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Impact of Climate Change on Sustainable Utilization of Non-Timber Forest Products: In Ghanaian Case

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Abstract

Increased vulnerability and proneness of Non-Timber Forest Products (NTFPs) to climate change shocks have had consequential negative effects on the food security of rural dwellers, that depend on NTFPs to enhance their livelihood outcomes considering the unstable national economy which beset the people irrespective of gender composition. The products obtained from the forest can be categorized into two main types. Timber forest products and Non-Timber forest products. Non-Timber Forest Products are any biological output that is obtained from the forest apart from timber. In many developing countries timber products in the forest have greatly received attention and have been acknowledged as a great contributor to the local, national and international economies while at the same non-timber forest product has received little attention from the international, national and local economies.

The alteration of climate is seen to have effects on the production levels of NTFPs in Ghana. The main objective of the research was to analyze the impact of Climate change on non-forest timber forest in Ghana. This study was examining the impact of climate change on the contributions of selected NTFPs like honey, Mushroom, and Archachatinamarginata (Snails) to household food security in Ghana and how it helps to alleviate poverty and improve the standard of living of the people living adjacent to the forest reserves. The research work was conducted in Ghana, in the forests areas to compare impact of climate change on NTFPs. Quantitative and qualitative information was collected from the people living in the forest areas within the period of the research, structured and Semi-structured questionnaires was administered at randomly selected households in selected communities adjacent to the forest areas in Ghana. Secondary data was also used. Questionnaire survey was supplemented with key informant interviews, focus group discussions, informal interaction, direct field observation and participant observation was also used

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I. INTRODUCTION

Non-Timber Forest Products(NTFPs) are any biological products or resources derived or taken from either managed or natural wooded areas (Peters, 1996) It can also define as any products or materials obtained from forests excluding timber but including “bark of trees, roots, tubers, corms, leaves, flowers, seeds, fruits, sap, resins, honey, fungi, and animal products” (Sunderland, 2000). NTFPs are collected from a wide range of ecotypes such as high forest, farm fallow, disturbed forest, and farmland which are used as food, medicine, barter, and for sale. In some cases, they are the only means for residents of remote forests forest adjacent communities to participate in the cash economy (Arnold, 1996). Most of the People throughout the tropics rely or depend on the harvest and sale of NTFPs for their economic wellbeing and for their living.

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People are dependent upon natural resources for meeting most of their basic needs of life. The kind of resources and sustainable utilization patterns, however, differs by ecological zone and socio-cultural area. Forest provides a wide range of benefits at the local, national and global levels. It is estimated that three-quarters of the world's poor live in rural areas (IFAD, 2001.). Most of these poor homes living adjacent to the forest mostly rely on the forest for their livelihood. The lives of the rural forest dwellers are therefore seen to be integrated with these resources (Thomas, 2005). The contribution of NTFP to forest regions in particular and rural household generally in most countries is significant and cannot be undervalued. Many rural dwellers in tropical regions use non-timber forest products (NTFPs) for subsistence and as a source of income for the family keeping. Numerous local, national and world-level estimates exist of the number of people in different areas who are more or less dependent on NTFPs. It is estimated, for instance, that 1.5 million people in the Brazilian Amazon derive part of their income from harvesting and extractive products (Non -Wood News, 1994.). According to (Zhong, et al., 1995) 700,000 people work in the bamboo sector in China, while a frequently quoted figure for India refers to 50 million tribal people living mainly depend on NTFPs. In the forest zone of Southern Ghana, It is estimated that 258,000 people, or 20 % of the economically active population, earn part of their income from NTFP (Falconer, 1992).

1.0.1. Background

Over the years, the benefits of Non- Timber Forest Products have been significant in the lives of people particularly those of rural communities and forest adjacent communities (Udeagha, 2014). Non-Timber Forest Products have played a vital role and have continually been an important element of the forest resources. People are dependent upon natural resources for meeting a large number of needs for their livelihoods. Food, fodder, firewood and medicine are important non-timber values of forests collected all year round in various locations in the world. Apart from forest plants serving as food, it also serves as medicine.

