the middle of the 21st century, this function of forests takes on strategic importance.

Biological diversity. In terms of the number of plant species per unit area, Azerbaijan is one of the most biologically diverse countries in Europe and Western Asia. The country's forests are home to more than 4,500 species of higher plants, of which around 240 are endemic, found only here (İbrahimov, 2018). The Hyrcanian forests alone support around 180 relict species. The reduction in forest cover inevitably leads to the fragmentation of habitats and, in the long term, to the extinction of unique species, which represents an irreparable loss for global science and the biosphere as a whole.

Table 3. Ecological functions and quantitative characteristics of forests

Function	Quantitative description
Climate-regulating	A temperature drop of 1.5-2.5°C in forested areas
Carbon sink	Approximately 180–220 million tonnes of CO ₂ equivalent have been stored.
Soil-protection	A 15-20-fold reduction in erosion
Water conservation	A 20–30% reduction in flooding
Biological	240 species of endemic plants
Recreational	A base for the development of ecotourism

The data presented in Table 3 show that Azerbaijan's forests are not only an important natural resource but also a multifunctional ecosystem that fulfils a wide range of environmental and socio-economic functions. Forest ecosystems play a significant role in regulating climatic processes, conserving biodiversity, protecting soil from erosion, and maintaining the water balance of the land.

In today's world, the carbon sequestration function of forests is becoming particularly important. Due to their ability to absorb and store carbon, forest stands help to reduce the concentration of greenhouse gases in the atmosphere and mitigate the effects of climate change. In light of the development of international carbon regulation mechanisms, this function is taking on not only environmental but also economic significance.

Equally important are the soil conservation and water protection functions of forests. Forest vegetation helps to reduce the severity of erosion, improve soil structure, regulate surface runoff, and reduce the risk of flooding. Furthermore, forests help to preserve the natural habitats of numerous plant and animal species, thereby supporting biodiversity and the sustainability of natural ecosystems.

The environmental role of Azerbaijan's forests extends far beyond their traditional use as a source of timber. In the context of the development of the green economy, forest resources should be regarded as a key component of the country's natural capital, the conservation and sustainable use of which are essential for ensuring environmental security and sustainable socio-economic development in Azerbaijan.

The economic importance of forests within the green economy: The economic valuation of forest resources within the framework of the green economy concept differs fundamentally from the traditional approach, under which forests were regarded solely as a source of timber. Modern economic theory is based on the need to take into account the full range of ecosystem services provided by forests, including not only direct benefits (timber, non-timber products) but also indirect (carbon sequestration, water regulation, tourism) and intangible (biodiversity, aesthetic value) benefits (Одум, 1986).

Azerbaijan's forestry sector and green economy. The direct contribution of forestry to Azerbaijan's GDP remains relatively small — according to various estimates, no more than 0.5–0.8%. However, this figure drastically underestimates the actual economic contribution of forests, as it does not take ecosystem services into account. If the methodology for assessing ecosystem services developed as part of the TEEB

(The Economics of Ecosystems and Biodiversity) and OECD programmes (OECD, 2017) is applied, the total economic value of Azerbaijan's forests increases severalfold.

Eco-tourism. Eco-tourism is one of the fastest-growing sectors in the use of forest resources. Azerbaijan has exceptional potential in this field: its network of national parks and nature reserves encompasses unique natural areas ranging from the subalpine meadows of Shahdag to the subtropical forests of the Hyrcanian Nature Reserve. According to estimates by the Ministry of the Environment, with the right infrastructure and marketing, the potential for ecotourism in the country's forested areas is estimated at 50–80 million dollars annually (ETSN, 2024). By way of comparison, Georgia, having begun to actively develop ecotourism in the 2010s, had increased its revenue from this sector to \$120 million by 2019.

The carbon market is a promising, but as yet not fully realised, tool for monetising forest ecosystem services. Under the Paris Agreement on Climate Change, countries are entitled to establish national carbon trading schemes and participate in international REDD+ (Reducing Emissions from Deforestation and Forest Degradation) mechanisms. According to UNEP estimates, realising the potential of REDD+ for Azerbaijan could attract additional funding of between 20 and \$40 million a year, provided that an appropriate regulatory framework is put in place (UNEP, 2011).

Protection of agriculture and water resources. The indirect contribution of forests to the economy through the protection of agricultural land is significant, although it is more difficult to quantify precisely. According to estimates by Azerbaijani agricultural economists, the damage caused by wind and water erosion of soil in the country's treeless regions amounts to at least 80–100 million annually in lost agricultural output. By preserving soil cover and moisture levels, riparian strips and water protection forests effectively subsidise the agricultural sector without receiving any market compensation in return (Məmmədov, 2004).

