A Seminar Paper

On

Drivers, Impacts and Mitigation of Global Forest Loss

Course Title: Seminar

Course Code: AFE 598

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Drivers, Impacts and Mitigation of Global Forest Loss[1]

By

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ABSTRACT

Global forest loss is a significant environmental issue with numerous drivers and impacts. The drivers of global forest loss can be classified into two main categories: natural and human. The major drivers of global forest loss are commodity-driven deforestation, shifting agriculture, forestry, wildfire, urbanization which shares the forest loss sequentially 25%, 21%, 31%, 22%, 1%. The resulting deforestation has a significant impact on biodiversity, climate, and local communities. Tropical forest loss currently accounts for 8 percent of the world's annual carbon dioxide emissions. In other words, if tropical deforestation were regarded as a country, it would be the third-biggest emitter globally – ranking just below the U.S and significantly above the EU. Global warming is the major impact of global forest loss. The decrease in carbon sinks can contribute to the increase in atmospheric carbon dioxide levels, which can exacerbate the effects of climate change. Deforestation is a major threat to global biodiversity, with the potential to cause irreparable harm to ecosystems and the species that depend on them. Forest loss can have a negative impact on human health, particularly in terms of air and water quality. Policies such as carbon pricing and emissions trading can help create a market-based incentive for reducing emissions from deforestation and forest degradation (known as REDD+). These policies can also support sustainable forest management and reforestation efforts.

Keywords: Deforestation, biodiversity, carbon sink, climate change, REDD+

[1]Title of the seminar paper presented as a part of course, AFE 598 during Winter'2022

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CHAPTER I
INTRODUCTION

Forests play a critical role in regulating the Earth's climate and maintaining biodiversity, yet they are disappearing at an alarming rate (Ansari et al., 2021). Forest loss is a significant environmental problem that has been occurring at an alarming rate in many parts of the world. The global forest cover is around 4.06 billion hectares, which roughly equates to 5,000 square meters (or an area of 50 by 100 meters) per person (Oswalt et al., 2019). However, forests are not evenly distributed worldwide. The majority of the world's forests are concentrated in only five countries (Russia, Brazil, Canada, the United States, and China), accounting for more than half of the total forested area. Additionally, ten countries together account for 66% of the world's forests (FAO, 2020).

This trend is driven by a range of complex social, economic, and environmental factors, and has significant implications for the well-being of local communities, the global economy, and the planet's ecological health. Furthermore, forest loss also has economic and social impacts on local communities (Almond et al., 2020). Forests provide important resources such as timber, non-timber forest products, and ecosystem services such as carbon sequestration, water regulation, and climate regulation. The loss of these resources can have a significant impact on the livelihoods of communities that depend on forests for their survival (Agarwala et al., 2014).

This paper presents a systematic review of the literature on the drivers, impacts, and mitigation of global forest loss, drawing on a wide range of interdisciplinary literature. Forest loss is driven by a complex set of interrelated factors, including both direct and indirect drivers. The primary direct driver of forest loss is agricultural expansion, which accounts for approximately 80% of global deforestation (Kissinger et al., 2012). As the demand for food and other agricultural commodities increases, forests are often cleared to make way for crops and grazing land (Ritchie & Roser, 2021). The demand for wood products, such as paper and furniture, contributes to forest loss through logging and other forms of extraction (Jolley et al., 2020).

Other drivers of forest loss include infrastructure development, such as roads and dams, which can lead to the fragmentation and isolation of forest ecosystems (Liu et al., 2019). Climate change also plays a role in forest loss, as rising temperatures and changes in rainfall patterns can exacerbate the impacts of other drivers of deforestation, such as fire and pests (Baldrian et al., 2023). Agricultural expansion is one of the main drivers of deforestation worldwide. The

conversion of forests to agricultural land has been driven by the growing demand for food and biofuels, as well as population growth and changing diets (Berenguer et al., 2021). Infrastructure development, including road construction, mining, and dam building, is also a major cause of forest loss, as it opens up previously inaccessible areas to exploitation (Laurance et al., 2009). The recent wildfires in Australia and the western United States have caused significant forest loss and have been attributed in part to climate change and a history of forest management practices (Williams et al., 2019).

Forests play a vital role in maintaining the balance of the earth's climate, and the loss of forests contributes to the increase in greenhouse gas emissions and global warming (FAO, 2020). Forests provide a wide range of resources such as timber, non-timber forest products, and ecosystem services such as carbon sequestration and water regulation. The loss of these resources can have significant economic consequences, leading to job loss and income reduction for forest-dependent communities (Agrawal & Redford, 2009). These impacts can lead to reduced agricultural productivity, decreased water availability, and increased vulnerability to natural disasters such as floods and landslides (Veldkamp et al., 2020).

The impacts of global forest loss are widespread and far-reaching. Deforestation is a major source of carbon emissions, accounting for up to 15% of global greenhouse gas emissions (IPCC, 2018). Forest loss also leads to a decline in biodiversity, as many species depend on intact forest ecosystems for their survival (Betts et al., 2017). The loss of forests can also have significant social and economic impacts, particularly for local communities that rely on forests for their livelihoods and cultural heritage (Feng et al., 2019).

To address the complex and multifaceted problem of global forest loss, a range of policy and technological solutions have been proposed. Payments for ecosystem services, such as carbon credits and REDD+ (Reducing Emissions from Deforestation and Forest Degradation), aim to provide financial incentives for the conservation and restoration of forests (Wunder, 2007).

This review provides a valuable resource for researchers, policymakers, and practitioners working to address the urgent and complex problem of global forest loss.

The objectives of the study

1. To identify the main drivers of forest loss globally
2. To evaluate the impact of global forest loss
3. To ensure the mitigation strategy for reducing the negative impact of global forest loss

CHAPTER II

MATERIALS AND METHODS

The main focus of this seminar paper is a review. Therefore, all the data and information presented in this paper are mainly collected from the secondary sources. Secondary sources include a variety of papers, journals, and articles that have been already published. The data was also collected from different relevant reports, and websites which are available on online platforms.

I was able to make this paper better with the help of valuable criticism and suggestions from my major professor, and the course instructors. Afterward, all of the collected information was arranged according to the sequence and presented in this paper.

