



Review Paper

## Analysis on the Causes of Deforestation and Forest Degradation in Liberia: Application of the DPSIR Framework

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### Abstract

The world's forests are of great importance in many aspects. They provide many functions and services that support livelihoods and ecosystem processes. However, deforestation and forest degradation (D&FD) have continued to be a major global environmental problems as vast areas of forest cover are lost on a daily basis. This paper reviews and analyzes the trends in forest cover and the causes of D&FD in Liberia from a period of 1990 to 2010. A thorough review of relevant and existing literatures about the study was done. Additionally, field observations were constantly carried out during the study in different forested areas in Liberia. Primary and secondary data from reputable international and national institutions were collected and analyzed. Furthermore, data and information on all the different elements in the Driver-Pressures-State-Impacts-Responses (DPSIR) analytical framework were also collected. Analysis was done using this framework, based on the identified causes of D&FD. It is evident from our results that Liberia is gradually experiencing loss of forest cover as a consequence of anthropogenic drivers of D&FD which include but not restricted to shifting cultivation, unsustainable logging practices, mining activities, population growth.

**Keywords:** Deforestation and forest degradation (D&FD), population growth, shifting cultivation, unsustainable logging, and DPSIR framework.

### Introduction

Deforestation and forest degradation (D&FD) are amongst the major global environmental problems the world is trying to solve as vast areas of forest cover are being lost on a daily basis. These problems are being faced by many countries especially in the tropical region. Deforestation, forest degradation and related environmental issues are being discussed and have raised tensions at numerous environmental conferences while measures to combat the impacts are also being dealt with. To accurately and clearly analyze D&FD, this paper distinguished between these two terms. Accordingly, the Food and Agriculture Organization (FAO) defined deforestation as the conversion of forest to another land use or the long-term reduction of the tree canopy cover below the minimum 10 percent threshold while forest degradation is defined as the changes within the forest which negatively affect the structure or function of the stand or site, and thereby lower the capacity to supply products and/or services<sup>1</sup>. Simply put, while deforestation denotes the loss of forest cover by human actions, forest degradation on the other hand refers to reduction in the quality of goods and services provided by the forest.

The world's forests are of great importance in a number of aspects. They provide lots of functions and services that support livelihoods and ecosystem processes. Forests provide a multitude of services such as shelter, habitats, fuel, food, fodder,

fiber, timber, medicines, security and employment; regulating freshwater supplies; storing carbon and cycling nutrients; and helping to stabilize the global climate<sup>2</sup>. In spite of these, the global forest covers are slowly changing - in quality and quantity - as a result of human activities. Many studies have estimated and proven that forests covered large portion of the earth's land area several decades ago. Unfortunately, it is not the situation presently as the total forest cover is far less than what it was. The total forest area in 2010 was estimated to be 4 billion hectares, or 31 percent of total land area<sup>3</sup>.

Over the decades, the global forest areas have been deforested, degraded and reduced. From 1990-2000, the global deforestation was 14.6 million hectares per year<sup>1,3</sup>. In addition, between 2000 and 2010, the world lost about 3.2 percent of the total forest area<sup>4</sup>. The rate of forest loss from both deforestation and natural causes is slowing, but remains alarmingly high<sup>2</sup> and of worldwide concerns. The annual deforestation rate in the tropics is approximately 0.6 percent, three times higher than the global rate<sup>5</sup> with 13 million hectares being destroyed each year<sup>6,7</sup>, even though the rate varies from one country to another. Note that the highest rates of tropical forest loss between 2000 and 2010 occurred in South America and Africa<sup>2</sup>.

Globally, there are several causes of D&FD. These causes vary from one country and region to another and are considerably

related to multi-factors which are cross-cutting. Beside the forestry sector, they are linked to other sectors - sociopolitical, economic, demographic etc. Hence, the solutions to the causes of D&FD should be holistic. Many African countries have loss forest areas and Liberia is of no exemption. There are numerous data and information to explain that Liberia is facing D&FD. FDA and USAID estimated that the annual rate of deforestation in Liberia is about 12,000 hectares (0.3 percent)<sup>8,9</sup> while 2% per annum is estimated for natural forest<sup>10</sup>. However, it was argued that the average deforestation rate in Liberia was low at 0.2% per year during 1986–2000<sup>11</sup>. Furthermore, they estimated that the deforestation rates averaged over the 14-year period were greatest in Margibi (26%), Bomi (13%) and Grand Bassa (9%) counties, and rates in remaining counties were 0.5-8%<sup>11</sup>.

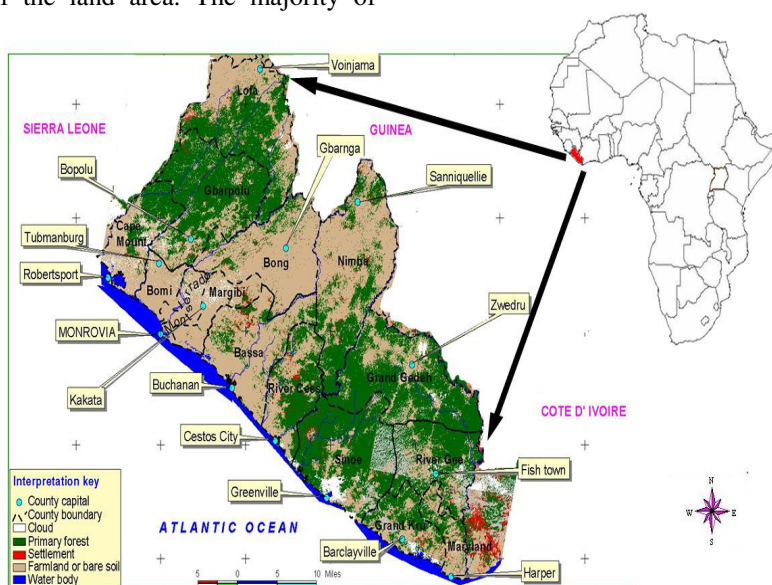
There are several known causes of D&FD in Liberia; nevertheless, understanding and analyzing them is full of complexities. Therefore, this study is aimed at analyzing the trends in Liberia’s forest area as well as providing a clearer understanding of the direct and indirect causes of D&FD from a period of 1990 to 2010. Additionally, it is aimed at aiding decision makers in the sustainable management of forest resources.

