BioCore Exploring Scientific Community

International Journal of Biotechnology and Bioengineering

Review Article ISSN 2475-3432

Unsuastainable Forest Management Threaten Biodiversity and Climate Change

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Abstract:

Forest ecosystems are extremely significant for conservation of biodiversity and mitigation of climate change. This significance multiplies in mountain ecosystems where they provide such services as, soil protection, water regulation and climate stabilization. Mountain forests are important habitats for many endemic and endangered plants and animals. For sustainable development of the country government must have priorities of environmental sustainability actions among them sustainable management of forests and integration of climate change mitigation and adaptation into national policy. Growing demand on timber and firewood on interior and world markets gave additional impulse to legal as well as illegal overexploitation that lead to deforestation and degradation of major part of forests of the country. Air pollution, improper waste management and forest degradation due to illegal logging, grazing, etc. are the main environmental concerns leading to higher frequencies of such natural disasters as floods, torrents, mudflows, avalanches. Georgia still has sufficient forest resources but unsustainable management may result in their increasing degradation and extinction in near future followed by biodiversity loss and acceleration of climate change processes.

Keywords: Forest, Sustainable, Mountainous, Ecosystem, Management, Mitigation

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Citation: Tamaz Patarkalashvili (2020), Unsuastainable Forest Management Threaten Biodiversity and Climate Change Int J Biotech & Bioeng. 6:5

Received: July 03, 2020

Accepted: July 17, 2020

Published: July 31, 2020

1.Introduction

Forests provide a broad range of environmental, economic and social benefits. These benefits include: timber and biomass production, biodiversity, water supply and quality, soil protection and erosion control, water infiltration and storage, carbon storage, people's health and recreation and climate change mitigation [1,2]. Forests play decisive role in mitigation of climate change by absorbing the carbon dioxide emitted into the atmosphere from human activities mainly from burning fossil fuels for energy and other purposes [3]. Forests influence on local temperatures providing cooling effect through transpiration and shading. It is particularly important in cities where trees help counteract the urban heat effects. Due to the capacity to store and recycle water forests help to moderate floods [4,5]. Especially valuable are mixed-species forests for regulation of water supplies and moderating floods than monoculture forests because variation of root length different species help each other through water infiltration levels and erosion control [6,7].

In present world forest ecosystems are in particular need of protection. The felling of trees for timber and firewood remains one of the main threats to biodiversity. Firewood is still the major source of energy in many small towns and villages. Climate change and biodiversity loss are two major environmental threats of the 21st century and it is widely admitted that they are closely interconnected. The changing climate has implications for ecosystems and biodiversity [8,9]. According to the Millennium Ecosystem Assessment climate change is to become one of the most severe drivers of biodiversity loss by the end of the century [10]. The negative impacts of climate change increase the pressure on natural resources, interfere into natural interaction among ecosystems, threaten genetic diversity and favor the appearance of invasive species. Majority of future scenarios indicate on alarming consequences for biodiversity leading to extinction rates that could

be qualified as the sixth mass extinction in the history of the earth [11].

Biodiversity and climate change are both equally important and fundamental questions having essential role for humanity nowadays. They are closely connected and must be reflected in government polices of all countries [12]. Conserving biodiversity can help to mitigate climate change by protecting and enhancing the natural carbon capture and storage capacity of ecosystems. It will also help to adapt to climate change."Ecosystems with high biological diversity are more resilient to climate change and climate variability than impoverished ecosystems "[13].

Forests play significant role in provision of resources for local population particularly timber, firewood for heating homes and secondary materials (brushwood, dry trees) and non-timber resources (wild fruits and berries, mushrooms, nuts, condiments, etc.)[14,15]. High mountain ecosystems are very important for protecting local population from mud-flows, torrents, avalanches, stone-falls, etc. These ecosystems usually located above 2000m.elevation.They include sub-alpine and alpine ecosystems. The main habitats of high mountains are shrubs, tall grass and meadows. High mountain flora in Georgia is very diverse due to location of the Caucasus range on the boarder of Europe and Asia and diverse climatic conditions [16]. Alpine meadows are used mainly for pastures and it results in vegetation deterioration. Consequently it raises erosive processes, landslides and avalanches. High mountain ecosystems in Georgia are located in the protected areas of Tusheti, Lagodekhi, Kazbegi, Borjomi-Kharagauli, Svaneti and Ajara [15].