Table 4. The economic benefits of Azerbaijan's forests

Directionality	Estimated economic benefit
Eco-tourism	Potential of \$50-80 million per annum
The carbon market (REDD+)	Potential of \$20-40 million per annum
Protection of agricultural land	Preventable damage caused by erosion: 80-100 million per annum
Water supply	Flow control: reducing water treatment costs
Biodiversity	Intangible value: a foundation for the pharmaceutical industry and science

The data in Table 4 show that Azerbaijan's forests are of not only ecological but also considerable economic value. In addition to the traditional use of forest resources, ecosystem services linked to the development of eco-tourism, the conservation of biodiversity, the regulation of water regimes in these areas, and the mitigation of the negative impacts of climate change are becoming increasingly important.

Of particular interest is the potential for the development of ecotourism and participation in international mechanisms for reducing greenhouse gas emissions. As part of the transition to a green economy, these areas could become additional sources of economic benefits and help to attract investment in environmental protection measures. At the same time, effectively realising this potential requires improving the forest resource management system, developing infrastructure and strengthening measures to protect forest ecosystems.

The protective functions of forests are also of great importance. Preserving forest stands helps to reduce soil erosion, maintain the sustainability of agricultural land, and regulate water resources. This helps to minimise potential economic losses associated with land degradation, a decline in soil quality, and disruption to the hydrological regime of the areas concerned.

An analysis of the economic significance of forests shows that their contribution to the country's development extends far beyond the direct income generated by the forestry sector. Forest ecosystems

provide a range of environmental and socio-economic benefits that must be taken into account when formulating government policy on the use of natural resources. Against the backdrop of the development of the green economy, there is a growing need to improve approaches to the valuation of natural capital and to take fuller account of the economic value of forest resources.

The main challenges facing Azerbaijan's forestry sector: Despite the obvious environmental and economic value of forests, Azerbaijan's forestry sector faces a range of interrelated challenges which, without a systematic solution, will continue to hinder the transition to a green economy. The analysis shows that these problems are of both an objective, natural nature and a subjective nature — linked to shortcomings in governance and legislation.

Illegal logging and poaching in forests. According to the Ministry of Ecology and Natural Resources, several hundred cases of illegal tree felling are recorded in Azerbaijan every year (ETSN, 2024; Атрохин, 1982; Бельгард, 1971). The actual scale, however, is considerably greater than that identified: experts estimate that the volume of timber harvested on the black market is two to three times higher than the officially recorded figure. Despite tighter state controls and improvements to environmental legislation, cases of unauthorised timber harvesting continue to be reported in various regions of the country. The main reasons are the population's need for firewood, the economic difficulties faced by certain rural areas, and inadequate monitoring in some forest areas. Illegal logging leads to a reduction in forest area, disruption to the structure of forest stands, a deterioration in the conditions for natural forest regeneration, and a decline in the forest's ecological sustainability (Яхьяев & Абиев, 2015). The degradation of forest ecosystems caused by human activity remains a serious problem.

Degradation caused by overgrazing. The traditional practice of grazing livestock in forests continues in many mountainous regions of the country, despite the legal restrictions on it. Grazing has a multifaceted impact on the forest ecosystem: livestock destroy young trees, compact the soil—thereby preventing it from becoming saturated with water—and lead to the fragmentation of the forest cover. According to estimates by Azerbaijani forestry experts, up to 15–20% of the country's mountain forests are suffering from some degree of degradation, caused in part by overgrazing (Əmirov, 2003).

Forest fires. Given the predicted climate warming, the risk of forest fires in Azerbaijan is increasing significantly. According to the IPCC report (2021), climate change poses one of the most serious threats to forest ecosystems on a global scale (FAO, 2012; UNEP, 2019; IPCC, 2019). In the case of Azerbaijan, this means that by 2050, the number of fire-risk days per year could increase by 20–30%. At the same time, the forest fire protection system is in need of modernisation: the network of observation posts is inadequate, and there is a shortage of specialised equipment and trained personnel. This problem is particularly acute in the mountainous regions of the Greater and Lesser Caucasus, where forests play a vital role in soil conservation. The reduction in forest cover contributes to increased water and wind erosion, a decline in soil fertility, and a greater risk of landslides and mudslides. This not only worsens the environmental conditions of the areas but also results in further economic losses.