## Methodology

**The Study Area:** This study was conducted in Liberia, a developing country, found in the tropical rainforest belt of West Africa. It lies between the longitudes of 7°30' and 11°30' west and latitudes 4°18' and 8°30' north. The country has a land area of 9.58 million hectares (111,370 km<sup>2</sup> or about 43,506 square miles). As shown in figure 1, Liberia contains tropical rainforest which covers about 4.32 million hectares and accounts for approximately 45 percent of the land area. The majority of

Liberia’s forest cover is found in two blocks - northwest (semi-deciduous forest) and southeast (evergreen forest). Moreover, Liberia is situated in the fragmented band of forest known as the “Upper Guinean Forest” which is one of the two most significant forest blocks in Africa, the other being the “Congolese Forest”<sup>9</sup>. The country accounts for about 42% of West Africa’s remaining Upper Guinean tropical forest<sup>8,12</sup> which may provide the last remaining opportunity to protect significant habitat for Upper Guinean biodiversity<sup>11</sup>.

**Data Collection and Analysis:** To review and analyze the current situation of the environment in the study area, this paper used both primary and secondary data. Firstly, a thorough review of existing reports relevant to our study was carried out to obtain information and data. Primary and secondary data were gathered from reputable government and international institutions. Also, primary data and information were collected through constant field visits and observations. During the field observations, several forests in different regions of Liberia were visited during a period of 2010 to 2012. These forests are located in Lofa, Bong Gbarpolu, River Cess and Sinoe counties respectively. Data and information collected during field visits were compared and validated with existing secondary data sources. In addition, the primary and secondary data and information obtained were processed in a computer environment. For the statistical analyses of the research data, Microsoft software were used to provide a clear understanding. Furthermore, some of the data and information on the causes of D&FD were identified during field visits before being applied to the DPSIR analytical framework. Based on the causes identified, a DPSIR analytical framework on the causes of D&FD in Liberia was formulated.



**Figure-1**  
**Forest Cover Map of Liberia**

**DPSIR Analytical Framework:** DPSIR is a causal framework and environmental tool for analyzing and solving environmental problems. It is used to identify and evaluate the complex and multidimensional cause-and-effect relationships between society and the environment<sup>2</sup>. Hence, the framework has been applied to several reports and a lot of environmental problems including forest management, climate change, biodiversity, sustainable development etc. Infact, it was also used in the United Nations' Global Environment Outlook assessments<sup>2,13</sup> a report which discussed the world's environment. The DPSIR framework is a modification of the Pressure-State-Response (PSR) model. The PSR model was initially developed by the Organization for Economic Co-operation and Development (OECD) to structure its work on environmental policies and reporting<sup>14</sup>. Later, the European Environment Agency (EEA) proposed and widely adopted the use of the DPSIR framework, which distinguished driving forces, pressures, states, impacts and responses<sup>15,16</sup>. According to this framework, social and economic developments exert Pressure on the environment and, as a consequence, the State of the environment changes, such as resources availability and biodiversity. This leads to Impacts on human health and ecosystems etc. The negative impacts eventually lead to responses by society, such as the formulation and execution of policies, strategies, laws and international treaties for the protection and management of the environment.

## Results and Discussion

**Application of the DPSIR analytical framework:** The forestry sector of Liberia has significant impacts on the lives of the people and it provides many benefits - economic, environmental and social. Despite its significance, D&FD in Liberia's forests have been driven by many factors. Here, we discuss and analyze the direct and indirect causes of D&FD in Liberia using the DPSIR framework:

**Drivers (D) of D&FD: Civil crisis:** Conflicts in some West African countries; for example Liberia and Sierra Leone have led to the destruction of forests and infrastructure as well as the settlement of refugees in forested areas<sup>1</sup>. The conflict in Liberia started in 1989 and ended in 1997 but later continued from 1999 and ended in 2003. During that time, the country was divided among different rebellious groups that exercised political and military control over those areas captured which were mostly forested. Also, the Government of Liberia could no longer manage forest areas and resources. As a result, those rebel groups were involved in illegal logging activities. In addition, their actions led to vast areas of forest being cleared. Accordingly, the civil conflict [...] further contributed to the loss of Liberia's forest cover<sup>8,9</sup>. During the crisis, Liberia's forest sector grew until most forest areas were under the control of rebel factions<sup>11</sup>.

**Fuel wood Collection and Charcoal Production:** In most developing countries, fuel wood and charcoal are important

sources of energy for the majority of people. About 1.5 billion people rely on fuel wood for cooking and heating<sup>17</sup> similarly, Liberia is experiencing same. It is estimated that approximately 99 percent of the country's population is now dependent on charcoal and fuel wood to satisfy their cooking and heating needs<sup>12,18</sup>. With about 1 percent of the population having access to other alternative sources of energy; Liberia is currently dependent on fuel wood and charcoal as major sources of energy. The production of charcoal in Liberia is increasing. For example, in 1998, a total of 14,807 kilograms of charcoal was produced; this rose to 255,624 kilograms in 1999 and totaled 258,934 kilograms in 2000<sup>10</sup>. In addition, between 1993 and 1995, the research plantation of the University of Liberia at Fendell was cleared by charcoal producers, people scrambling for food and fuel wood gatherers<sup>18</sup>. The destruction of the electricity production and distribution network resulted in a massive increase in the use of charcoal<sup>12</sup>. For that reason, the rehabilitation of the hydroelectric plant is critical to the survival of Liberia's remaining forests. Also the method of charcoal production in Liberia is unsustainable as majority of charcoal producers in the country are using the earth mount kilns.

