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Causes and Drivers of Deforestation and Forest Degradation in Georgia

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Abstract

Forests still cover about 30% of the world's land. According to the United Nations Food and Agriculture Organization (FAO), the annual rate of deforestation is about 13 million hectares annually, with most losses in the tropics. Scientists call it the present day,,plague". This process didn't bypass Georgia too. Our research aimed to assess the historical and present-day causes and drivers of forest degradation and deforestation according to their damage. Our research showed that historically the main human causes and drivers have been human induced fires and loggings in early and middle centuries by foreign invaders, over-exploitation at the beginning of 20th century, after World War II, deforestation for agricultural use in the first years of the Soviet period. From present causes and drivers should be mentioned insect pests and diseases, natural and human induced fires, illegal loggings, overexploitation, projects of gigantic hydro-power electric stations, infrastructure projects and road development. In conclusions the recommendations are given to mitigate the human causes of forest degradation and deforestation.

Keywords: Dam; Deforestation; Degradation; Fire; Hydropower project; Overexploitation; Infrastructure

Introduction

H Human society and global economy are closely linked to forests. More than one billion people depend on forests for their livelihood. Forest ecosystems play critical role in stabilizing the climate, providing food, water, wood products and vital medicines, supporting the world's biodiversity [1, 2]. Despite decreased deforestation rates in last periods, in some regions of the world forest ecosystems are still under great threat. According to the World Resources Institute(WRI) research, 30% of the global forest cover has been cleared, while another 20% has been degraded. Most of the rest has been fragmented leaving only 15% intact [3].

Deforestation generally refers to destruction and conversion of forest land to other land uses, usually considered more profitable for that region. Forest degradation is used to mean the destruction of specific aspects of forests such as decrease in tree cover (stand density), changes in their structure(canopy density) and loss of biodiversity[4-6]. 96% of global deforestation and forest degradation takes place in developing countries of the tropical and subtropical regions where 70% of the world's species are found [6,7]. In Europe, intensive deforestation has occurred at different times in history. Today this process decreased and restricted to only a few regions. Reforestation trend is actually occurring in many EN member states as a direct result of tree planting and the natural tree growth. Forest degradation usually takes place as a result of frequent human-induced fires in the Mediterranean region, excessive grazing and poor forest management [1].

Forest loss and degradation affect forest-dependent communities, wild species and global climate. Deforestation and forest degradation have negative impact on environment and drives the climate change [8, 9]. To limit this process and preserve biodiversity, it is essential to reduce the rate of deforestation and forest degradation, increase the amount of carbon stored in forests and improve forest sustainable management worldwide. [10]

Results and Analysis

DDeforestation is usually occurring as a result of direct or indirect natural, economic, institutional or social factors. Their importance and damage varies among continents and regions and change in time. The main direct causes and drivers of deforestation are: changing of land use for agriculture, when farmers cut forests to provide more space for planting crops. It is also called, ,,slash and burn" agriculture; overexploitation of forests, when more and more remote forests are logged; infrastructure development; construction of big dams for hydropower electric stations; natural and human induced fires; urbanization; mining; insect pests and diseases [3-11].

The indirect causes include: institutional and governance weakness; weak law enforcement; incentives to convert forest land to other use; insufficient human resources to monitor forests. Deforestation and forest degradation can be contributed by illegal loggings and unsustainable forest management. In our research we aimed to determine historical and present day natural and human causes and drivers of deforestation and forest degradation in Georgia.

Human Induced Fires and Loggings

According to the historical documents [12,13], in early centuries the most part of Georgia's territory was covered by thick forests, but during the frequent invasions of Persians, Mongols, Seljuk and other foreign invaders, the considerable part of them have been destroyed. Historians confirm that invaders have been armed with axes and had special instructions to cut down and burn all forests around towns and villages, as they had strategic importance for natives [12, 13].

We don't have information about legal amount of loggings that time, or natural fires, as well as about middle centuries, until the end of the 19th century when early stage of capitalism development began in Georgia. In that period, including the first years of the 20th century, demand on wood increased and many valuable forests have been destroyed in Abkhazia, Samtskhe-Javakheti, Kartli, around Tbilisi and other regions of the country to satisfy this demand.