In recent years, the effects of climate change, accompanied by rising air temperatures and longer periods of drought, have contributed to an increased risk of wildfires. Forest fires lead to the destruction of woodland, a reduction in biodiversity, and a deterioration in the environmental situation in the affected areas. Furthermore, the restoration of forests following major fires requires significant financial and time resources. In this context, the development of an early fire detection system, the improvement of fire safety infrastructure, and the enhancement of the effectiveness of preventative measures take on particular importance.

A major problem is the impact of climate change on the condition of forest ecosystems. Rising average annual air temperatures, changes in precipitation patterns, and an increase in the frequency of extreme weather events are having a negative impact on the growth and development of forest vegetation. Droughts, strong winds, and other adverse climatic factors reduce the resilience of forests, increase the risk of the spread of diseases and pests, and hinder the natural regeneration of forest stands.

The issue of preserving biodiversity deserves special attention. Azerbaijan's forests are home to a large number of plant and animal species, many of which are rare or endemic. However, the reduction and fragmentation of forest areas lead to a deterioration in the habitats of certain species and a decline in the resilience of natural ecosystems. Conserving biodiversity requires the further development of the network of specially protected natural areas and the strengthening of measures to protect rare species of flora and fauna.

Another problem is the insufficient uptake of modern technologies for monitoring and managing forest resources. Effective management of forest resources requires the regular collection of reliable information on the condition of forests, the scale of reforestation, and the extent of human impact. In today's world, geoinformation systems, satellite monitoring and digital technologies play a key role in enabling the rapid detection of changes in forest cover and improving the effectiveness of nature conservation efforts. Furthermore, expanding the scale of reforestation work remains an important task. Despite the measures being taken to plant trees and restore degraded areas, there remains a need to increase the area of forest. Increasing the country's forest cover is vital for strengthening the environmental sustainability of natural ecosystems, improving climatic conditions and developing the green economy.

Consequently, the main challenges facing Azerbaijan's forestry sector are illegal logging, the degradation of forest ecosystems, soil erosion, forest fires, the impacts of climate change, a decline in biodiversity, the insufficient use of modern monitoring technologies, and the need to further expand reforestation efforts. Addressing these issues requires a comprehensive approach, including the improvement of public policy, the strengthening of environmental protection measures, the introduction of innovative technologies, and the promotion of the principles of sustainable forest management (Prilipko, 1954; Peймepc, 1990).



Figure 3. Degradation of forest areas and reduction in forest cover

Figure 3 shows an area exhibiting signs of forest cover degradation. A significant part of the area is characterised by a reduction in tree cover, the presence of dead standing trees and bare patches of soil. Such changes increase the risk of soil erosion, reduce biodiversity, and undermine the environmental sustainability of natural ecosystems.

The pace of reforestation is insufficient. F.A. Amirov's research emphasises the need to introduce more effective reforestation techniques and to improve the quality of care for young forest stands (Amirov, 2003).

Table 5. An Analysis of the Challenges Facing Azerbaijan's Forestry Sector

The problem	Scale and consequences
Illegal logging	2-3 times higher than the officially recorded figure
Overgrazing	Up to 15–20 per cent of mountain forests are in a state of degradation
Forest fires	A 20–30% increase in the number of fire-risk days by 2050
The rate of reforestation	Below 15,000–20,000 hectares per year
The Degradation of Karabakh's Forests	80,000–120,000 hectares
Poor economic assessment	Indirect ecosystem services are not taken into account

Table 5 clearly demonstrates that the problems facing the forestry sector are complex and interrelated. For example, the lack of funding for reforestation is exacerbated by the fact that the economic value of forests is officially underestimated — indirect services are not taken into account. It is a vicious circle: until forests are fully accounted for in the national system of economic accounts, their conservation will be funded on a residual basis. In recent years, work has been carried out in the liberated territories to clear forest land, create new green spaces, plant trees and shrubs, and restore specially protected natural areas. The restoration of forest resources is regarded as one of the priority areas of the state's environmental policy in the liberated territories. One of the main challenges facing the reforestation of Karabakh remains the need to carry out demining operations in the area, as the presence of mines and unexploded ordnance significantly limits the scope for reforestation activities. Further difficulties stem from the destruction of infrastructure, a shortage of specialised forest nurseries, and the need to select tree species that are best suited to current climatic conditions.