**Chainsaw Milling (CSM):** Commonly referred to as pitsawing in Liberia, CSM is one of the drivers of forest degradation. It is the felling of tree species and converting the logs into sawn timber with the use of a mechanical saw for different purposes on site. It started long before the civil crisis but on a small scale. Chainsaw milling permits are issued for operations only in community forests and private or deeded forest land<sup>19</sup>. On the contrary, these millers are still working within various forest concessions and even protected forest areas. Consequently, Blackett et al estimated that about 240-260 timber traders exist in Liberia, with an average monthly sale volume of 27.3 cubic meter per traders<sup>20</sup>. However, this estimation seems to be understated considering the intensity and expansion of the CSM sector in Liberia.

**Bushmeat Trade:** Flora and fauna are integral part of the forest ecosystem. Despite that, bushmeat trade drives forest degradation in Liberia as fauna are hunted and killed by poachers. Majority of Liberians regard bush meat as a major source of protein. Overtime, trade in bushmeat has intensified. This intensity is associated with the increasing demand for bushmeat from increasing urban population and the high income generated from the trade. Infact, some rural people have abandoned farming for hunting animals which they believed bring "quick money". Moreover, most Liberians are of the notion that animals are abundant and cannot face extinction. An increase in the commercial trade of bushmeat in Liberia is posing a serious threat to a number of hunted species<sup>12</sup> and it is thought that Liberia's rate of bushmeat consumption may be among the highest in Africa<sup>18</sup>. With bushmeat basically sold in all markets found in rural and urban areas; it is now the major source of protein for many Liberians.

**Commercial Logging:** This started in the 1960s after the first and only intensive national forest inventory. Logging activities in Liberia are mainly regulated by the Forestry Development Authority (FDA). They remained highly centralized institution that predominantly focused on the commercial harvesting of forest products<sup>8</sup>. Unsustainable commercial logging drives forest degradation in Liberia rather than deforestation. A lot of logging companies have operated in Liberia and currently there are several FMCs, TSCs and PUPs.

As seen in table 1, from 1990 – 2000, the removals of forest products from Liberia’s forest increased. During that time, the removal of industrial round wood increased from 609,000 cubic meters to 856,000 cubic meters respectively whereas the quantity of wood fuel removed increased from 3.8 million cubic meters to 5.2 million cubic meters over bark respectively. However, in 2005, industrial round wood removal reduced to 370,000 cubic meters over bark while the removal of wood fuel further increased to 6.6 million cubic meters over bark. Hence, the reduction in the removal of industrial round wood is a consequence of the sanction imposed on the exportation of wood products from Liberia by the United Nations Security Council in 2003. On the other hand, the removal of wood fuel increased continuously because it was mostly used for domestic consumption.

**Mining Activities (Artisanal and commercial):** Liberia has many mineral resources – which include gold, diamond, iron ores, etc. These resources are of immense importance to the economic growth and development of the country. Prior to the civil crisis, several mining concessions operated in some parts of Liberia. As a consequence, the mining for natural resources in forest land has also driven D&FD in the country. Gold and diamond mining in Liberia consists largely of alluvial and small-scale operations<sup>9</sup> with artisanal miners found working in mineral-rich areas which are mostly located in the forests. They mostly used shovels, diggers and other crude tools to drill into the soil in search of minerals. However, a lot of them are without mining licenses but still mining due to the fact that government lacks the capacity to regulate these activities. It was estimated that there were over 6000 illegal artisanal miners in

Sapo National Park alone<sup>8</sup>. Besides, they reported that illegal artisanal mining is taking place in nearly all of Liberia’s protected areas.

**Policy Failure:** The formulation of forest policies is essential for the management of forest resources; although the execution of existing policies is also significant. In some cases, policies encourage deforestation through agricultural incentives, transportation and infrastructure development, urban expansion, and timber subsidies<sup>6,21</sup>. Several studies have concluded that “policy failure is usually a more important driver of tropical deforestation than market failure”<sup>22</sup>. Nowadays, Liberia has several environmental policies, laws and regulations to govern the environment. However, the full implementation of these legal frameworks remains a challenge. As a consequence, they have been constantly violated by forest contract holders; thus creating room for environmental degradation and the misapplication of revenue from the forestry sector. On the other hand, components of these instruments did not employed the bottom-up approach wherein stakeholder; most especially rural people should be involved. In short, some of Liberia’s forest policy frameworks are ambiguous and not applicable the sector.

**Climate Change:** Climate change is the most important environmental issue<sup>2</sup> which is caused by the emissions of greenhouse gases (GHGs) into the earth’s atmosphere. It is at both ends of D&FD; that is, it can be regarded as a driver or an impact. Although forests are playing a significant role in the sequestration of carbon dioxide (CO<sub>2</sub>), they can also be a source by emitting CO<sub>2</sub> through human activities. It was reported and increasingly clear that by the 2000s, D&FD were major contributors to global climate change<sup>19</sup>. Despite the absence of substantial climate change data (temperature and rainfall) in Liberia, the country’s emission of GHGs into the earth’s atmosphere cannot be overlooked. As seen in figure 2 below, Liberia’s carbon stock in living forest biomass reduced increasingly over few decades while the country’s emissions of CO<sub>2</sub> from human activities like shifting cultivation, charcoal production, commercial logging etc. and natural causes increased significantly.