The process of deforestation was confirmed by well-known Russian scientists D.I. Sosnovsky [14] and V.I. Kuznetsov [15,16], who worked that time in Georgia. They noted in their works that the deforestation in different regions of Georgia caused climate and soil deterioration in east and west parts of the country and facilitated creation of desert-like associations. In 1917 the forest fund of Georgia decreased on 654.113 hectares compared to 1885. In 1917-1922, when fuel oil export from Baku canceled, it was compensated by firewood and the considering part of forests have been destroyed again [17,18].

The next phase of forest degradation and deforestation began in first years of the Soviet period, when great amount of forests have been logged for agricultural use. The most part of deforestation took place on rather steep slopes and after several years have been eroded and washed down, especially on south exposure slopes.

After World War II Georgia's economy needed great amount of wood materials, so the overexploitation of forests continued. It 4-5 times exceeded the annual loggings of 1980s.

In 1970-1975 was worked out the General Scheme of forestry development and forest raw materials of Georgian SSR on 1976-1990 [19]. The research revealed very alarming facts, namely: 55% of forests of Georgia were of 0.5 density and lower; the stands of high density 0.8 and higher were only 6.1%. It must be noted that according to the logging rules in mountain forests of Georgia, selecting loggings are permitted only in forests stands of high density [20].

In 1951 forest stands with 0.3-0.4 density were 18.8% from all forests. In 1973 it increased to 21.5%. The stands of 0.5 density in 1951 were 29.9% and it increased in 1973 to 39.9%. The average density of forests decreased accordingly from 0.61 in 1951 to 0.54 in 1973 (Table 1).

Inventory Year	Density								Middle Density	Forest covered Area, thousand hectare
	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1		
1951	124.1	264.7	618.4	564.6	260.6	173.7	62.1	-	0.61	2068.2
%	6	12.8	29.9	27.3	12.6	8.4	3	-	-	100
1956	120.2	292	548.6	532.8	232	147.9	41.4	-	0.56	1911.9
%	6.3	15.2	28.6	27.9	12.1	7.8	2.1	-	-	100
1961	126	329	598	533	239.6	140	41	-	0.54	2006.6
%	6.3	16.4	29.8	26.5	11.6	7.4	2	-	-	100
1966	115.7	318.6	658.4	571.2	296.5	95	21.7	-	0.55	2077.1
%	5.7	15.3	31.6	27.5	14.3	4.6	1	-	-	100
1973	101.6	336.3	691.7	555.8	259.5	76.7	15.5	1	0.54	2038.1
%	5	16.5	33.9	27.3	12.7	3.8	0.8	-	-	100
Source: K.Targamadze, V.Chikhradze. 1976. Forest Resources of Georgian SSR. Tbilisi [17,18].										

Table 1: Distribution of Forest Fund of Georgia According to the Stand Density in 1951-1973 (thousand hectare).

Yield class and merchantability of forests also deteriorated (Table 2). For example: if in 1951forests of high density(I, 0.9, 0.8) were 13.5%, in1973 it decreased to 6.4%. Also decreased the forest stands with II yield class. Forests with IVyield class increased from 16.4 to 23.7% and forests of V yield class from 5.5 to 10.5%. The average yield class also decreased from II.8 in 1951 to III.2% in 1973.

On forest degradation indicates also the fact, that the amount of valuable species decreased in forest fund of Georgia and less valuable spices increased. For example, the area and volume of spruce forests decreased from200.2 thousand hectares and 91.9 million m^3 in 1951 to 178.6 thousand hectares and 71.3 million m^3 in 1973. In the same period beech forests also decreased on 43.8 thousand hectares by the area and 12.7 million m^3 by the stand volume.