Arid and semi-arid ecosystems are located in the south-eastern part of Georgia. These ecosystems are characterized by desert and semi-desert vegetation, steppes, arid light woods, rock xerophytes and riparian forests along rivers. Steppes are mainly used for grazing in winter. They are seriously damaged by overgrazing that led to reduction of some species diversity. The arid thin forests have been widely presented in past but now are seen only in the Vashlovani state reserve. Regulation of flow in river Iori and deforestation led to decrease of unique floodplain riparian forests [16,17].

The most acute problems of today's world are loss of biodiversity and climate change. The main causes of these threats are: deforestation, forest degradation, unsustainable forest management. All these causes are of anthropogenic origin and scientists in couple with policy-makers are obliged to solve it. To enhance biodiversity resilience and climate change mitigation it is necessary to follow principles of sustainable forest management, to slow down rates of deforestation and forest degradation, to use renewable energy sauces like wood and crop waste, solar, wind and geothermal energy [18,19].

2.Results and Analisis

Georgia always was considered to be forest abundant country. Historically, in early centuries of the Christian era the whole country was covered by thick forests, but due to constant invasions from neighboring countries and overexploitation of forests in different periods of country's development, especially in 20th century, forests have been greatly degraded [20,21]. Currently, according to the official data, about 38.6% of Georgia's territory is covered by forests. But it is rather doubtful because precise forest inventory was not done since breakup of the Soviet Union and the real picture of current forest cover or changes in forests real condition is not available.

In 1975 the general plan of forestry development of Georgian SSR was worked out that showed alarming facts about the real situation in forest management [22]. Namely, it was revealed that average density of forests reached the critical threshold of 0.55. Moreover forests with density below the critical level (0.5) were more than half (55%) from the total territory covered by forests. High density forests (0.8, 0.9) remained only 6.1%. It is well known that degraded forests have decreased protective functions of soil protection, water storage, water stock regulation, sanitary-hygienic functions, low natural self-renewable ability, etc. These adverse factors had negative influence on forests condition their economical value and ecological state of the whole country.

Georgia is a mountainous country and 98% of its forests are located in mountains, only 2% of forests grow on Kolkheti depression. By vertical allocation 7.3% of forests are located up to 500m, 19.5% from 500 to 1000 m., 35.5% from1000 to 1500m. and 37.7% above 1500m [23]. So, the greater part of forests 73.2% are located above 1000m. Such disposition of forests arise many problems in their exploitation and defense. Forests growing above 1,000 m. have decisive ecological value for the country. They defend mountain soils from erosion, torrents, mud-flows, avalanches, rock-slides. They retain rain-falls and let it to penetrate into deeper parts of soil slowly. They defend highland villages and people from strong winds and storms in winter. At last they defend and maintain biodiversity and ecological stability of mountains.

In tables 1,2,3,4 are presented the data characterizing current condition of forests of Georgia. Especially alarming are data of illegal loggings that increased more than 5 times lately. But in reality illegal loggings are much more and as a rule concealed (Table 4).

Year	Area of Georgia covered by forest *	
	Area, million hectares	Percentage of Forest cover
2000	2,77	39,9
2005	2,77	39,9
2010	2,77	39,9
2015	2,70	38,8
2016	2,69	38,7
2017	2,69	38,7
2018	2,68	38,6

Table -1: Area of Georgia covered by forest

*Including area covered by forest of Abkhazia AR and Tskhinvali region.

Sources: Ministry of Environment Protection and Agriculture of Georgia

LEPL Forestry Agency of Adjara.

LEPL National Forestry Agency.

LEPL Agency of Protected Area.

According to the steepness forests are growing this way: 22% grow on slopes with steepness from 00 to 200; 78% of forests grow on steep 210-350 and very steep (360 and more) slopes. According to the 2000 year data forests density in forest fund of Georgia is: low density forests (0.3-0.4) occupy 17.4% of the whole forest fund of the country, middle density forests (0-5-0.7) are 79.2% and high density forests (0.8-0.9) represent only 3.4% [23]. So, the greater part of forests 96.6% are of low and middle density. According to the rules of loggings in mountains they are prohibited on slopes with more than 350of steepness and lower than 0.5 density due to the threats of soil erosion and other detrimental processes. According to the forest-formative species Georgia's forests consist of coniferous and deciduous forests. Coniferous forests share 16.4%, among them: pine-4.4%, spruce-5.1% and fur-6.9%. Deciduous forests represent 83.6%, among them: beach-42.5%, oak-10.5%, hornbeam-9.9% and chestnut-3.8% [23]. These data are published in 2000 and we are sure the situation worsened. Unfortunately we don't know the present situation for the lack of new precise inventory data for last 20 years.