**Table-1**  
**Trends in the removals of wood products from Liberia (1990-2005)**

Year	Industrial Roundwood		Woodfuel	
	Total volume (1000 m <sup>3</sup> over bark)*	of which from forest 2005 (%)	Total volume (1000 m <sup>3</sup> over bark)*	of which from forest 2005 (%)
1990	609	-	3 843	-
2000	856	-	5 226	-
2005	370	100	6 678	100

Source: FAO2010, \*Five year averages for 1988-1992, 1998-2002 and 2003-2007.

In 1990, the carbon stock in living forest biomass was 666 million tons while about 484 kilo tons (kt) of CO<sub>2</sub> was emitted into the atmosphere. However, within a decade - in 2000, the emission of CO<sub>2</sub> into the atmosphere reduced to about 436 kt while the carbon stock in living forest biomass continued to reduce to 625 million tons. Accordingly, from 2005 to 2010, the CO<sub>2</sub> emitted into the earth's atmosphere increased further from about 740 kt to 799 kt respectively whereas, the CO<sub>2</sub> stock in

living forest biomass continued the downward trends from 605 million tons to 585 million tons respectively.

**Population Growth:** Most often, D&FD take place rapidly in populated areas around the fringes of forests. Accordingly, as shown in figure 3 below, the total population of Liberia has increased significantly as the country's forest cover gradually reduced over the study period.

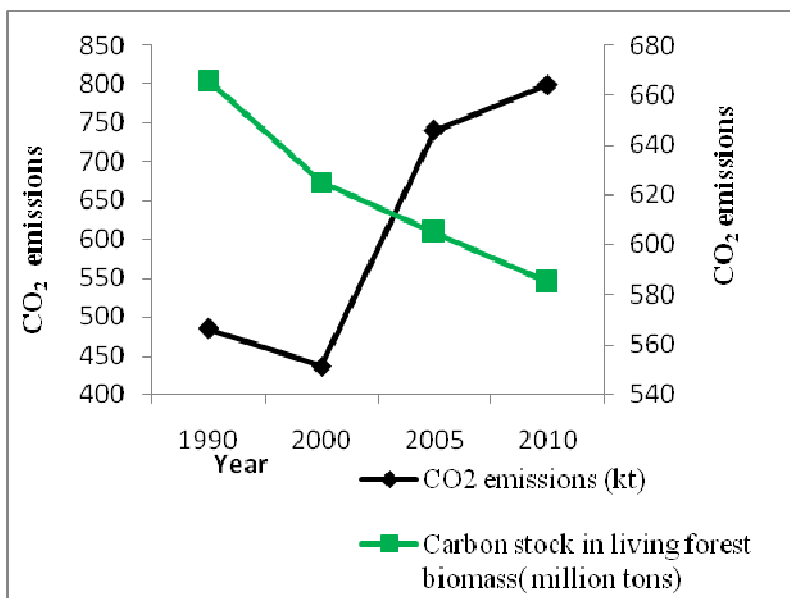


Figure-2  
 Trends in Liberia's carbon stock in living forest biomass and CO<sub>2</sub> emissions (1990-2010)

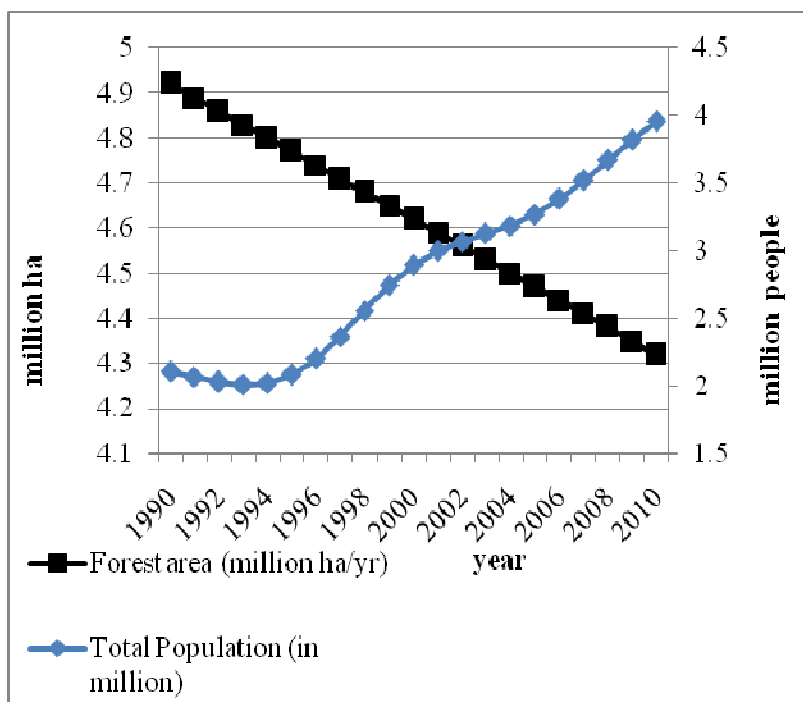


Figure-3  
 Trends in forest cover versus population growth of Liberia (1990-2010)

From 1990 to 2000, the total population of Liberia increased from 2.102 million people to 2.891 million people respectively. As a consequence of the growing population, the forest area decreased from 4.92 million hectares in 1990 to 4.62 million hectares in 2000. Historically, increasing human population has been correlated to decline in forest cover. As human populations have expanded, forests have changed and evolved in diverse ways in different regions of the world<sup>4</sup>. In 2010, the population of Liberia increased to 3.957 million people while the forest area decreased to 4.32 million hectares.