Climate variability affects NTFPs which in turn influence the contribution of NTFPs to the livelihood of rural dwellers, this results to adjustment in their income and food security levels. The effect of climate variability on NTFPs has led to a decline in the food security of the rural dwellers. This has called for the attention of all stakeholders concerned. This has affected optimum yield of *Archachatinamarginata* (Snails), mushroom, and honey production in Ghana,

1.1.0. Climate change

The world's climate is been altered due to the effects of anthropogenic factors and occurrences and this is causing a fast change of it. It is a fact that there are natural variations in climate, the climate change that the world is most concerned about, is in regard to the high content of carbon in the atmosphere caused by human activities that has resulted in the high production of greenhouse gases which turn to have adverse effects on human life and activities. Referring to the Intergovernmental Panel on Climate Change (IPCC), in its Fourth Assessment Report, concluded with more certainty that global climate change is leaving no doubt and it is widely believed to result primarily from the effects of emissions of carbon dioxide (CO2) and other greenhouse gases (GHGs) such as methane (CH4) and nitrous oxide (N2O), from human activities. This has resulted in the depletion of the ozone layer and has resulted in various climate alterations. The world's surface temperature has risen by an estimated 0.74 degrees Celsius (°C) over the past century. Over the five decades period from 1956 to 2005 the warming trend was nearly twice that for the 100 years from 1906 to 2005 (Lewis, 2006). [1] Over the last 50 years,

[1]It has been observed that Eleven (11) of the twelve (12) years from 1995 to 2006 rank among the 12 hottest years on record (since 1850, when sufficient worldwide temperature. measurements began). Increases are widespread globally and are greater at higher northern latitudes

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cold days and nights as well as frosts have become less frequent over most land areas, while hot days and nights and heat waves have become more and more frequent (IPCC, 2007).

Climate change is impacting the world's ecosystems and it is expected that, the great size of these impacts will be an increase along with temperatures over this century. Many species (flora and fauna) and ecosystems may not be able to adapt as the effects of global warming and associated disturbances, such as floods, drought, wildfire and insect outbreaks, are constitute to other stresses such as land use change, overexploitation of resources, pollution and fragmentation of natural systems. If the global average temperature increases more than 1.5 to 2.5 °C, it is believed likely that approximately 20 to 30 percent of plant and animal species assessed so far will be at an increased risk of extinction and will be wiped off on the planet.

1.2.0. Climate variability in West Africa.

The climate of West Africa is characterized by high interannual differences as well as significant inter-decadal variability. Figure 1 below depicts the variability in the mean decadal (ten year) temperature and the mean temperature over the 1963 to 2012 period over the region (West Africa). There is a clear warning signal as all locations in West Africa were warmer, on average, in the 2000s than in the 1970s. It was recorded that in 2000s were particularly warm in the northern part of the region with parts of Mali and Mauritania at least 1.5°C warmer in the 2000s compared to the 1970s. However, it is also clear and obvious that in some locations more recent decades have been cooler than preceding decades; for example, Togo, Benin, western Nigeria and southern Mali were all warmer in the 1980s than in the 1990s. The temperature in the region of which Ghana is not an exception is still rising and expected to be risen and this can be attributed to the rate at which the tropical natural forest is degraded. The forest is considered as the main source of carbon sink but looking at the rate of the deforestation and the high rate of pollution we should expect much alteration of the climate.

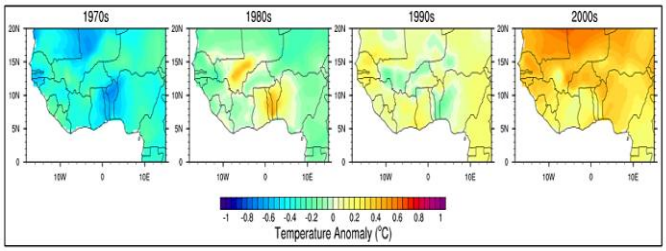

Figure 1:Difference between decadal mean temperatures and 1963 to 2012 mean temperatures at each grid cell.

Source: Data is taken from the CRU TS3.22 dataset

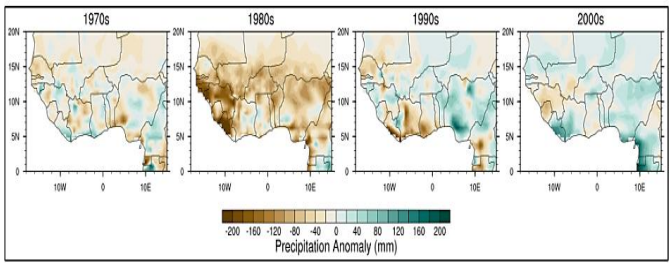

Figure 2: Difference between decadal mean annual rainfall totals and 1963 to 2012 mean annual rainfall totals for each grid cell.