It should be noted that the restoration of Karabakh's forests is significant not only from an environmental perspective but also from a socio-economic one. Increasing the area of forest cover will help to improve the state of the environment, reduce erosion, preserve biodiversity, and promote the development of eco-tourism. Furthermore, the restored forests will be able to perform important climate-regulating functions and contribute to the achievement of Azerbaijan's sustainable development goals and green economy. The degradation of Karabakh's forests is one of the most serious environmental problems facing Azerbaijan today. Addressing this issue requires a long-term government strategy, substantial financial resources, and the use of modern methods of reforestation and environmental monitoring. Government policy on forest conservation is a key instrument in the transition to a green economy. For Azerbaijan, where forests have historically been subject to significant human impact, the quality of this policy will largely determine whether the country succeeds in realising the environmental and economic potential of its forest resources. A critical analysis of the regulatory framework and the practice of its application reveals both achievements and systemic limitations.

Legal framework. The basis of Azerbaijan's forestry legislation is the Forest Code of the Republic of Azerbaijan (Azərbaycan Respublikasının Meşə Məcəlləsi, 2017), which establishes the legal framework for the protection, use and regeneration of forests. An important achievement is the enshrinement in law of the principle of multi-purpose forest management, under which the protective functions of forests are recognised as taking precedence over their commercial functions. At the same time, experience shows that there is a significant gap between the letter of the law and its enforcement: regulations prohibiting felling in water protection zones and on steep slopes are being flouted, whilst the administrative penalties for forestry offences remain insufficiently severe. The Ministry of Ecology and Natural Resources of the Republic of Azerbaijan is the main regulatory body in the forestry sector (ETSN, 2024). However, the forest management system requires clearer coordination. Thus, issues relating to reforestation on agricultural land require a coordinated approach between the relevant authorities, which will help to improve the effectiveness of the measures being implemented.

An important aspect of government policy is the implementation of programmes for reforestation and the expansion of the forest area. In recent years, initiatives have been carried out in Azerbaijan to plant trees, restore degraded forest areas, and green up the countryside. Particular attention is being paid to the

liberated territories of Karabakh and Eastern Zangezur, where the restoration of forest ecosystems is regarded as one of the priorities of the state's environmental policy. Azerbaijan's participation in international environmental initiatives and the fulfilment of its environmental protection obligations are of great importance. The country has acceded to a number of international conventions on nature conservation, climate change, and the preservation of biodiversity. This helps to promote the adoption of modern approaches to forest resource management and to draw on international expertise in the field of forestry. In recent years, increasing attention has been paid to the digitalisation of forest management systems. The use of geographic information systems, remote sensing, and satellite monitoring makes it possible to obtain more accurate information on the state of forest resources and to promptly detect illegal logging, forest fires, and other adverse impacts. The introduction of modern technologies helps to improve the effectiveness of state oversight and the quality of management decisions.

At the same time, an analysis of existing policy reveals a number of unresolved issues. These include insufficient funding for certain forestry measures, the need to modernise the material and technical infrastructure of forestry enterprises, the limited use of economic incentives to promote forest conservation, and the insufficient application of an ecosystem-based approach in management decision-making. Improving the economic mechanisms for managing forest resources is becoming particularly important. Globally, payment schemes for ecosystem services, carbon projects, and programmes to encourage reforestation are becoming increasingly widespread. The use of such tools could help to attract additional funding for the conservation and restoration of Azerbaijan's forests. Azerbaijan's state policy on forest conservation is therefore aimed at preserving the country's forest resources, improving the efficiency of forest resource management and ensuring the country's environmental sustainability. Despite the progress made, further improvements to the legislative framework, the introduction of modern technologies and the expansion of reforestation programmes remain key prerequisites for the successful development of the forestry sector within the framework of the green economy.

Reforestation programmes: In recent years, the government has been implementing several programmes aimed at expanding the forest area. The most extensive programme is the one aimed at reforesting the liberated territories of Karabakh and Eastern Zangezur, under which it is planned to establish forest plantations covering an area of several tens of thousands of hectares [9]. A positive example is the mass tree-planting campaigns, which have become an annual event: according to the Ministry of the Environment, more than 3 million trees were planted during such events in 2022–2023 alone (ETSN, 2024)

The system of specially protected natural areas (SPNAs). Azerbaijan has a network of SPNAs comprising 11 state nature reserves, 11 national parks, and a number of wildlife sanctuaries (ETSN, 2024). The total area of protected areas accounts for around 10 per cent of the country's territory. The inclusion of the Girkhan National Park on the UNESCO World Heritage List in 2019 marked a significant international recognition of the country's conservation efforts (UNEP, 2021). At the same time, funding for protected areas remains insufficient: according to experts' estimates, effective management of protected areas requires at least 2-3 times more funding than is currently allocated.