**Economic Growth:** The world’s economy is growing rapidly. Causes of D&FD in Liberia are influenced by economic factors (global and national). The country’s economy is reliant on the extractive industries largely agriculture (rubber), timber and minerals – which include and not limited to gold, diamond, iron ore. The forestry sector of Liberia has contributed immensely to the economy. It continues to provide revenue, raw materials and employment opportunities for national government. Forestry and cash crop production are two other important economic activities which accounted for 6.7 per cent of GDP during the decade before the crisis in Liberia<sup>18</sup>. Table-2 shows that in 1998, forestry activities contributed US\$53.4 million of which logs and timber accounted for US\$ 13million while remaining US\$ 40.4 million was contributed by charcoal and wood. Meanwhile in 2001, of the US\$ 66.9million contributed by forestry, log and timber accounted for US\$27.8million while charcoal and wood

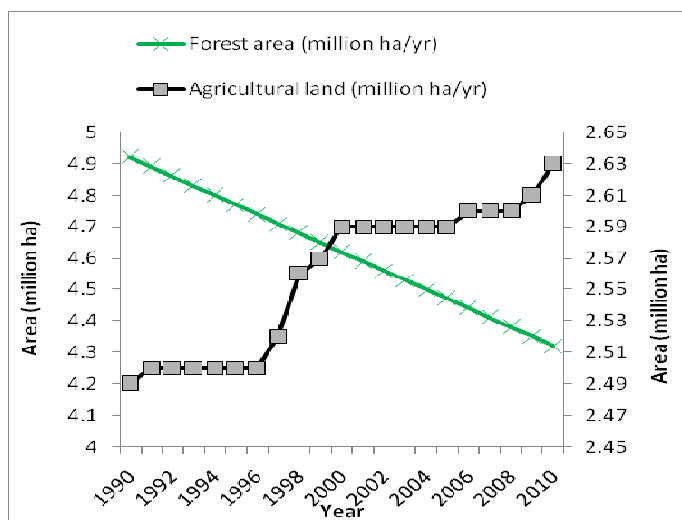
provided US\$39.1 million. Also in 2005, forestry activities contributed US \$105.8 million while logs and timber and charcoal and wood, US\$64million and US\$ 35.5 million respectively. Additionally, bushmeat trade has contributed immensely to Liberia’s economy. For instance, rough estimates for the cash value of Liberia’s annual bush meat harvest are \$US 66 million and \$78 million which may comprised 4% or more of Gross National Products<sup>9</sup>. With economic growth coming at the expense of natural resources and ecosystems<sup>2</sup>, the natural resources of Liberia are constantly being affected in that quest. They are being overexploited to provide raw materials for different sectors of the economy.

**Agricultural Expansion:** Agricultural activities are driving D&FD in a number of countries around the world – including Liberia. Agriculture has expanded and replaced vast tracts of forests in all parts of the world to meet the [growing] demand for food and fiber<sup>1</sup>. Figure-4 shows that the trends in Liberia’s forest area and agriculture land are noticeably different. It reveals that forest area is decreasing while the agricultural land is rapidly increasing. For example, in 1990, the area of Liberia’s forest was 4.92 million ha while agriculture land covered 2.49 million hectares of the land area. Within a decade – i.e. in 2000, the forest area decreased considerably to 4.62 million ha while the agriculture land significantly increased to 2.59 million ha of the land area. Agriculture is a key livelihood activity in Liberia with about 60 percent of the population depending on the sector.

**Table-2**  
**Contribution of the forestry sector to GDP at current price (in US\$ million) from a period of 1998 to 2005**

Activities	Years							
	1998	1999	2000	2001	2002	2003	2004	2005
<b>Forestry</b>	53.4	60.7	63.7	66.9	68.3	95	101.5	105.8
Logs and Timber	53.4	60.7	63.7	66.9	68.3	95	101.5	105.8
Charcoal & wood	13	19.3	23.2	27.8	32	59.7	61.1	64

Sources: MPEA (Ministry of Planning and Economic Affairs, Liberia, 2003) and MPEA/IMF (Ministry of Planning and Economic Affairs, Liberia/International Monetary Fund, 2005)



**Figure-4**  
**Trends in Liberia’s forest cover versus agriculture land (1990 – 2010)**

According to UNDP, about 70 percent of Liberia's rural households rely on food from their own farms or gardens<sup>18</sup>. Despite that, the country cannot produce food to feed its population and relies on imports from foreign countries. From 2005 to 2010, the agriculture land of Liberia increased from 2.59 million hectares to 2.63 million hectares of land area respectively. On the other hand, the forest area reduced from 4.47 million hectares in 2005 to 4.32 million hectares in 2010 of the land area. However, between 1991 and 1996, the agriculture land remained constant - it was 2.50 million hectares. Additionally, the same happened from 2000 to 2005, i.e. the agriculture land was 2.59 million hectares. This can be linked to the Liberian civil crisis as well as other factors. During this period, many agriculture concessions seized operations and halted the expansion of their concession areas fearing economic loss. Additionally, the majority of the rural population was displaced, fleeing for survival and not really involved in subsistence farming. Also, the development and expansion of oil palm and rubber plantations in Liberia have increased recently. However, they are largely concentrated in few counties – notably Bomi, Bong, Nimba and Margibi.

**Unsustainable Land-use Planning:** Sustainable land-use planning brings together various sectors of the society that use or competes for land space. It highly considered the sustainable utilization of the land area and issues such as land tenure and property rights. To prevent conflicts, sectorial-overlapping and environmental problems on forestland, property rights and land tenure issues must be carefully looked at. Thus, the potential for environmental degradation increases where different sectors and interests coincide in the same geographical area<sup>12</sup>. In Liberia, there is a high degree of geographic overlap between mineral deposits and exploration permits and the protected area or forest reserve network<sup>9</sup>. Due to the lack of proper land-use planning in the country, different sectors – agriculture, forestry, mining, infrastructure development - of the society are competing for the landscape.