CHAPTER III

REVIEW OF FINDINGS

3.1 Forest distribution around the world

The world has a total forest area of 4.06 billion hectares (ha), which is 31 percent of the total land area. This area is equivalent to 0.52 ha per person – although forests are not distributed equally among the world's peoples or geographically. The tropical domain has the largest proportion of the world's forests (45 percent), followed by the boreal, temperate and subtropical domains (FAO,2020). Forests are distributed around the world in different regions and biomes. The largest forest biome in the world is the boreal forest, also known as the taiga, which covers a vast area across the northern hemisphere, including Russia, Canada, and Scandinavia. The boreal forest is characterized by coniferous trees and cold winters (Kayes & Mallik, 2020)

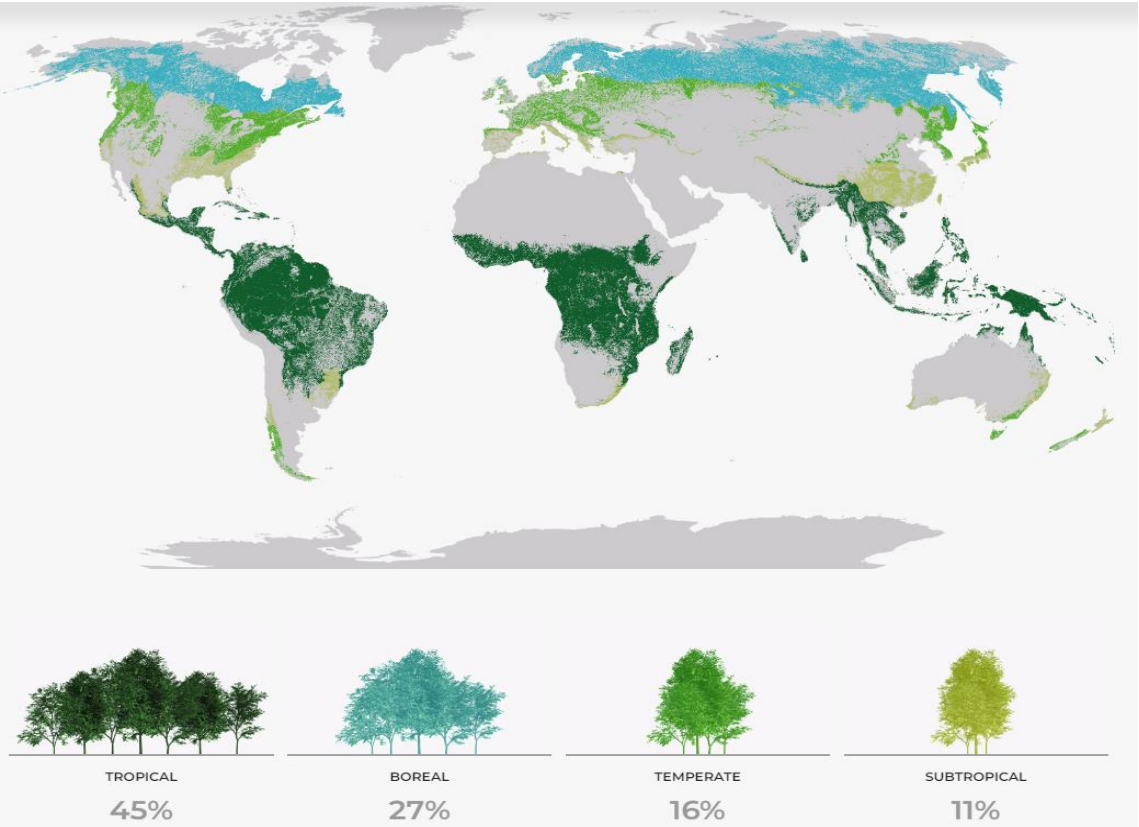

Figure 1: Proportion and distribution of global forest area by climatic domain, 2020

(Source: Jambo, 2020)

3.1.1 Proportion of forest in protected areas, by region, 2020

More than half of the world's forests are found in only five countries (Brazil, Canada, China, Russian Federation and United States of America). Almost half the forest area (49 percent) is relatively intact, while 9 percent is found in fragments with little or no connectivity (White & Martin, 2002). Amazon Rainforest covers most of northern Brazil, characterized by high biodiversity and rainfall. Atlantic Forest covers parts of eastern Brazil, with a high level of endemism and fragmentation (Silveira et al., 2019). In Canada Boreal Forest covers most of the country, with spruce, pine, and fir trees dominating and Temperate Rainforest covers parts of the Pacific Northwest region, with large conifers such as Douglas fir and western red cedar (Hickey & Innes, 2008)