Inventory	**Yield Class**						**Forest**
year	I	II	III	IV	V	V^A	coverage
1951	279.1	420	916.2	345.4	107.5	-	2068.2
%	13.5	20.3	44.3	16.4	5.5	-	100
1956	267.8	376.3	827.9	334.7	105.2	-	1911.9
%	14	19.7	43.3	17.5	5.5	-	100
1961	182	481	862	341	140.6	-	2006.6
%	9	24	43	17	7	-	100
1966	144	391.2	903.1	452.9	185.9	-	2077.1
%	6.9	18.8	43.5	21.8	9	-	100
1973	130	346.4	855.4	484.8	214	7.2	2038.1
%	6.4	17	42	23.7	10.5	0.4	100
Source: K. Targamadze, V. Chikhradze.1976. Forest Resources of Georgian SSR. Tbilisi [17-18].							

Table 2: Distribution of Forest Fund of Georgia According to the Yield Class in1951-1973(thousand hectare).

Illegal Loggings

Illegal loggings always had considerable share in process of forest degradation and deforestation. But we don't have information about illegal loggings until 2000 (Table 3). The reason is that officials, responsible for information always conceal it. According to unofficial sauces after breakup of the Soviet Union in period of transmitting of the country from command to market economy, annually illegally was logging and taken from the country about 4-5 million m^3 valuable round wood, mostly coniferous and beach. The forest coverage of the country in last two decades decreased on 1.1 %, instead of increasing as in the Soviet period (Table 4).

Year	2001	2005	2010	2011	2012	2013	2014	2015	2016
Georgia Total	**43287**	**62764**	**32948**	**7060**	**6104**	**5283**	**45915**	**44612**	**28586**
Sources: 2001-2004 Ministry of environment protection of Georgia; 2005 Statistics national office of Georgia; 2010-2011 Ministry on energy and natural resources of Georgia; 2012-2017 Ministry of Environment and Natural Resources Protection of Georgia; National Forestry Agency; Forestry Agency of Ajara; Agency of Protected Areas.									

Table 3: Illegal loggings in Georgia in 2001-2017 (m^3) [21].

Year	Area, million hectares	Percentage share in the country's territory
1985	2.77	39.7
1995	2.75	39.6
2000	2.77	39,7
2002	2.77	39.9
2003	2.77	39.9
2004	2.77	39.9
2005	2.77	39,7
2006	2.77	39.9
2007	2.77	39.9
2008	2.77	39.9
2009	2.77	39.9
2010	2.77	39.7
2011	2.77	39.9
2012	2.82	40.5
2015	2.71	38.9
2016	2.69	38.6

Sources: 1985-2004 Ministry of environment protection of Georgia; 2005-2006 Statistics national office of Georgia; 2007-2011 Ministry of energy and natural resources of Georgia; 2012-2017 Ministry of environment and natural resources of Georgia; National forestry agency; Forestry agency of Ajara; Agency of protected areas.
*With occupied territories of Abkhazeti A.R. and Tskhinvali region.

Table 4: Area of Georgia Covered by Forests* [21].

Gigantic Hydroelectric Projects

As country's energy demand increase our government began looking to hydropower as potentially large and easy way of energy and revenue generation. The construction of more than 50 hydroelectric power stations have been announced to be built in near future in most beautiful and tourist-attracted regions of the country Svaneti and Racha which are famous by their biodiversity. Along with such valuable species as spruce, fir, pine, beach, chestnut and others, there grow many relict and endemic trees and bushes [22-25].

In Upper Svaneti two hydroelectric projects are planned: the first is Khudoni HPP, with 200-meter height dam (total capacity of 700 mw). It will flood 530-hectare territory of forests, agricultural land and villages, including Khaishi. The total projected area is 1538 hectares. The reservoir of 3.5 million cubic m will be created. More than 525 families will be displaced. Presently there live about 14591 people in Mestia municipality. Resettlement of about 2000 people will have devastating impact on Svans living in the region. Besides it will have adverse effect on local natural habitats (including water fauna), loss of biodiversity of sub-alpine and alpine forests and meadows, as well as wildlife fauna, that may occur irreversible. Another adverse effect is the loss of local cultural heritage, such as medieval historical monuments, churches, castles and graveyards [26].

Khudoni HPP site is located in Upper Svanetri that has been a UNESCO World Heritage Site area since 1996 due to the exceptional examples of mountain scenery with medieval-type villages and tower-houses preserved by its long isolation. The Svans, an ethnographic group of Georgian people, have their own language and traditions, which are still a part of everyday life. The environmental and social impact assessment of Khudoni HPP project does not include a detailed description of the cultural heritage sites, their precise location and stakeholder responses [27].