**Road Construction:** It was estimated that 51 percent of the world's forests lie within 10 km, and 75 percent within 40 km, of major transportation infrastructure and potentially accessible for wood supply<sup>1</sup>. Similarly, most of the remaining forests in Liberia are readily accessible as it is within a few km of existing roads<sup>11</sup>. Additionally, it was revealed that 80 percent of Liberia's FMCs and 77 percent of TSCs lie within five km of a road<sup>20</sup>. The availability of road networks provides access to the forest area; as logging roads are transitory and built to remove forest products (round log) from stump-site, landings or sawmill to market. Consequently, logging roads provide easy access and encouraged the establishment of settlements, shifting cultivators, chainsaw millers and so on. Also, the expansion of logging roads has enabled organized gangs to increase the scale of commercial bushmeat hunting to supply a growing export market<sup>12</sup>.

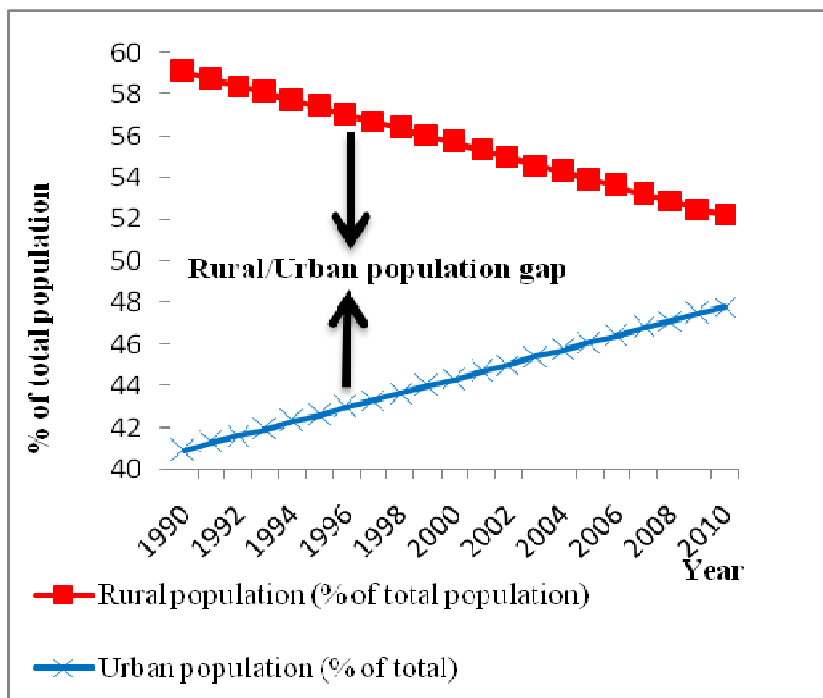
**Poverty:** An estimated 350 million of the world's poorest people, including 60 million indigenous people, use forests

intensively for their subsistence and survival<sup>4</sup>. About 1.4 million people in Liberia lived in abject poverty<sup>18</sup> with the women, children and rural people mostly affected. As an example, in 2007, the poverty gap at national poverty line was 24.4% while the poverty gap at rural poverty line was 26.3%. Therefore managing the forest resources on a sustainable basis could alleviate poverty, create employment and contribute to the Poverty Reduction Strategy (PRS) of Liberia. This is essential because with poverty and unemployment, people care less about protecting the environment in the midst of hunger. They are mostly concerned with the tangible goods and services the forests can provide at the moment for their survival.

**Pressures (P) on Liberia's forests: Shifting Cultivation:** It is globally recognized that shifting cultivation which is characterized by slash and burn and/or bush fallow puts pressure on forest land. In Liberia, it is a major form of farming and a cause of D&FD. It accounts for about 95% of deforestation in Liberia<sup>10</sup>. Though, it was argued that the threat of deforestation posed by shifting cultivation is difficult to measure<sup>9</sup>. Nevertheless, it is regarded as the greatest threat facing Liberia's forests<sup>10</sup>; which is why primary and secondary forests are affected.

**Urbanization and Rural Settlement:** Globalization and urbanization are aggravating competing demands on land<sup>2</sup>. In Liberia, urbanization and rural settlements are being pressured by increasing population. Figure-5 below shows that Liberia's rural population is increasing at a decreasing rate while the country's urban population is increasing at an increasing rate. From 1990 to 2000, of the total population, the urban population increased from 40.9% to 44.3% respectively. Subsequently, it further increased to 47.8% in 2010 of the total population. Conversely, of the total population, the rural population decreased from 59.1% to 55.7% in 1990 to 2000 respectively. Additionally, it decreased to 52.2% in 2010. The increasing urban population is associated with rapid urbanization while the decreasing rural population can be attributed to hardship and poverty in rural communities. Urbanization is a necessary part of development and is a good thing as long as it is planned, well managed and controlled<sup>18</sup>. On the contrary, in Liberia, it is unplanned, uncoordinated and therefore resulted to a lot of rural settlements found deeply in forested areas. These rural settlers heavily rely on the forest for food, farming and other services. Likewise, urbanization puts pressure on the environment as forest resources are required for the provision of food, housing and other materials.

Besides, as you may have noticed in figure-5, the rural/ urban population gap – the distance between the trends in rural and urban populations – is narrowing overtime. Therefore, considering the trends, it can be predicted that within few decades, the urban population will exceed that of the rural population. It can also be assumed that at that time, additional pressure will be exerted on forest resources to support the growing urban population demand for forest products. Consequently, this could further decrease Liberia's remaining forest – which is already reducing - at an alarming rate.