Source: Data is taken from the CRU TS3.22 dataset

Figure 2 depicts the variations in the mean annual rainfall total for each decade and the mean annual rainfall total over the period 1963 to 2012 period at each grid cell, illustrating considerable variability in rainfall on multi-decadal time scales. The figure clearly shows that in the 1980s was considered to be a particularly dry decade for the region, which occurred simultaneously with Sahel drought that caused considerable famine and resulted in hardship to almost all communities across the region. By contrast, the 2000s were slightly wetter for much of the region, with the exception of Guinea, Sierra Leone, southern Mali and southern Ghana. (Lebel&Ali, 2009)suggest that while there has been a recovery of the rains in eastern parts of West Africa, there has been a continuation of drought conditions in western regions, which is consistent.

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1.3.0. Impacts of climate change on forestry

The increase in temperature, carbon dioxide concentration and precipitation caused by climate change will help and boost the growth of trees in both temperate and tropical forest, and the timberline is expected to increase in both the tropics and temperate regions. Alteration in Climate will lead to changes in soils and vegetations. Changes caused by climate change will lead to an increased abundance of grasses and herbs and the decline of shoots, mosses and lichens in the forest areas. Vegetation will become more diverse as the share of southern species increases. On the other hand, northern species of plants may decline and partly disappear. The success of heterotroph species relies on changes in vegetations. Increased broadleaf litter will be able to maintain a more diverse range of soil species and helps in soil microbial activities. The rise in forests dominated by broad-leaved trees will also add to the diversity of plant-eating insect species. Oak attracts a wide range of insect species.

Forests are subjected to a variety of disturbances that are themselves strongly influenced by climate. Disturbances such as long drought, fire, landslides, species invasions, insect and disease outbreaks, and storms such as hurricanes, windstorms and ice storms influence the composition, structure and function of forests. Climate change is expected to impact the susceptibility of forests to disturbances and also affect the frequency, intensity, duration, and timing of such disturbances. For example, increased fuel loads, longer fire seasons and the occurrence of more extreme fire weather conditions as a consequence of a changing climate are expected to result in increased forest fire activity (Mortsch, 2006.). A changing climate will also alter the disturbance dynamics of native forest insect pests and pathogens, as well as facilitating the establishment and spread of non -indigenous species. Such changes in disturbance dynamics, in addition to the direct impacts of climate change on trees and forest ecosystems, can have devastating impacts particularly because of the complex relationships between climate, disturbance agents and forests.

1.4.0. Aim of Research

Several research works have been conducted on the benefits of NTFP's in Ghana but the impact, how to adapt to the impact of climate change has been left out. The aim of my research is to determine the impact of Climate change on non- timber forest products in Ghana, how none-timber forest products is contributing to the overall livelihood of the people of Ghana. My work will be focusing on impact of climate change on Non-Timber Forest Products (NTFPs) like honey, mushroom, snail production in Ghana. I have chosen honey, snail, mushroom production as of NTFPs because it is easier for its production and does not need much capital. Beehives can easily be constructed and placed along the forest boundaries which nectars of trees can be used by bees to produces honey and this will also help pollination in the forest and helps regeneration. According to (Paterson, 2006), beekeeping is a sustainable form of agriculture that can provide rural people with a source of much-needed income and nutrition and with advanced agricultural skills and equipment the beekeepers can produce a wider range of bee products such as honey, beeswax, propolis, pollen, venom, and bee brood.

1.5.0. Research Objectives.

The main objective of the research is to access the impact of climate change on non-timber forest products in Ghana.

a. To assess the impact of climate change on some selected non-timber forest products like honey, Mushroom, and snailswithin 10 years' time from 2010 to 2020 in Ghana.

b. To find out the sustainable measures in the utilization of non-timber forest products to adapt to the impact of climate change.

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1.6.0. Research Questions.

a. What are is the impacts of climate change on non-timber forest products in Ghana?

b. Are there any sustainable measures to be put in place for non-timber forest to adapt to the impact of climate change?

II. RESEARCH METHODS

2.0.1. *Study Area.*

Figure 3: Map of Ghana

Ghana, officially the Republic of Ghana, is a country located along the Gulf of Guinea and Atlantic Ocean, in the subregion of West Africa. Ghana has a Spanning land mass of 238,535 km^2 (92,099 sq mi), Ghana shares her borders with the Ivory Coast in the western part of Ghana, Burkina Faso in the north, Togo in the east and the Gulf of Guinea and Atlantic Ocean in the south. Ghana is characterized by a tropical climate but the annual rainfall level decreases as the altitude increases to the north, where a savannah climate becomes dominant. Most part of the country belongs to the Tropical Savannas Climate and the Sub-SahelianAfrican moist region. The annual mean temperature ranges from 25°C to 27°C and is constant throughout the year. The annual rainfall is as high as 2,000 mm in the southwestern part of the country but decreases towards the northeast, dropping to 1,000 mm at the northern border area.