Another big project in Svaneti region is Nenskra HPP that will be built above Khudoni HPP. It's installed capacity will be 300 mw. Hydropower plant dam of 140-meter height and reservoir with storage capacity of 200 million m^3 will be created. The project will have significant adverse impact on Nanskra and Nakra Valleys, as well as on ecosystems. 400 hectares of virgin forests will be cleared up. Melting of glaciers will be activated in the areas directly affected by the project(due to 2.3 C^o rise of annual average temperature within 5 km. radius). The project also involves disposal of 330 thousand m^3 of waste rock at the valley adjacent to the project site and clearance of valley's slopes of vegetation [28,29]. The additional reason for cancelling such projects are very heavy rains that usually take place in these mountains with subsequent floods, mud-currents end landslides. It was just confirmed by heavy rains on July 5-6 2018, when Nenskra and Nakra rivers flooded so dangerously that 6 bridges, many village houses and roads have been destroyed.

On March 5 2018 representatives of all 17 communities of Upper Svaneti gathered in Mestia for a traditional Svan council meeting - Lalkhor to oppose the development of gold mining and hydropower projects in Svaneti that threatens local livelihoods, ecosystems and cultural heritage. The protesters restated their demands-discontinuation of over 50 dam projects, including the Nenskra hydropower plant, Nenskra dam and the Mestiachala hydropower plant.

The Lalkhor came up with the joint statement and developed a petition addressing the Georgian government, diplomatic missions accredited in Georgia and international financial institutions. The Lalkhor demands to recognize Svans as ancient, indigenous people with appropriate rights for customary and community property in Svaneti and to ban development of any infrastructure projects

without their prior consent [30].

For another site of hydropower energy boom in Georgia is chosen Racha which is also famous by resorts, recreational and touristic facilities and natural biodiversity. It is a cascade type hydroelectric power station Tvishi-Namakhvari, which will include two HPP. About 630 hectares will be flooded including the center of the region Oni and six other villages, as well as valuable forests and agricultural lands. It must be underlined that Central Georgia and especially Racha is an area strongly affected by earthquakes and landslide hazards.For example, on April 29, 1991 a major earthquake of M_w=7.0 struck Racha region that followed by aftershocks and significant after slips. It exceeded Spitak (Armenia) earthquake on December 7,1988 (M_w=6.8). According to different sauces about 2,000 people were killed. More than 100,000 inhabitants were left homeless. More than 46,000 houses were damaged or destroyed thoroughly [31,32].

Many important historical monuments were badly damaged, particularly the Archangel Church near Upper Krikhi and the Mravadzali Church, which were completely destroyed. The debris avalanche, that had an estimated volume of over $30x10^6$ m^3, swept down a valley through Kholkheti, blocking the Gebura Riva, forming a 100m. height dam that breached soon afterwards, causing more destruction. Many scientists agree that it was the most powerful earthquake recorded in the Caucasus region ever. On September 7, 2009 another strong earthquake (M_w=6.0) took place in Racha. Fortunately, there were no reports about human losses. However, the tremors damaged at least 200 buildings, with some roads blocked by rock falls and subsequent damage to service lines [33-36].

Among other announced hydroelectric projects are: Dariali, Shilda, Larsi, Khudoni- 2, Kazbegi and other projects. Local population of Svaneti and Racha, NGOs and ecologists with better part of the society protest against this hydro energetic boom in the country and demand to stop this aggression against nature. They advise the government to think about alternative sauces of energy generation instead.

Generally, the hydro power generation is considered as less polluting sauce than the more common fossil fuel-based forms of energy generation [37,38]. However, hydro power projects often have a whole range of beneficial, as well as detrimental impacts on communities near the project sites. Positive socioeconomic benefits can include provision of employment, welfare and market accessibility. Detrimental Impacts include: flooding land for a hydro power reservoir which has an extreme environmental impact on forests, destroying them, wildlife habitat, agriculture lands and scenic landscapes. It has adverse impact on aquatic ecosystems too. In spite of various methods for minimizing this impact (fish ladders, in-take screens), fish and other organisms can be injured and killed by turbine blades. Besides, reservoir water is usually more stagnant than normal river water. As a result, the reservoir will have higher than normal amounts of sediments and nutrient, which can cultivate an excess of algae and other aquatic weeds. These weeds can crowd out other river animals and plant life and they can be controlled only by manual harvesting, or by introducing fish that eat these plants. In addition, water is lost through evaporation in dammed reservoirs at a much higher rate than in flowing rivers.