**Figure-5**  
**Trends in Urban and Rural population of Liberia (1990-2010)**

**Selective Felling System:** Liberia uses the selective felling system in the commercial logging industries. This system is pressuring the forest cover most probably its quality, as few species are desired by concessionaires considering market demand and price. An estimation of 60 timber species was harvested in Liberia for commercial activities<sup>8,10</sup> of the 225 known tree species<sup>8</sup>. In short, this system more or less contributes to forest degradation rather than deforestation.

**Poaching, Hunting and Snaring:** In Liberia, biodiversity has suffered from widespread wildlife poaching<sup>8</sup>. Poaching, hunting and snaring are some of the most common methods by which wildlife are captured and harvested. These methods are used by a lot of rural people and hunters as means of livelihood. Additionally, people use firearms mostly “single barrels” or set traps to harvest wildlife. In most instances, snares captured wildlife and are abandoned by hunters which is why fauna are loss/or decayed.

**Unemployment and Livelihood Activities:** The forestry and agriculture sectors are labor intensive; and therefore require large workforce. These sectors are greatly relied on by lots of people to provide many jobs-skilled and unskilled. For instance in 2002, the forestry sector of Liberia provided about 10,000 jobs for both skilled and unskilled laborers. It is estimated that 1,500 people are employed in the retail chainsaw lumber business; 3,850 work in CSM<sup>20,23,24</sup> and it includes jobs provided both in rural and urban areas for millers, lumber porter, loaders and many others. Also, trade in bushmeat provides income and employment. However, the UN sanction

on Liberia’s forest sector in 2003 and the civil crisis resulted to the loss of many jobs. Consequently, unemployment in Liberia stands at 85 percent<sup>18</sup>. In short, as a result of the high level of unemployment, many people are engaged in different activities, i.e., bushmeat trade, charcoal production, artisanal mining, chainsaw milling amongst others for livelihood. Hence, these activities affect the forest ecosystem when practiced unsustainably- as it is the case of Liberia.

**Unsustainable Harvesting Practices:** It refers to the felling of tree species or harvesting of wildlife in a manner that affects the present and future potentials of the forest ecosystem. Under-diameter tree species are frequently harvested by chainsaw millers and; sometimes in forest concessions. The diameter at breast height (DBH) of tree species is not considered by these millers. As a result, species of lower DBH are also harvested. However, Kamara J., et al<sup>23</sup> stated that chainsaw millers harvest nearly all trees of the desired species above 35-cm DBH and nearly 75% of sawn timber produced for the trade is concentrated on six species.

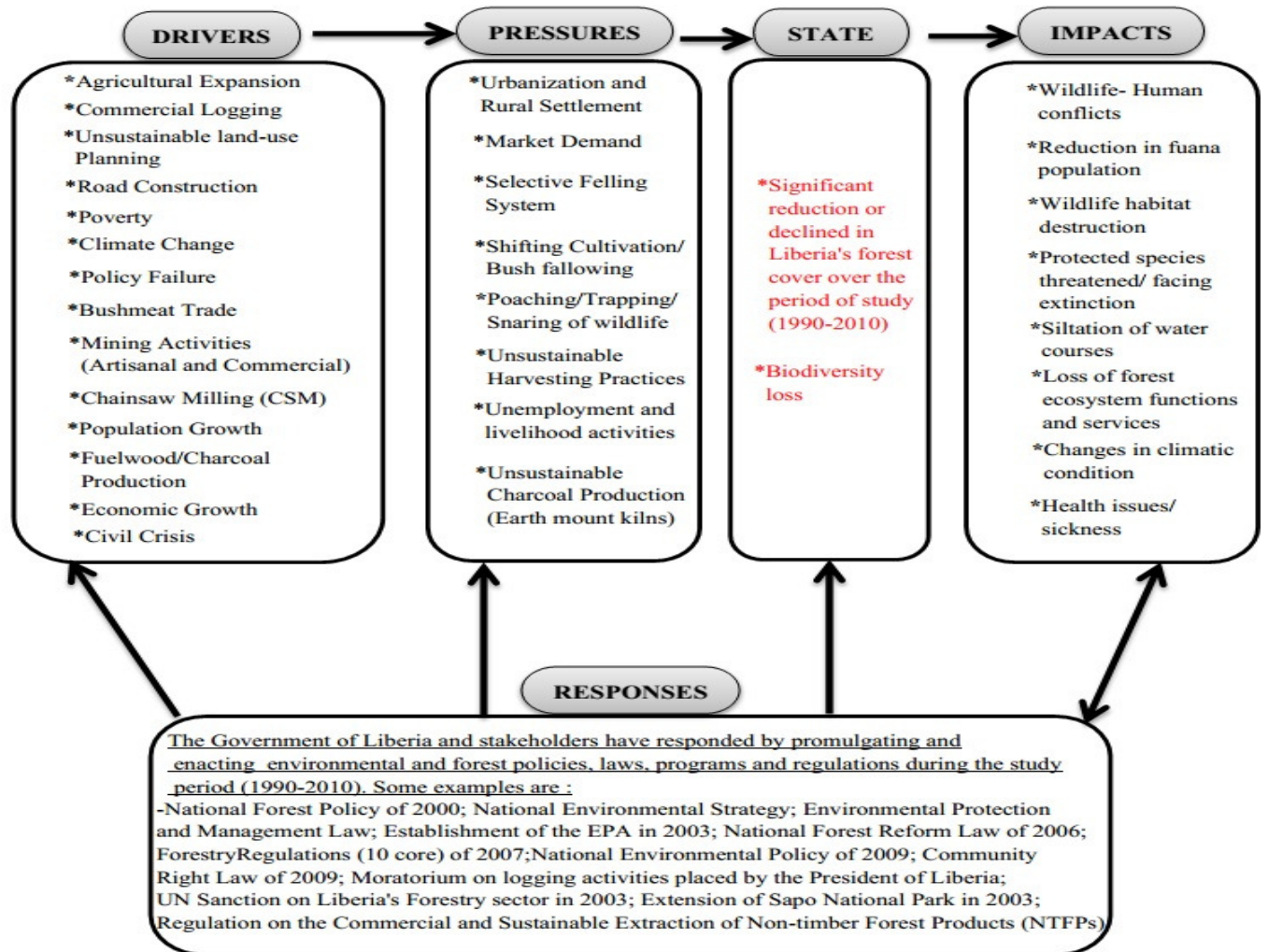
**Markets Demand:** Market forces are putting pressure on the forests of the world as international and domestic markets demand for forest products. For example, the root causes of the bush meat crisis are the large national and probably international demand for Liberia’s bushmeat<sup>9</sup>. As the price of the forest product or species increased on the domestic or international market, more of that product is required and harvested in the forest concession.