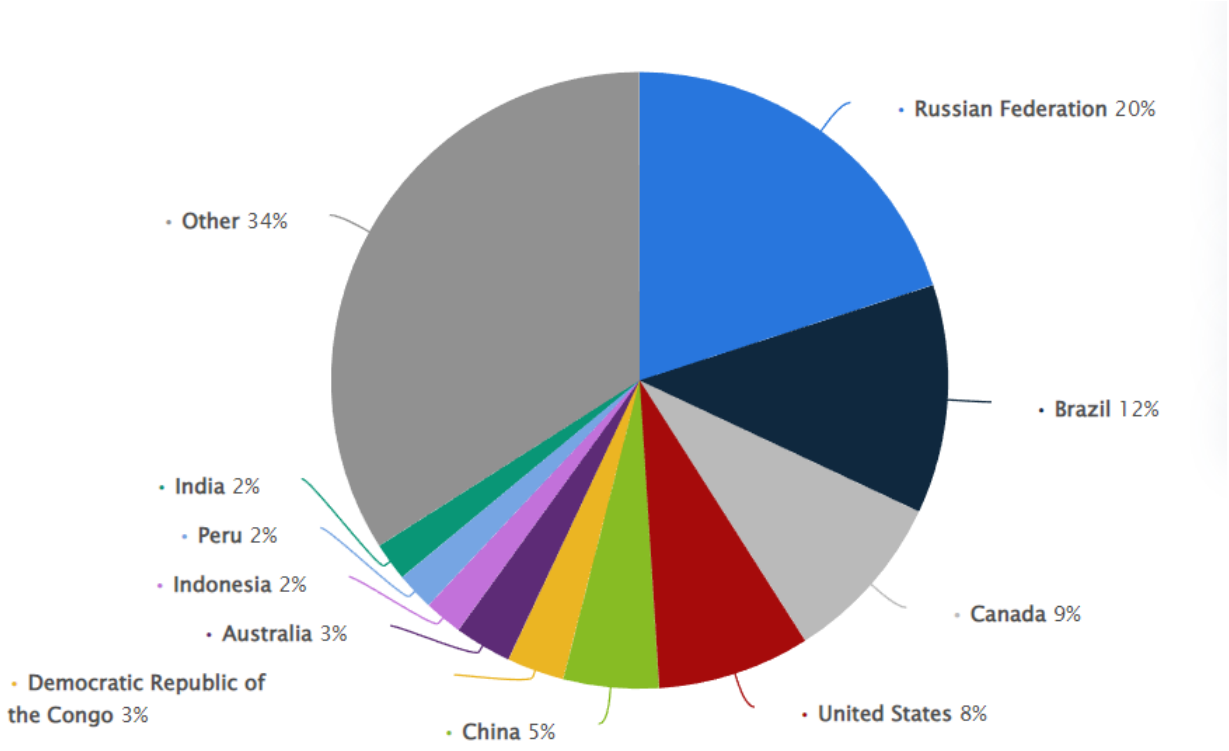

Figure 2: Distribution of global forest area, by country in 2020

(Source: FAO, 2020)

3.2 History of forest:

The chart depicts changes in the Earth's surface cover over the past 10,000 years, excluding ice, glaciers, and barren land. Out of the total land area, 71% is habitable, but only 4 billion hectares of forests remain out of the original 6 billion hectares. The loss of one-third of the world's forest occurred gradually over the last 10,000 years, with only 10% lost until 5,000 years ago, when the global population was small. However, from 1700 onwards, with the increase in the population, land for agriculture expanded into forested areas and other land uses, like grasslands and shrubbery. The loss of forests accelerated in the last century alone, with an area the size of the United States lost due to the expansion of land for agriculture. The per capita footprint of our ancestors was large due to low agricultural productivity and reliance on wood for fuel. Urban land accounts for just 1% of global habitable land, whereas the biggest human footprint is due to food consumption (Ritchie & Roser, 2021)

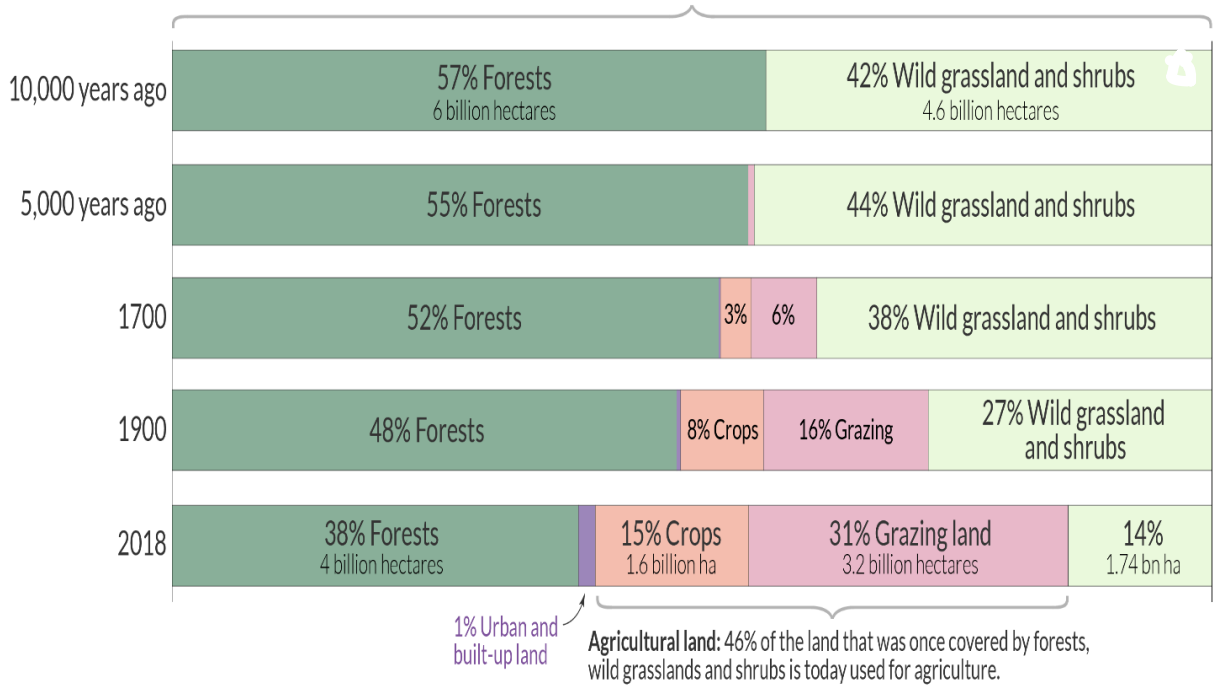

Figure 3: Historical data on forest

(Source: Ritchie & Roser, 2021)

3.3 Drivers of Global Forest Loss:

There are two types of drivers. Those are direct drivers and indirect drivers. The main indirect drivers were common among forest types and also common to deforestation and forest degradation.