These changes also threaten the livelihoods of millions of river dependent communities that rely on a natural flow regime for subsistence through fishery or agricultural activities. Deforestation reduces in surrounding areas the evapotranspiration capacity of forests, which in turn reduces the amount of water that is cycled as rainfall [39,40].

Adverse climate changes today and in future can threaten the energy security of Georgia. In this context heavy reliance on hydropower generation as warn The World Bank [41], is not sustainable for the country. The energy sector strategy needs to diversify energy generation with renewable energy souses. Excessive dependence on hydropower is associated with possible hydrological risks and population displacement, risks for cultural heritage sites. The transformation of landscapes through hydropower projects, continued in the World Bank report [41], can affect the delivery of important ecological services and undermine nature based touristic prospects. In short, concludes the World Bank, there is a need for a more systematic assessment of environmental and social impacts. [41]. We hope that after such negative diagnosis of the World Bank and protests of society our government change mind on gigantic hydropower projects.

Natural and Human Induced Fires

Fires create ecological, social and economic problems that occur in local and country scale [42,43]. Beside immediate impacts there are many follow-ups that unfold their full effects in medium and long-term periods. In forests that are not adapted to fire (Mediterranean forests) the result can be long-term or permanent change of vegetation. Moreover, the whole forests can be lost or replaced by other, less valuable species, that often takes place. Forest biodiversity is endangered or thoroughly lost as an immediate impact of forest fire.

Apart from effect on forest vegetation, fire can have significant impact on habitat, feeding ground and roaming areas of wildlife [44-45]. The direct effect of fire on forest fauna is death. Indirect effects include loss of habitat, shelter and food. The displacement of local fauna species can upset the local balance and result in loss of wildlife as displaced animals and other fauna individuals often have nowhere to go [46-49].

Forest fires are one of the major causes of deforestation and forest degradation. Besides, burning down trees and other

vegetation they reduce the quality of certain forest features like soil fertility and biodiversity of ecosystems. Strong and long-termed fires often burn down the whole ecosystems. Wildfires kill beneficial soil microorganisms that are responsible and promote soil microbial activities. Burning of trees and vegetation cover leaves the soil bare making it vulnerable to soil erosion. Many scientists from different countries agree that about 90% of forest fires are of human origin directly or indirectly, deliberately or due to carelessness [42,43].

Beside negative biological impacts on deforestation and forest degradation fires have considerable economic loss. According to the U.S. fire service, more than 700 wildfires occur every year, burning down approximately 7 million acres of land and destroying more than 26,000 structures. The U.S. spends over 5 billion dollars to fight fires each year [42,43].

In nearest past in Georgia forest fires didn't have such devastating damage as in Australia, Indonesia, Russia or the U.S., but for a small country like Georgia, even small or moderate fires can have considerable adverse impact on environment, biodiversity and economy.

Year	1995	2000	2005	2007	2008*	2009	2010	2012	2015	2017
Number of event	1	34	16	1	32	15	6	11	72	42
Burned are, ha	7	85	26	0.3	126	718	370	199	205	184

Sources: 1995-2004 Ministry of environment protection of Georgia; 2005-2006 Statistics national office of Georgia; 2007-2011 Ministry of energy and natural resources of Georgia; 2012-2017 Ministry of environment and natural resources protection of Georgia; National forestry agency; Forestry agency of Ajara; Agency of protected areas.
*Without Borjomi fire in 2008.

Table 5: Forest fires in Georgia in 1995-2017 [21].