**State(S) and Trends in Liberia’s Forest Cover:** Although Liberia is rich in biodiversity and a signatory to United Nations Convention on Biological Diversity (CBD) which aims at protecting biodiversity globally; biodiversity is being lost. Meanwhile, the forest area is reducing gradually due to several factors – both direct and indirect. As discussed earlier in figures-3 and 4, the area of Liberia’s forest has significantly declined over the study period - it decreased from 4.92 million ha in 1990 to 4.32 million ha in 2010.

**Impacts (I)of D&FD on Liberia’s Forests:** Drivers and pressures of D&FD in the area under study have impacted the forest and human environment. They have resulted in the destruction of wildlife habitat. Additionally, fauna are exposed to poaching and their population reduced. It was estimated that prohibited or fully protected wildlife species account for about 35 percent of bush meat sales and partially protected species account for a further 40-50 percent<sup>8,9</sup>. Therefore, Liberia’s protected species could be lost if the bush meat industry continues to be poorly-regulated<sup>9</sup>. In addition, the

settlement of people deeply into forestland has caused a number of wildlife-human conflicts in Lofa, River Cess and other counties respectively. Furthermore, loss of forest ecosystem functions and services, siltation of water courses which serve as a major source of water mostly for rural households are some impacts of D&FD. Forest dependent communities are highly vulnerable and affected by biodiversity loss and changes within ecosystem services. Their livelihood, culture and traditions are attached to the forest. D&FD have also caused serious health problems especially in rural areas wherein species of medicinal value are cleared. For example, the main environmental concern with regards to shifting cultivation is in the loss of valuable tree species<sup>18</sup>. Furthermore, large tract of forest have been cleared for mining operations. It has caused intense localized disturbances as well as river and riparian zone disturbance downstream of major mines<sup>12</sup>. For example, mining activities have caused the pollution of surface and ground water; affected the water quality of watersheds and fragmented forest areas. Here we present the DPSIR framework analysis which summarizes the cause of D&FD in Liberia (figure-6).



**Figure-6**  
 DPSIR Analytical framework on the causes of D&FD in Liberia

**Responses (R) to D&FD:** The Government of Liberia and international partners have responded to the problem under study in several ways. To address the issue of biodiversity loss, ten (10) national forest reserves and two fully protected areas have been gazetted<sup>18</sup>. Sapo National Park and East Nimba Nature Reserve are under full protection while there are several proposed protected areas in Liberia. In recent years, many policies, laws, regulations and strategies to combat environmental degradation have been drafted and enacted. For example the Liberia's National Forestry Reform Law (NFRL) of 2006 calls for the integration of commercial, conservation and community (3Cs) forestry. Nevertheless, the execution of these legal frameworks remains a problem that needs to be resolved. In response to the misappropriation of timber revenues generated from Liberia's forestry sector, the United Nations Security Council in 2003 placed sanction on the exportation of wood products from Liberia. Furthermore, in recent year, the President of Liberia, - Ellen Johnson Sirleaf - placed a moratorium on forestry concessions agreement.

## Conclusion

After a comprehensive review of a number of documents and frequent field visits of several forests within the study area, our analysis shows that Liberia's forest areas and resources are being deforested, degraded, pressured and driven by multifactor including commercial logging activities, mining, increasing population, and collection of fuel wood etc. Although the country is facing enormous challenges in addressing these environmental issues – i.e. the lack of financial, human and institutional capacities -however, the Government of Liberia needs to reverse this state and trends. In order to address D&FD the authorities should develop plans and strategies to minimize the impacts of the drivers and pressures on forest resources. In so doing, reforestation programs have to be carried out nationwide to decrease the pressures on the natural forests. Additionally, the setting up of plantations and woodlots for the production of charcoal and fuel wood are also needed. When these are done, stress on the natural forests will decrease. Liberia also needs to rehabilitate or reconstruct the broken energy facilities to reduced charcoal and fuel wood consumption. Improvements in the energy sector will play a crucial role in development<sup>18</sup> and save Liberia's remaining forests. Also, forest concessions need to be monitored frequently to ensure compliance with the legal and policy frameworks of Liberia's forest sector. On the other hand, although few farms are presently using small modern agricultural equipment, it is necessary that Liberia modernize the agricultural system to feed its growing population, ensure food security and promote sustainable agricultural practices. Finally, Liberia needs to formulate a comprehensive land-use plan that will incorporate all sectors of the society. That is, agencies and ministries of government need to harmonize their policies and plans to ensure sustainable utilization of the landscape.

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