Region	Forest area	Forest area covered by forest
Georgia, total	3,112.0	2,676.6
Forest area of Abkhazia AR*	369,0	346,0
Forest area under the Forestry Agency of Adjara	150,1	141,8
Forest area under the Agency of Protected Areas**	596,0	312,4
Forest area under the National Forestry Agency***	1,996,9	1,876,4
Guria	86,0	82,6
Imereti	312,4	301,1
Kakheti	288,4	268,2
Mtskheta-Mtianeti	238,0	222,9
Racha-Lechkhumi and Kvemo Svaneti	282,0	268.0
Samegrelo-Zemo Svaneti	272,7	256,4
Samtskhe-Javakheti	133,4	130,1
Kvemo Kartli	146,7	133,5
Shida Kartli	237,3	213,6

Table -2. Forest area of Georgia by regions, 2018 (thousand hectares)

*On January 1, 2003

**Including Autonomous Republic of Abkhazia and Tskhinvali region

***Including Tskhinvali region

Sources: Ministry of Environment Protection and Agriculture of Georgia.

LEPL Forestry Agency of Adjara.

LEPL Agency of Protected Areas

LEPL National Forestry Agency.

The political and economic crisis of 1990's resulted in intensive (mostly illegal) overexploitation of forests and degradation of a substantial part of forest fund. The balance between deforestation rate and forests natural growth capacity was violated. It led to degradation of the major part of forest of the country [15, 18]. All forests of Georgia are under state ownership. So they belong to whole nation and are closely intertwined with environment, economic and social issues. Therefore important decisions related to forests must be taken with participation of wider public involvement, on basis of national consensus. This principle was violated in 2006-2012 when about 70 licenses for long-term commercial use were given to foreign businessmen on 5, 10 and 20 years in most valuable beech forests on about 167 thousand hectare. From 70 licenses 38 still remain which will be expired in 2028. Foreign as well as local independent experts agree that it was the most detrimental decision of our previous government that provoked further degradation of beech forests. The worst thing is that it didn't have big financial effect on country's budget as it was predicted. Today the permission on licenses is stopped but they already did and some of them will do their adverse affect on our beech forests until 2028 when all licenses will be expired. Coming from this situation sustainable management of forests and strict monitoring is necessary to establish in the country to avoid such mistakes. At the same time precise inventory of forests is urgently necessary to know the real condition of remained forests to make up reliable plans for their rehabilitation [19, 24].

Summarizing different parameters of present condition of Georgia's forests we can conclude that they are degraded by overexploitation in different periods of country's development and decisive measures must be taken to restore them. Such measures can be reforestation, afforestation and launching moratorium on principle loggings in beech and chestnut forests. Only nursery and sanitary loggings must be remained in practice to support sanitary condition and formation of forests of future by nursery loggings. First of all the major demand must be stopping of large-scale overexploitation of forests of Georgia [19, 24].

Beside overexploitation the main threats to most of Georgia's ecosystems are overgrazing and damage inflicted by forest pests and fires. The forest fire caused by Russian aggression in 2008 greatly damaged valuable coniferous forests near resort Borjomi. The war condition and difficult terrain of the region (steepness of slopes), along with lack of special overland and air facilities didn't allow fast extinguishment of the fire that resulted in annihilation of valuable coniferous forests. By different estimations approximately 950 to 1,000 hectare of valuable forests have been burned down. Vegetation of the whole ecosystem lost its ecological and economical function. Scientists defined this phenomenon as ecocide. The fire also damaged coniferous forests of Borjomi-Kharagauli national park and other ecosystems [18].

Another problem is the occupied in 2008 war by Russia territories of Abkhazeti and Samachablo. As of the 1st of January 2010, 527,600 hectare of total 2,456,000 hectare of the state forest fund of the country are located in the occupied territories where no inspection can be undertaken. According to unconfirmed reports significant amount of illegal loggings are taking place in most valuable beech forests.