In (Table 5)is given the official information about forest fires in 1995-2017.According to this table the situation isn't so alarming but in reality the picture is different. In August 2008 during Russia-Georgia war, Russia bombed forests near well-known resort Borjomi and the fire continued for several days and was put out by friendly help of Turkey and Ukraine who sent their helicopters. According to unofficial sauces about 1000 hectare of coniferous forests was burnt. The fire was so strong that even soil was burnt thoroughly. The scientists called it ecocid. In August 2017 fire burned about 1000 hectare of coniferous forests near village Daba (Borjomi gorge). The fire continued 7-8 days and was extinguished by help of Azerbaijan and Belorussia. In the same August there were about 25 fire events mostly in east part of the country, among them in Tbilisi 50 hectare, Tsagveri 300 hectare, Tusheti 210 hectare and in other places. Until now we don't have official information about real burnt areas in 2017. If our country had special helicopters and well-trained fire brigades for extinguishing forest fires the damage would have been lesser. Unfortunately, many valuable forests (mostly coniferous) have been burnt. The ecological and economical damage wasn't estimated until now. It will need hundreds of thousand dollars to reforest these burned areas.

Forest Insect Pests

Forest insect pests and diseases are also the significant disturbance agents. Biological invasions are among the most serious environmental problems facing our forests. The process of globalization has broken down barriers to movement, resulting in exchange of species among countries and continents. While some invasions are inconsequential, others are ultimately damageable and profoundly alter invaded environments, greatly effecting local ecosystem processes. Unfortunately, biological invasions of nonnative species are a by-product of the present day economic activities [50].

The official information about significant damage caused by insect pests and diseases in Georgia is in coniferous forests in Borjomi gorge at the end of 19th century. [51] But the greatest destruction of our coniferous forests in the same Borjomi gorge began in 1956 when by irresponsible behavior of customs officials un-barked round wood was imported in the country and with them - great spruce bark beetle (*Dendroctonus micans Kug.*). It quickly spread in all the regions of west and central parts of Georgia where spruce grows. In 1963 the epidemic was fixed on 120,000 hectares. Only in Borjomi gorge 12,700 trees of spruce have been logged. The epidemic continued next several decades and according to some sauces 200,000 hectare of spruce forests were destroyed. [52] The consequences of the epidemic are observed even today. All spruce forests that have been infected by *Dendroctonus micans* are degraded on different degree.

From other diseases and insect pests that degrade our forests are: pathogenic fungus chestnut blight *Endothia parasitica*

and Dutch elm disease that are destroying chestnut and elm trees for several decades; fungal pathogen of Colchis box tree- *Cylindocladium buxicola* that appeared in 2009 and parasitic insect pest *Cydalima perspectalis* in 2012. Both defoliated and degraded Colchis box trees in Georgia, especially in western part (Ajara and Samegrelo).

Another problem is black pine tree *Pinus nigra* that was widely cultivated in Georgia. From 1960s they have been infected by Zimmerman pine moth- *Dioryctria Zimmermani*. Today about half of all trees growing in Tbilisi and its suburbs are dry, others are infected by different degrees and remain cause of further spreading of the infection. The only way is to log them [53].

Significant economic, ecological and social impacts on forests by insect pests and diseases can be reduced and managed only within tolerable limits [54]. Standards on the processing of trade products before crossing international boundaries can be the most effective for reducing their adverse impacts. Organizations responsible for introducing or spreading invasive plants and other products should impose extra tariffs on products suspected in unacceptable risks on native forest ecosystems. We must refrain from introduction of big plants with clods. Entomological and phytopathologic control on customs must be restricted.

Other Causes and Drivers of Deforestation and Forest Degradation

From other causes and drivers of deforestation and forest degradation are: Infrastructure projects (roads, pipelines); enlargement of town borders (especially of the capital of the country); mining (open-cast mines of coal and gold); climate change and unsustainable forest management.

Conclusions

Our research of causes and drivers of deforestation and forest degradation in Georgia showed that historically, in early and middle centuries, up to the 18th century constant foreign invasions must be considered as the most destructive. We don't have information about the following periods up to the 20th century, when at the early stage of capitalism development in Georgia great amount of forests have been logged and destroyed by foreign and local businessmen who had forests on concession. Overexploitation of forests took place also after WWII up to 1960s. Presently the major causes and drivers of deforestation and forest degradation are: overexploitation, forest fires (mostly human induced), insect pests and diseases, projects of gigantic hydropower stations, illegal loggings, infrastructure projects and road development, mining and enlargement of towns. The only way to prevent our forests from further degradation and deforestation is the introduction and maintenance of principles of sustainable forest management on independent certification.