There are several drivers of tropical forest loss, including subsistence and commercial agriculture, pasture management, commercial oil palm and other palm plantations, managed forestry and logging, infrastructure development such as roads, mining and crude oil extraction, natural disturbances such as wildfires, drought, wind throw, and flooding, as well as other unidentified tree loss drivers. There is increasing recognition that to effectively reduce environmental impacts, pressure must be alleviated not only at the point where environmental impacts occur, but also by addressing the broader socio-economic drivers of those impacts, which are often distant. According to research conducted by Weinzettel et al. (2013), foreign demand has been found to be a significant factor behind carbon emissions resulting from the burning of fossil fuels and air pollution, especially in developing countries. Likewise, Hoekstra and Mekonnen (2012) have found that foreign demand plays a role in water extraction practices, while Erb et al. (2008) have shown that it is also a factor behind biomass consumption. However, despite the fact that tropical deforestation—the second largest source of anthropogenic greenhouse gas emissions (Smith et al., 2014) and a major driver of biodiversity loss (Tilman et al., 2017)—is increasingly driven by international demand for agricultural commodities up-to-date, comprehensive (pan-tropical) assessments of embodied emissions from deforestation are still lacking. Existing studies analyzing deforestation emissions embodied in trade have either considered only a handful of countries (Karstensen et al., 2013), or are based on outdated data on deforestation and carbon stocks that do not draw on recent advances in remote sensing estimates of both forest loss and associated carbon emission (Baccini et al., 2017).

3.3.1 Drivers of Forest Loss in Bangladesh:

Agriculture is estimated to be the main direct driver for approximately 80% of global deforestation and timber harvesting (often illegal) is a major driver of degradation, along with fuelwood collection, grazing by animals, and charcoal production (Kissinger et al. 2012). Most authors distinguished between indirect and direct drivers, as well as between the drivers of degradation and those for deforestation. The indirect drivers were generally the same for deforestation and degradation and included poverty, over-population, and a group of drivers

related to ineffective governance including lack of land-use planning, corruption, insufficient capacity to manage and enforce, and unclear land tenure. These led to some direct drivers of deforestation common to all forests including over-harvesting (excessive and illegal), agriculture (including shifting cultivation) and encroachment (industrial, military, and settlement). For forest degradation, the nationally common direct drivers were: fuelwood harvesting, and excessive and illegal logging.

Table 1: Drivers of Forest Loss in Bangladesh

Factor	**Indirect driver**	**Leading to direct driver**
Coastal Forest Mangrove Deforestation:		
Economic	Global demand for seafood	Shrimp farming (e.g., Chakaria Sundarbans), Forests cleared for agriculture, coastal erosion
Sundarbans mangroves - degradation:		
Governance	Poor interdepartmental cooperation	Increasing salinity and reduced water flow, Tree diseases, coastal erosion
Sal forest – deforestation:		
Governance	Poor interdepartmental cooperation, policy failure	Loss of forest to military and other govt. agencies, land tenure disputes, litigations
Economic	Demand for food, living space and industrial other products	Forests cleared for crops, settlement and industries
Sal forest – degradation:		
Governance	Demand for wood products	Plantations
Hill forests – deforestation:		
Economic	Demand for electricity, demand for wood products and food	Flooding from dams, authorized/unauthorized flooding, shifting cultivation

(Source: Thompson et al., 2017)

3.3.2 Major causes of global forest loss:

The drivers of global forest loss can be classified into two main categories: natural and human. Natural drivers include wildfires, insect outbreaks, and diseases, which can cause forest loss on a smaller scale. However, the majority of global forest loss is caused by human activities.

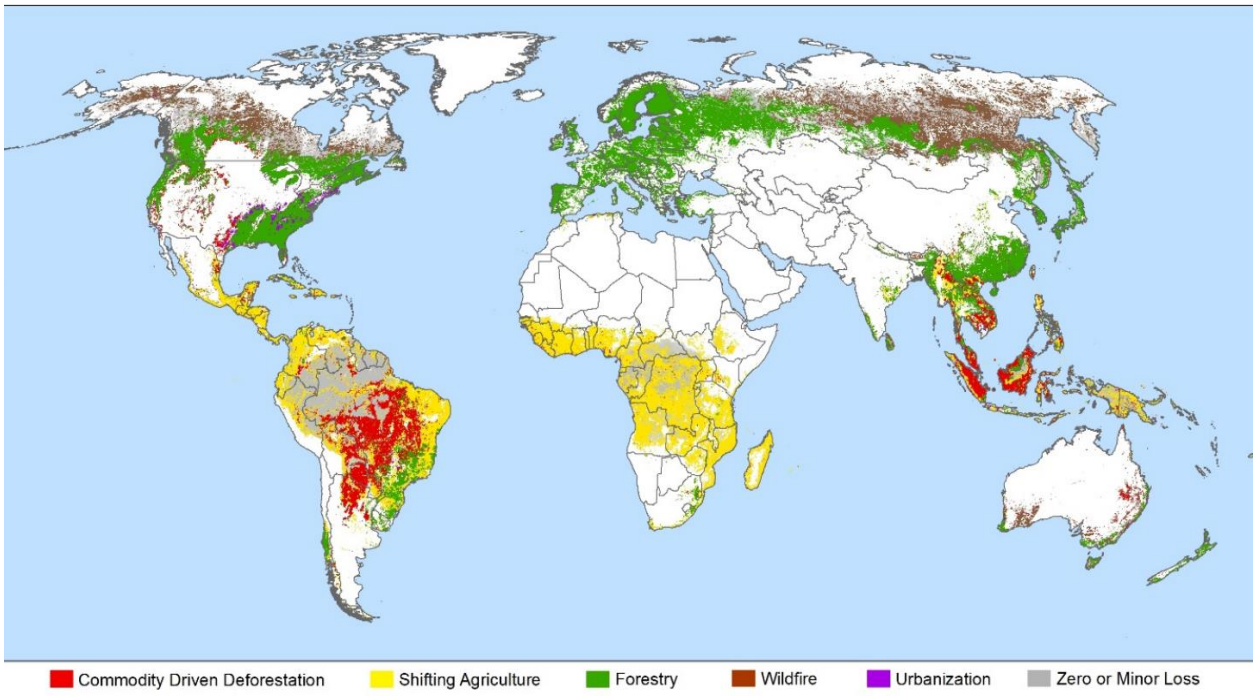

Figure 4: Major drivers of global forest loss

(Source: Curtis et al., 2018)