Region	2000	2005	2010	2015	2016	2017	2918
Georgia, total	442,140	810,615	876,749	712,336	628,035	630,462	578,031
Tbilisi	4,741	6,278	-	-	-	-	-
Adjara AR	44,648	73,007	77,868	75,510	65,422	69,034	58,631
Guria	24,463	56,384	16,193	12,269	8,526	13,185	9,268
Imereti	45,270	103,718	97,440	80,775	57,443	53,277	45,483
Kakheti	61,893	119,479	181,706	140,086	121,773	132,o67	97,051
Mtskheta-Mtianeti	36,029	68,938	86,944	74,956	63,545	66,790	52,485
Racha-Lechkhumi and Kvemo Svaneti	52,706	52,713	37,148	60,919	59,145	49,523	50,114
Samegrelo-Zemo Svaneti	55,923	110,376	91,524	29,019	39,538	49,564	54,202
Samtskhe-Javakheti	72,483	123,253	94,374	89,170	79,784	81,956	102,682
Kvemo Kartli	20,757	44,100	89,704	52,496	44,222	42,799	34,343
Shida Kartli	23,227	52,369	103,848	76,661	71,284	58,267	58,257
Protected areas	-	-	-	20,475	17,353	14,001	15,515

Table -3. Volume of logging (cubic meter)

Sources: Ministry of Environment Protection and Agriculture of Georgia

LEPL Forestry Agency of Adjara.

LEPL Agency of Protected Areas.

LEPL National Forestry Agency

Region	2013	2014	2015	20916	2017	2018
Georgia, total	6,039	45,915	44,612	28,586	35,022	32494
Tbilisi	-	-	-	-	-	-
Adjara AR	1,671	1,895	1,880	1,044	1,514	1,250
Guria	225	474	729	647	331	194
Imereti	1,182	9,105	3,087	3,958	4,539	6,947
Kakheti	432	565	18,686	9,568	9,685	5,769
Mtskheta-Mtianeti	102	20,498	1,576	993	447	362
Racha-Lechkhumi and Kvemo Svaneti	268	802	1,993	320	2,032	1,717
Samegrelo-Zemo svaneti	236	2,291	1,766	2,11239	3,928	1,562
Samtskhe-Javakheti	752	1,583	10,648	7,170	9,022	6,253
Kvemo Kartli	229	6,636	1, 783	1,738	1,227	6,015
Shida Kartli	188	1,596	1,581	845	2,975	1,632
Protected areas	756	472	883	185	324	793

Table -4. Illegal logging (cubic meter)

Sources: Ministry of Environment Protection and Agriculture of Georgia

LEPL Forestry Agency of Adjara.

LEPL Agency of Protected Areas.

LEPL National Forestry Agency

Currently, the main products obtained from forestry sector are timber and firewood. In the Soviet period Georgia was getting major part of firewood and other wood materials from Russia, but after break-up of the Soviet Union this source was closed and the whole burden of the problem with appropriate adverse consequences fell on the local forests. Taking into account the degraded condition of our forests and still big demand in firewood in small towns and villages the only decision can be using firewood obtained from sanitary and nursery loggings, that can be about 500,000 cubic meter and to buy firewood in neighboring countries. It is necessary for saving our forests. Other ways of filling the gap are: accelerating of gasification of highland villages; using remains of biological resources of loggings that now are absolutely ignored and don't even estimated (in many countries such resources are used for production of pellets); to use clean and renewable energy sources as: wind, solar and geothermal.

Georgia is noted by biodiversity and considered as one of the 34 biodiversity "hotspots" by Conservation International [6] as an area distinguished for richness of species and complex of landscapes, variation of climate and ecosystems. There are: forests, wetlands, marine and coastal habitats, high mountain ecosystems. About 4,130 vascular plant species grow in Georgia among them 300 vascular species on plant are endemics of Georgia and 600 more of the Caucasus regional endemics. The central and eastern parts of Caucasus mountain range are particularly rich by endemics. Besides vascular plants there are 812 species of mosses, over 800 lichens and about 7,000 fungi found in Georgia. In inland waters there are over 2,600 algae [6,8]. Currently in Georgia's Red List there are 123 fauna species and 56 vascular plant species [26].