Environmental monitoring. The introduction of remote sensing systems to monitor forest resources is one of the priorities of government policy. As part of its cooperation with the FAO and UNEP, the country is establishing a national forest inventory system that enables changes in forest area and condition to be monitored with a high degree of accuracy (FAO 2012, UNEP, 2011).

This provides the necessary information base for management decision-making.

Table 6. Assessment of government policy on forest conservation

Area of Focus	Assessment and key challenges
Legal and Regulatory Framework	Well-developed, but requires strengthening
Reforestation	The scale is growing, but monitoring of take-up is insufficient
Protected Areas	Insufficient funding and staffing
Environmental Monitoring	The system is being developed with the support of FAO/UNEP
Combating Illegal Logging	Requires stricter sanctions and digital monitoring
Karabakh Programme	Large-scale and a priority; long-term results remain to be assessed

Table 6 shows that Azerbaijan's state policy on forest conservation has the necessary regulatory and institutional framework but suffers from a gap between its stated objectives and actual results. The key areas for improvement are: ensuring the quality of reforestation work (not just the quantity), strengthening law enforcement, and providing adequate funding for protected areas. An analysis of the main areas of government policy shows that Azerbaijan has established the necessary legislative and institutional framework for forest conservation. However, the further development of the forestry sector requires a shift from predominantly administrative management methods to a comprehensive approach based on the principles of sustainable development, the digitalisation of management and the economic valuation of ecosystem services. In modern conditions, the effectiveness of forestry policy should be assessed not only in terms of the number of trees planted or the area of land restored, but also in terms of the quality of forest stands, their state of conservation, and their ability to fulfil ecological functions.

International experience of sustainable forest management: For Azerbaijan, studying international experience in sustainable forest management is not of academic interest but of purely practical importance: the country faces the need to significantly accelerate reforestation and improve the effectiveness of forest conservation within a short timeframe.

An analysis of the experience of leading forestry nations reveals both universal principles applicable in any context and specific mechanisms which, if adapted, can yield rapid results (Исаченко, 2001).

Finland: a model of sustainable forest management. Finland is a country with 73% forest cover and, at the same time, one of the world's largest timber exporters. This paradox can be explained by the application of the principle of continuous cover forestry: felling and reforestation are planned in such a way that the total area and volume of forests do not decrease but increase. The law requires forest owners to plant new trees within two years of felling and to ensure that they take root.

For Azerbaijan, the key lesson is not the principle itself (which is already enshrined in Azerbaijani legislation), but the system for monitoring its implementation: in Finland, every reforestation site is inspected by a state forester after three years.

Germany: long-term planning and climate adaptation. German forestry is known for its commitment to long-term management, with forest management plans drawn up for periods of 10–20 years. However, over the past decade, Germany has faced a serious challenge: droughts and a bark beetle infestation have destroyed around 300,000 hectares of spruce forest – a direct consequence of the monocultural plantations of the last century. Germany's response to this crisis, which involves a shift towards mixed forests using drought-resistant species, is of direct interest to Azerbaijan, where climate change also poses a threat to monoculture plantations.

China: scale as a tool. The Three-North Shelter Forest Programme, which has been running since 1978, is the largest reforestation project in human history. Over four decades, more than 66 billion trees have been planted in China, and the forest cover in the northern regions has increased from 5% to 13% (FAO, 2012). For Azerbaijan, it is not only the scale that matters, but also the organisational mechanism: the programme combines state funding with the mandatory participation of local communities, which are

granted rights to a share of the timber harvested, providing a powerful incentive to ensure high-quality care of the plantations.

Table 7. International experience and applicability

Country/mechanism	A key lesson for Azerbaijan
Finland	Mandatory monitoring of planting survival rates after 3 years
Germany	Transition to mixed drought-resistant forests
China	Involvement of local communities with rights to forest resources

Table 7 presents a comparative analysis of international experience, which shows that three areas are of particular benefit to Azerbaijan: monitoring the survival rate of plantings, transitioning to mixed and drought-resistant forests, and developing mechanisms to finance reforestation.

Practical recommendations for the development of a green economy in Azerbaijan's forestry sector: Based on the analysis carried out – covering the state of the forest resources, the ecological and economic functions of forests, an assessment of government policy and international experience – a set of practical recommendations has been drawn up. They are organised in order of priority: from measures that yield quick results to long-term structural reforms.