References

1. Brussels (2008) Questions and answers on deforestation and forest degradation. European Commission- Press Release Database Brussels 2008.
2. Bradford A (2018) Deforestation Facts, Information and Effects. National Geographic 2018.
3. Chakravarty S, Ghosh SK, Suresh CP, Dey AN, Shukla G (2012) Global Perspectives on Sustainable Forest Management. Chapter 1. Deforestation: Causes, effects and Control Strategies27.
4. Lanly JP (2003) Deforestation and Forest Degradation Factors. Proceedings of the XII World Forestry Congress. Quebec. Canada8.
5. Addressing Drivers of Deforestation and Forest Degradation.
6. Bradshaw CJA (2012) Little left to lose: deforestation and forest degradation in Australia since European Colonization. Journal of Plant Ecology 5: 109-120.
7. Angelson A (1999) Agricultural expansion and deforestation: modeling the impact of population, market forces and property rights. Journal of development Economics 58: 185-218.
8. Angelson A, Kaimowitz D (2001) Agricultural Technologies and Tropical Deforestation, CABI Publishing, Wallingford, United Kingdom436.
9. Myers N (1994) Tropical Deforestation: rates and patterns in: The causes of tropical deforestation. The economic and statistical analysis of factors giving rise of the loss of the tropical forests. UCL Press Pg No: 27-40.
10. Rowe R, Sharma NP, Bonder J (1992) Deforestation: problems, causes and concern. In: Managing change the world's forest: looking for balance between conservation and development. Kendall/Hunt Publishing Company, Iowa33-46.
11. Kissinger G, Herold M, De Sy V (2012) Drivers of Deforestation and Forest Degradation. A synthesis for REDD+ Policymakers. Vancouver, Canada48.
12. Bagrationi V (1997) Geography of Georgia. Tbilisi 1997.
13. Bagrationi V (1997) Atlas of Georgia (18th Century). Institute of geography. Academy of Sciences of Georgia. Tbilisi 1997.
14. Sosnowski DI (1915) The Process of Disappearing Forests in Tbilisi Suburbs. Caucasus Department of Geographical Society. I-XXIII, N1. (in Russian) 1915.
15. Kuznetsov DI (1902) About Botaniko-Geographical Researches of Caucasus. Imperial Russian Geographical Society 38: 206-227(in Russian) 1902.
16. Kuznetsov DI (1909) The Principle of Caucasus Division on Botaniko-Geographical Provinces. S.P.B. (In Russian) 1909.
17. The Rules of Principle and Regenerating Fellings in Forests of Georgian SSR. Tbilisi. 1980.

18. The General Scheme of Development of Forestry and Forest Raw Materials of Georgian SSR on 1976-1990. (unpublished paper) Tbilisi. 1975.

19. Targamadze K (1973) Forest Fund of Georgia. Tbilisi 68.

20. Targamadze K, Chikhradze V (1976) Forest Resources of Georgian SSR. Tbilisi 104.

21. Kverghelidze N (2013) Natural Resources of Georgia and Environment Protection. Statistical Publication. Geostat. Tbilisi. (in Georgian) 2013.

22. Gigauri G (2000) Biodiversity of Forests of Georgia. Raritet, Tbilisi160 (in Georgian) 2000.

23. Gulisashvili V (1975) General Forestry. Ganatleba. Tbilisi 183 (in Georgian) 1975.

24. Gulisashvili V (1983) Forests and Wood Species of Subtropics. Metsniereba. Tbilisi93 (in Russian) 1983.

25. Abashidze I (1985) Dendrology. Ganatleba. Tbilisi 319 (in Georgian) 1985.

26. Khudoni Hydropower Plant Construction.greenalt.org.

27. Cagara DK (2016) Svan council convenes to stop hydropower plants. Democracy & Freedom Watch 2016.

28. Comments on the Nenskra HPP project revised supplementary. E&S Studies 2017.

29. Green Alternative's Statement on the Construction of Nenskra hydropower plant 2012.

30. From residents of Chubbier community (2018) Upper Svaneti, Georgia. Statement to International Financial Institutions 2018.