1. Agriculture: Forests are often cleared to make way for crops or livestock, particularly in developing countries where subsistence agriculture is prevalent. the original driver proportion for shifting agriculture tends to dominate nations in the tropics (Hurtt et al., 2020). Moreover, the mean driver proportion within species ranges over all threatened species revealed that the dominance of shifting agriculture was increased in all tropical nations and in some temperate and boreal nations. Drastic increases in shifting agriculture proportions were found for forest habitat specialists, especially in central Africa for amphibians in several nations in central and northern Africa and for critically endangered species in a few nations in Latin America and central Africa (Conklin et al., 2022)

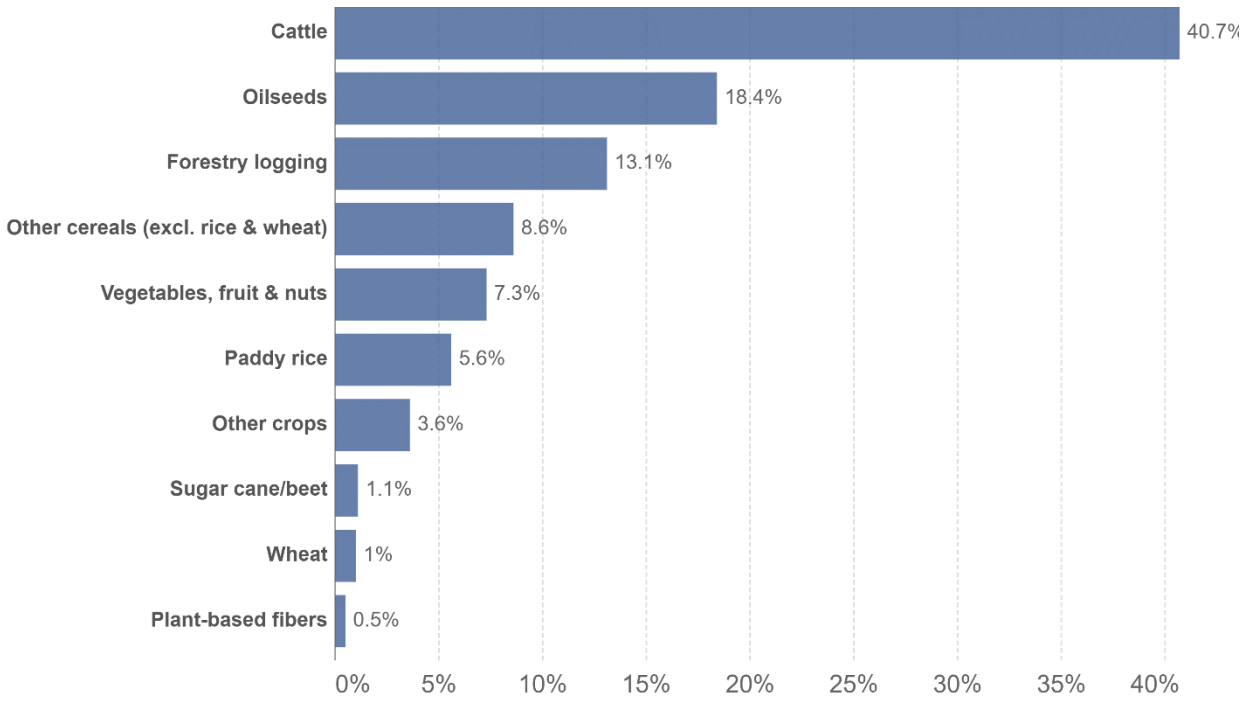

Figure 5: Share of tropical deforestation from agricultural products

Source: (Pendrill et al., 2019)

2. Commodity driven deforestation: It is a major cause of forest loss around the world. The production of commodities such as palm oil, soy, beef, and timber are the primary drivers of deforestation in many tropical regions, including the Amazon rainforest, the Congo Basin, and Southeast Asia (Bager et al., 2020). The process usually starts with the clearing of forests for agriculture or the harvesting of timber. Large companies or small farmers may then use the cleared land for the production of commodities, often with little regard for sustainable practices or the preservation of forests. The resulting deforestation has a significant impact on biodiversity, climate, and local communities (Umunay et al., 2018).

3. Urbanization: Forest loss for urbanization refers to the conversion of forested land to urban areas to accommodate human settlement and development. This process usually involves the removal of trees, vegetation, and other natural features to make way for buildings, roads, and other infrastructure (Lin et al., 2019). Urbanization is a global phenomenon that has led to the rapid expansion of cities and towns, especially in developing countries. The demand for land for housing, industry, and other urban uses has resulted in the conversion of vast areas of forested land to urban areas. The loss of

forests due to urbanization has significant environmental impacts, including habitat loss, biodiversity loss, soil erosion, and water pollution.

4. Forestry: Forestry is the science and practice of managing and utilizing forests for human benefit while maintaining their ecological integrity. It includes a range of activities such as planting, managing, and harvesting trees, as well as conservation and restoration of forest ecosystems (Margono et al., 2014)

Table 2: Drivers of Regional Forest Loss

Region	Drivers	% Of Total Forest Loss
North America	Commodity-driven Deforestation	<1%
	Shifting Agriculture	0%
	Forestry	12%
	Wildfire	9%
	Urbanization	<1%
Latin America	Commodity-driven Deforestation	14%
	Shifting Agriculture	8%
	Forestry	3%
	Wildfire	<1%
	Urbanization	<1%
Europe	Commodity-driven Deforestation	0%
	Shifting Agriculture	<1%
	Forestry	5%
	Wildfire	<1%
	Urbanization	0%
Africa	Commodity-driven Deforestation	<1%
	Shifting Agriculture	11%
	Forestry	1%
	Wildfire	<1%
	Urbanization	1%

Region	Drivers	% Of Total Forest Loss
Russia/China/SE Asia	Commodity-driven Deforestation	<1%
	Shifting Agriculture	<1%
	Forestry	8%
	Wildfire	12%
	Urbanization	<1%
Australia/Oceania	Commodity-driven Deforestation	<1%
	Shifting Agriculture	<1%
	Forestry	1%
	Wildfire	2%
	Urbanization	<1%
Global	Commodity-driven Deforestation	25%
	Shifting Agriculture	21%
	Forestry	31%
	Wildfire	22%
	Urbanization	1%

(Source: Curtis et al., 2018)

5. Wildfire: Wildfires can lead to forest loss, as they can destroy large areas of forest and cause long-term damage to the ecosystem. Forests provide habitat for wildlife, regulate water cycles, and play a key role in carbon sequestration, so losing them can have significant environmental consequences. Fire is often a key process when considering the drivers of forest loss. At least half of the global forest loss may be caused by a combination of natural and anthropogenic drivers that are in principle associated with fire, such as wildfire, or that involve the use of fire for clearing or slash burning, such as with commodity-driven deforestation or shifting agriculture (Curtis et al., 2018). In regions where wildfires are dominant, including the boreal forests of North America and Eurasia, forest dynamics and fire are closely linked (Kasischke et al., 2008). Compared to the boreal region, where ignition by lightning plays a crucial role (Veraverbeke et al., 2017), wildfires in temperate regions are often closer to human

settlements and more likely to be ignited, but also suppressed, by humans (Schoennagel et al., 2017).