Some ecosystems of Georgia have global environmental value. For example, there are 31 sites of special importance for bird species, 17 sites of special interest for biodiversity, which are included in the Emerald Network [27]. Since 06.12.2019 Georgia officially Adopted Emerald cites of their terrirories. The wetland forests of central Kolkheti Lowland located at the Black Sea coastal line, as well as unique peat bogs and alder forests are included in the Ramsar List of Wetlands of international importance [28].

The main threats to biodiversity of Georgia today are: Degradation of forests; loss of habitats and unsustainable use of biological resources. As a result many species of flora and fauna became endangered. Poaching and illegal fishing are the main causes of decreasing of large mammals population. Only special conservation measures can save their status. For protection and sustainable use of species the fallowing measures are necessary to implement: in-situ protection of species, through expansion of the protected areas, as well as outside of them by conservation of migration routes and the habitats distinguished by biodiversity. The best way to protect species is to protect their habitats; facilitation of ex-situ measures, for example establishment of gene pool resources; elaboration of unified methodology of biodiversity monitoring within and without the protected areas including the territories of economic forestry fund.

Climate change is the most acute problem of the world today. Georgia is also have its adverse impacts lately in form of more frequent extreme natural occurrences and changed climatic parameters. The most sensitive regions of climate change are: high mountains, sea cost and semi-deserts in east part of Georgia. We wait for decisive measures from the government to reduce the main causes of climate change namely: to reduce transport emissions and to stop forests overexploitation. Motor transport is remain the main source of air pollution, especially in towns. For reduction of emissions from the transport the

following measures must be taken: restriction of motor fuel quality and vehicle emission standards, diminution of age limits for cars, traffic optimization in cities and facilitation of electric transport.

By altitudinal spectrum, climate change if affecting high mountain ecosystems too. Glacial retreat that is already observed in The Andes, the Alps and the Caucasus is occurring at an alarming rate lately. At lower mountain altitudes changes are observed in form of loss of water regulation and changes in ecosystem composition and resilience. Late scientific researches show that climate change will be more pronounced in high-elevation mountain ranges which are warming faster than adjacent lowlands. Hydrological and ecological changes of this magnitude would result in a loss of unique biodiversity, as well as loss of many of the environmental goods and services provided by these mountains, especially water supply, basin regulation and associated hydrological potential.

In recent years the intensity and frequency of extreme adverse events driven by global warming arose. Frequency of draughts and strong winds in spring increased in semi-arid regions. Climate related problems in Georgia are of great concern in those areas that are most vulnerable to it: coastal areas, mountain areas and semi-arid areas. Coastal erosion and abrasion processes have intensified in the Black Sea zone. In addition satellite images show that the average speed of glacial withdrawal on the Great Caucasus mountain range is 8m.per year and that their total surface decreased by 6-9%. The glaciers of the Caucasus when withdrawing are leaving behind huge masses of stones, pieces of rock and mud that can transfer into mud-streams during intense rains endangering the safety of local population.

More attention must be paid to the problem of invasive species. New research is required to better understand the influence of the invasive species on the local once. Preventative measures such as improved border control must be established in addition to existed control measures (mechanical, chemical, biological) to restrict the expansion of invasive species and to minimize their impact.

3.Conclusions

Due to lack of modern and effective tools for data collection, storage and analysis, identification of actual changes of different forest parameters in last periods characterizing present condition of forests of Georgia is difficult. It makes the assessment and definition of future trends of development difficult. One conclusion can be made definitely that most part forests of Georgia are degraded and decisive measures must be taken for their rehabilitation. Such measures can be reforestation, aforestation, facilitation to natural regeneration of forests. Presently forests of Georgia are managed unsustainably. We need new decisions and political will to improve the situation unless it is too late. Modern and effective mechanisms for data collection, processing and analysis are necessary for defining the changes in species and habitat status. Biodiversity of the country greatly depend on sustainable management of forests of Georgia. Sustainably managed forests are the guarantee of biodiversity. Unfortunately today there is not enough information and clear basis for effective decision-making in field of biodiversity conservation. In spite of the comparatively small territory of Georgia it still have enough forests, other green ecosystems and rich biodiversity and con have positive influence on processes of climate change and it must be saved for the whole planet.

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