31. Vakarchuk RN, Tatevossian RE, Aptekman Zh Y, Bykova VV (2013) The 1991 Racha Earthquake, Caucasus: Multiple source model with compensative type of motion. Izvestya, Physics of the Solid Eath. 49: 653-669.

32. 1991 Racha earthquake.

33. Nikolaeva E, Walter TR (2016) InSAR observations of the 2009 Racha earthquake, Georgia. National Hazards and Earth System Science16: 2137-2144.

34. Nikolaeva E, Walter TR (2016) InSAR observations of the 2009 Racha earthquake, the Republic Georgia 2016.

35. Nikolaeva E, Walter TR (2016) Interactive comment on InSAR observations of the 2009 Racha earthquake, the Republic Georgia. Natural hazards and Earth System Science 3.

36. Yibson RW, Prentice CS, Borisoff BA, Rogozhin EA, Langer CJ (1994) Some observations of landslides triggered by the 29 April 1991 Racha earthquake, Republic of Georgia. Bulletin of the Seismological Society of America 4: 963-973.

37. Ledec G, Quintero JD (2003) Good Dams and Bad Dams: Environmental Criteria for Site Selection of Hydroelectric Projects. Latin America andCaribbean Region Sustainable Development working paper series: no.16, World Bank, Washington, DC 2003.

38. Goodvin P, Meier CI, Jorde K, Parra O (2006) Minimizing environmental impacts of hydropower development: Transferring lessons from past projects to a proposed strategy for Chile. Journal of Hydro informatics 08: 253-270.

39. (2000) Hydropower and the Environment: Survey of the environmental and social impacts and the effectiveness of mitigation measures in hydropower development. IEA Technical Report 1: 92.

40. Zelenkova M, Fijko R, Diaconu DC, Remanakova I (2018) Environmental Impact of Small Hydropower Plant-A Case Study. Environments 5: 10.

41. Georgia from Reformer to Performer (2018) A Systematic Country Diagnostic. World Bank Group 105.

42. Hirschberger P (2017) Causes and effects of global forest fires. WWF Deutschland 107.

43. Dennis R, Meijaard E, Applegate G, Nasi R (2001) Impacts of human-caused fires on biodiversity and ecosystem functioning and their causes in tropical, temperate and boreal forest biomes. UNEP CND Technical Series N5 38.

44. De Faria BL, Branda PM, Macedo MN, Panday PK, Soares-Filho BS, et al. (2017) Current and future patterns of fire induced forest degradation in Amazonia. Environment Research Letters 12: 21.

45. Siscawati M (1997) Underlying causes of deforestation and forest degradation in Indonesia: A Case Study on Forest Fire. IGES International workshop 57.

46. Harrison ME, Page SE, Lewin SH (2009) The global impact of Indonesian forest fires. Biologist, 56: 156-163.

47. Juarez-Orozco SM, Siebe C, Fernandez DFY (2017) Tropical Rainforests: A Bibliometric Approach. Tropical Conservation Science 10: 14.

48. Causes and Effects of Wildfires.

49. Lierop P, Lindquist E, Sathyapala S, Franceschini G (2015) Global forest area disturbance from fire, insect pests, diseases and severe weather events. Forest Ecology and Management 352: 78-88.

50. Aukema JE, Leung B, Kovacs K, Chivers C, Britto KO, et.al. (2011) Economic Impacts on Non-Native Forest Insects in the Continental United States 2011.

51. Kanchaveli G, Supatashvili SH (1968) Forest Entomology. Tbilisi 373.

52. www.zoofirma.ru/nasecomye.dendroctonus-micans

53. Coulson RN, Saarenmaa H (2011) Integrated Pest Management of the Southern Pine Beetle 16.

54. Holmes TP, Aukema JE, Von Holle B, Liebhold A, Sills E (2009) Economic Impacts of Invasive Species in Forests. The year in Ecology and Conservation Biology 1162: 21.