Table 3: Proportion of forest-covered burned area in total wildfire area, by region or subregion, 2001–2018

Region/subregion	Share of forest-covered burned area in total wildfire (%)
Eastern and Southern Africa	35
Northern Africa	16
Western and Central Africa	39
East Asia	8
South and Southeast Asia	44
Western and Central Asia	0
Europe	25
Caribbean	19
Central America	47
North America	31
South America	30
Oceania	2
WORLD	29

(Source: FAO, 2020)

3.3.3 Forest loss in tropical and temperate region

Tropical regions, which are primarily located in South America, Africa, and Southeast Asia, have experienced the most significant forest loss. This is primarily due to the conversion of forests into agricultural land, as well as logging, mining, and infrastructure development. The

Amazon rainforest, for example, has lost around 17% of its total forest cover over the past 50 years, primarily due to agricultural expansion and cattle ranching (Sloan & Sayer, 2015)

In contrast, temperate regions, which are primarily located in North America, Europe, and parts of Asia, have experienced more limited forest loss. This is partly due to the fact that many temperate forests have been protected by conservation efforts, such as national parks and other protected areas. However, some temperate forests have still been impacted by logging, urbanization, and other forms of development. For example, the temperate rainforests of the Pacific Northwest have experienced significant logging and land conversion over the past century (Linke et al., 2017)

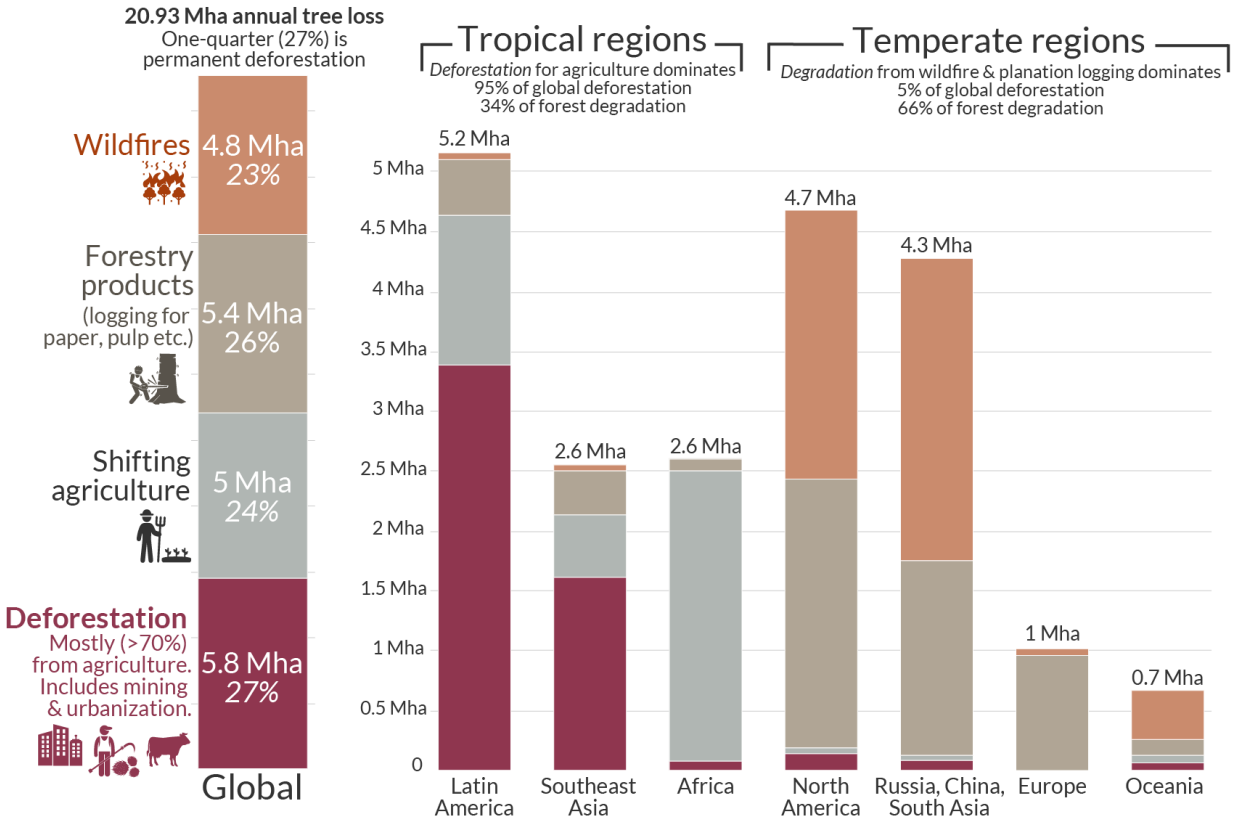

Figure 6: Forest loss in tropical and temperate region

(Source: Curtis et al., 2018)

3.4 Impacts of global forest loss

3.4.1 Climate change:

In order to properly assess the impact of forests on climate, it is important to differentiate between microclimates, regional climates, and global climates (Gupta et al., 2005). Deforestation has significant effects on global energy balance, not only through micrometeorological processes, but also by increasing atmospheric carbon dioxide concentrations, which absorb thermal infrared radiation. Deforestation also alters land surface albedo and radiation budget, affecting wind and water vapor flows, solar energy absorption, and ultimately influencing both local and global climate (Charney, 1975; Gupta et al., 2005; Chomitz et al., 2017).