Recommendation 1. Introduce mandatory three-year monitoring of the survival rate of all reforestation plantings. The point of the recommendation is that, without monitoring the results, a significant proportion of the funding for reforestation is wasted – trees are planted but do not survive. It is proposed that an amendment be made to the Forestry Code, requiring those carrying out reforestation work to submit a report on survival rates one and three years after planting. Target: a survival rate of at least 70 per cent by the third year. Source of funding for monitoring: the cost of monitoring is included in the budget for reforestation works (Həsənov, 2015).

Recommendation 2. To develop ecotourism in forest protected areas based on a public-private partnership model. It is proposed that a register of investment proposals in the field of ecotourism in forest areas be established. The state provides the access infrastructure (roads) and marketing support, whilst the investor is responsible for developing the tourism product. According to estimates by ecotourism experts, an initial investment of 15-20 million dollars could generate annual revenue of 50-70 million dollars within 5-7 years (Əmirov, 2003).

Recommendation 3. To implement a system for real-time satellite monitoring of forest resources. The use of publicly available Sentinel-2 satellite data (European Space Agency) makes it possible to detect changes in forest cover at five-day intervals and with a spatial resolution of 10 metres.

Table 8. Summary table of practical recommendations

Recommendation	Expected outcome and timeframe
1. Survival rate monitoring	Increase planting efficiency to 70%+; timeframe: 1-2 years
2. Ecotourism (PPP)	\$50-70 million per year in 5-7 years' time; timeframe: 2-3 years
3. Satellite monitoring	Reduction in illegal logging by 40-60%; timeframe: 1-2 years

The data in Table 8 show the cumulative effect of the proposed recommendations in terms of: accelerating the pace of reforestation; attracting additional funding; and ensuring that the forestry sector makes a measurable contribution to the achievement of Azerbaijan's climate targets. It is of fundamental importance that most of the recommendations are based on proven international practices and do not require fundamentally new technologies – only political will and organisational consistency.

3. Conclusion

As a result of the study, the role of Azerbaijan's forests in the development of the green economy was examined, the current state of the country's forest resources was analysed, the environmental and socio-economic functions of forest resources were investigated, and recommendations were put forward for improving the forest resource management system. First and foremost, the theoretical foundations of the study were examined. It was established that the concept of the green economy is aimed at ensuring economic development whilst making rational use of natural resources and preserving the environment. In this system, forests play an important role, fulfilling functions relating to climate regulation, water conservation, soil protection, recreation and socio-economic development. The analysis carried out has shown that the development of Azerbaijan's forestry sector has followed a long historical path and is currently based on the principles of sustainable forest management and the conservation of natural resources.

An analysis was carried out of the current state of Azerbaijan's forest resources and their significance for the development of the green economy. The study has shown that, in recent years, measures have been implemented in the country to conserve and restore forests, which has contributed to an increase in the total area of forest land. At the same time, problems persist relating to the degradation of certain forest areas, illegal logging, the effects of climate change and the need to improve the effectiveness of forest management measures. It has been established that Azerbaijan's forests possess significant environmental and economic potential and play a vital role in maintaining ecological balance, conserving biodiversity and improving the quality of life of the population. The main areas for improving the use of forest resources within the green economy were then examined.

An analysis of government policy and international experience has shown that the efficiency of the forestry sector can be improved by expanding reforestation efforts, introducing modern monitoring technologies, improving the forest resource management system and developing mechanisms for sustainable forest management. Of particular importance is the application of leading international best practice in the fields of forest protection, biodiversity conservation and the sustainable use of natural resources.

The study conducted leads to the conclusion that Azerbaijan's forests are a vital component of the country's natural capital and play a significant role in ensuring environmental security and sustainable socio-economic development. Effective management of forest resources not only helps to preserve natural ecosystems, but also creates further opportunities for the development of the green economy.

The practical significance of this work lies in the fact that the recommendations put forward can be used in the development of measures aimed at improving the system for the protection, restoration and sustainable use of forest resources. Their implementation will help to improve the environmental sustainability of these areas, conserve biodiversity and strengthen the role of the forestry sector in the development of the national economy.

Consequently, the rational use of forest resources, the conservation of natural ecosystems and the consistent implementation of the principles of the green economy are key prerequisites for Azerbaijan's sustainable development. Further improvements to government policy on forestry will help to achieve the country's environmental, economic and social development goals.

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