Furthermore, deforestation can alter normal weather patterns, leading to hotter and drier weather, increasing drought and desertification, crop failures, and coastal flooding, while disrupting cloud formation and rainfall, ultimately impacting major vegetation regimes (Lawton et al., 2001).

Global warming, which includes anthropogenic climate and ecological problems such as climatic temperature shifts, sea level rise, ozone depletion, atmospheric pollution, and forest decline, is also affected by deforestation. Tropical forests are shrinking at a rate of about 5% per decade due to logging and clearance for various purposes. Deforestation contributes to global warming by increasing greenhouse gas concentrations, resulting in a net increase in the global mean temperature, as forests are primary terrestrial sinks of carbon. Tropical deforestation is responsible for emitting approximately 2 billion tonnes of carbon (as CO2) annually, equivalent to an estimated 25% of emissions from fossil fuel combustion (Houghton, 2005).

Table 4: Total forest carbon stock by region and subregion; 1990-2020

Region/subregion	Forest Carbon Stock (million tonnes)			
	1990	2000	2010	2020
Eastern and Southern Africa	30932	29642	27978	26250
Northern Africa	2338	2242	2190	2090
Western and Central Africa	61005	58253	55745	52546
Total Africa	94274	90137	85913	80886
East Asia	27110	30261	33908	37907

South and Southeast Asia	45804	43792	43071	41468
Western and Central Asia	4180	4511	4959	5358
Total Asia	77093	78564	81938	84733
Europe excl. Russian Federation	31625	34260	36833	39192
Total Europe	158744	162457	168069	172442
Caribbean	1552	1783	1977	2098
Central America	4988	4617	4270	4069
North America	136644	137730	139324	139951
Total North and Central America	143184	144131	145572	146118
Total Oceania	33338	33111	33077	33063
Total South America	161765	154917	147917	144846
WORLD	668399	663316	662485	662088

(Source: FAO, 2020)

3.4.1.1 CO_2 emission and tropical deforestation

According to analysis by Global Forest Watch, tropical forest loss currently accounts for 8 percent of the world's annual carbon dioxide emissions. In other words, if tropical deforestation were regarded as a country, it would be the third-biggest emitter globally – ranking just below the U.S and significantly above the EU. And, according to GFW, forest-related emissions have gone up, not down, since the Paris Agreement. Between 2015 and 2017, forest-related emissions were 63 percent higher than the average for the previous 14 years, rising from 3 billion to 4.9 billion metric tons per year

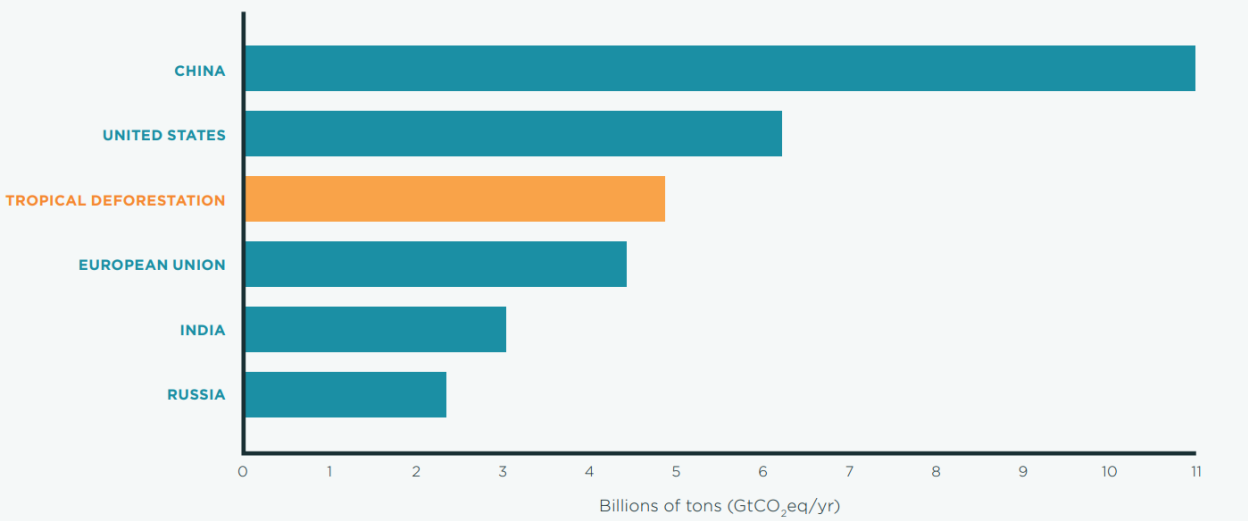

Figure 7: CO_2 emission with tropical forest loss

(Source: Seymour and Busch, 2016)

3.4.2 Water and soil resources loss and flooding

Deforestation has a significant impact on the global water cycle, as it reduces the capacity of the land to hold water and leads to a drier climate (Bruijnzeel, 2004). This, in turn, affects various water resources, including drinking water, fisheries and aquatic habitats, flood and drought control, waterways, and dams that can become silted. Additionally, deforestation can negatively impact the quality of water-related recreation and damage crops and irrigation systems due to erosion and turbidity. One of the critical services that forests provide is protecting urban water sources, as forests can actively filter runoff and substitute for areas that generate runoff, reducing the cost of filtering and treating water (Chomitz et al., 2017). Deforestation can also lead to watersheds that are no longer able to regulate water flows, leading to downstream flooding and soil erosion, which further silt water courses, lakes, and dams. Deforestation increases flooding mainly because soil is more likely to be fully saturated with water due to a smaller "tree fountain" effect, causing additional precipitation to run off and increasing flood risk (Chomitz et al., 2017). Deforestation can also lead to soil compaction, which reduces its ability to absorb rain, resulting in faster stream flow responses to rainfall and potential flash flooding. Moreover, deforestation can decrease dry season flows. Long-term effects of deforestation on soil resources include severe soil degradation due to the intensity of the tropical sun and torrential rains, which can result in increased erosion and siltation of waterways. The effects of deforestation on water availability, flash floods, and dry season flows depend on the balance between infiltration and evapotranspiration, or the "sponge" versus the "fountain" (Bruijnzeel, 2004). Deforestation and other land-use changes have increased erosion in many basins, such as the Yangtze river basin in China, the major river basins of humid tropics in East Asia and the Amazonian basin, contributing to siltation and increasing the risk of flooding.

3.4.3 Decreased biodiversity, habitat loss and conflicts

Deforestation has a significant impact on biodiversity and habitat loss for migratory and endangered species, especially in tropical forests which contain about two-thirds of all known species and 65% of the world's endangered species (Chakravarty et al., 2012). This loss of biodiversity can lead to irreversible changes such as regional climate change and the emergence of new pathogens. In addition to biodiversity loss, deforestation also leads to human-animal conflicts that can harm conservation efforts and endanger both human and animal lives.

3.4.4 Human Migrations

The migration of human populations is induced by extreme weather events such as prolonged drought, excessive rainfall, and food shortages. Additionally, agricultural practices and the search for land and rural properties can stimulate migrations to forest areas, while infrastructure projects and commodity market price fluctuations contribute to the mobility of significant population contingents in the Amazon region. Unfortunately, these demographic changes exacerbate deforestation. Moreover, climate-induced migration poses a major challenge to global health services (Reuveny, 2007).

Migratory events expose populations to new pathogens, particularly in biodiverse environments such as the Amazon rainforest, where disease vectors and pathogens circulate. This problem is further compounded when unvaccinated populations enter areas where vaccine-preventable endemic diseases are present, potentially impacting the herd immunity of vaccinated populations. Additionally, migrants may introduce new pathogens to populations that were not originally affected by the disease (Castelli & Sulis, 2017; Grillet et al. 2019), directly affecting the health of unvaccinated individuals.

3.5 Mitigation strategy of global forest loss

3.5.1 Reduce population growth and increase per capita incomes

The key to decreasing deforestation in developing countries is to reduce population growth. This reduction in population will lead to an increase in per capita income, as well as higher literacy rates. As a result, there will be less pressure on the remaining forests for new human settlements and land use changes (Erbaugh et al., 2020).

3.5.2 Reducing emissions from deforestation and forest degradation

Numerous global organizations, such as the United Nations and the World Bank, are implementing initiatives to combat deforestation, primarily through the implementation of programs like Reducing Emissions from Deforestation and Forest Degradation (REDD). These programs offer financial or other rewards to encourage developing countries to reduce or halt deforestation. Considerable efforts are being made to create monitoring tools that can be used to ensure developing countries adhere to their REDD targets (Chomitz et al., 2017).

3.5.3 Increase the area and standard of management of protected areas

Protected areas are crucial for conserving biodiversity (Myers et al., 2000). However, they are not enough and should be incorporated into a comprehensive strategy for conservation. The accepted minimum forest area to be protected is 10% of the total, and currently, 12.4% of the world's forests are under protection. The distribution of protected areas varies, with tropical and temperate forests having the highest percentages, while boreal forests have the lowest. The Americas have the largest proportion of protected areas, while Europe has the smallest.

3.5.4 Promote sustainable management

To ensure sustainable forest management, it is essential to achieve ecological, economic, and social sustainability. Ecological sustainability requires preserving and, if possible, improving the ecological values of the forest by avoiding the reduction of biodiversity, controlling soil erosion, maintaining soil fertility and water quality, and safeguarding forest health (Chomitz et al., 2017). However, focusing solely on environmental services is not economically or socially sustainable for developing nations unless they have achieved a certain level of development and affluence. Otherwise, the developed world must be willing to bear the costs. There are extensive areas of unused land that are degraded and of low fertility, which can be reclaimed through technological advances. This should be a top priority since a significant proportion of cleared tropical forests eventually become degraded land with low fertility.

3.5.5 Participatory-forest management and rights

In areas where the government and the rule of law are weak, forest ownership and management are often restricted, and property rights are insecure (Chomitz et al., 2017). Therefore, to promote successful forest management in such frontier areas, all stakeholders should be involved in planning, management, and profit-sharing, and community participation in forest ownership and management should be encouraged with restrictions on extraction and conversion. While state ownership and management can be retained, sustainable timber extraction should be allowed. Land reform is also essential to address deforestation, and enduring shifts in favor of peasants are needed for such reforms to be effective. Moreover, the rights of indigenous forest dwellers and others who depend on intact forests must be upheld, and the recognition of traditional laws of the indigenous peoples as indigenous rights can address conflicts between customary and statutory laws and regulations related to forest

ownership and natural resource use while ensuring conservation of forest resources by the indigenous communities. This requires Prior Informed Consent, ensuring that the indigenous communities know what they are agreeing to. Therefore, involving local and indigenous populations more closely in the decision-making process and considering the interactions between societies and forest resources can reconcile conservation and development (Chakravarty et al., 2012).

3.5.6 Increase investment in research, education and extension

Providing training and education to stakeholders is crucial in preventing and mitigating adverse environmental effects associated with deforestation and forestry activities. Research is also essential in understanding the problem and finding solutions, but it often lacks funding and investment (Wassie et al., 2019). There is a general lack of knowledge and awareness about forests and forestry among the public, and forest managers and policy-makers need comprehensive education to fully appreciate the complex ecological, economic, social, cultural, and political factors involved.

CHAPTER IV

CONCLUSIONS

The major drivers of global forest include commodity-driven deforestation, shifting agriculture, forestry, wildfire, urbanization which shares the forest loss sequentially 25%, 21%, 31%, 22%, 1%. Deforestation for agriculture dominates in the tropical region which is almost 95% of the global deforestation.

There are several impacts of global forest loss including climate change, biodiversity loss, water and soil resources loss, flooding, habitat loss, human migration etc. Carbon stock has been decreased throughout the years and the carbon emissions has increased from tropical deforestation significantly.

Reducing emissions from deforestation and forest degradation, Increase the area and standard of management of protected areas, Increase the area and standard of management of protected areas, promote sustainable management, Participatory-forest management and rights, increase investment in research, education and extension can mitigate the global forest loss.

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