The forest area of Ghana is estimated at 9.17 million ha accounting for about 40% of the total national land. The classification of these forests, based on ecological conditions, puts the Closed Forest Zone area at 8.1342 million ha, 1.036 million Transitional Forests and the Savanna Forest Zone at 14.66 million ha, giving the total area 23.85 million ha. The Closed Forest Zone is categorized into Evergreen Rainforest, Evergreen Moist Forest and Moist Semi-deciduous Forest. In 1992, it was estimated that only about 1.5 million ha of "intact closed forest" were remaining in Ghana. The annual rate of deforestation was said to have slowed in the 1980s to about 22,000 ha (IUCN, 1992). The current annual rate of deforestation is not known but it is estimated to be lower than what it used to be two decades ago.

2.0.1. *Materials and Methods.*

Decadal temperature and rainfall pattern in Ghana were used for the research work. Bio decadal honey production levels in honey and estimated income obtained from NTFPs in Ghana were obtained from local farmers, hunters[2] and NTFPs producers in the forest adjacent communities. Desk research approach where literature, government data and online resources were used.

Both primary and secondary data were collected and analyzed. The field investigation was designed as an exploratory and qualitative research because little organized information on the impact of climate change of NTFPs existed in the study areas. Several previous studies on NTFPs which utilized exploratory and qualitative designs provide inspiration for modeling the present investigation. Key informant interviews administration of questionnaires, participants' observations and stakeholder consultations were employed to solicit views on various facets of the production, harvest,

[2]

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and marketing of NTFPs and the differences that has occurred in harvesting of NTFPs in Ghana. Primary data was collected through direct in-person interviews with various market players who are defined as individuals or institutions that have a role in the marketing chain and include collectors, dealers, producers, and sellers of NTFPs. A total of 60 NTFPs producers in 15 districts were selected through purposeful sampling, while 50 sellers and hunters of NTFPs were selected through the snowball sampling technique. These product categories were mushrooms, snails and honey) were chosen because of their expected importance in the NTFPs trade in study areas. Two non- probability sampling methods were utilized: purposeful, where samples are selected out of the population for having certain characteristics such as ease of access changes in production.

2.1.2. *Results and Discussions.*

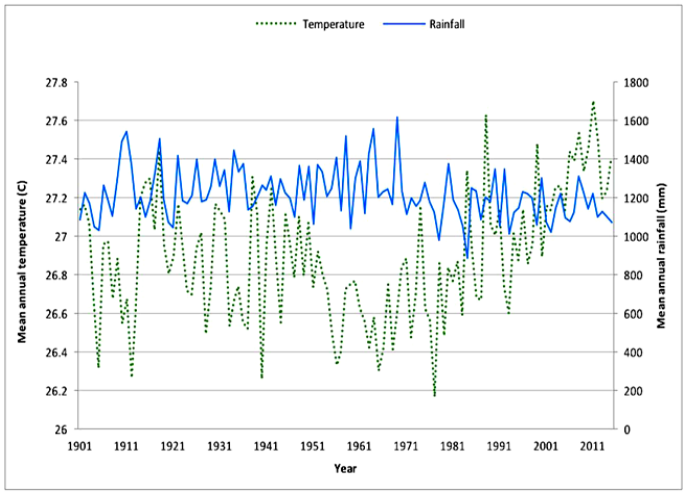

Figure 4:Temperature and rainfall pattern in Ghana 1990-2011

Source: Earth and Space Science

The Figure above shows the temperature and rainfall pattern in Ghana from 1901 to 2011. Looking at the figure it is observed that, from 1901 to 1971 there was a constant and steady temperature and rainfall pattern in the country. From 1971 to 20011 there has been a sharp decline in rainfall in the country. From 1981 to 2011 there has be a sharp rise of Temperature in Ghana from 26.2^{o}C to 27.6^{o}C. The sharp rise in temperature and fall in rainfall has have adverse effect on the forest and organism therein. Forests are subjected to a variety of disturbances that are themselves strongly influenced by climate. Long time drought can result in disturbances such as fire, which result to a high number of flora and fauna being wiped away.

Climate change is expected to impact the susceptibility of forests to disturbances and affect the frequency, intensity, duration, and timing of such disturbances (F.A.O., 2008).

Alteration of Climate is impacting the world's ecosystems and it is expected that, the magnitude of these impacts will increase along with temperatures and decline of rainfall over this century. Many species and ecosystems may not be able to adapt or withstand as the effects of global warming and its associated disturbances, such as floods, drought, wildfire and insect outbreaks, are compounded by other stresses such as land use change, overexploitation of resources, pollution and fragmentation of natural systems. If the global average increase in temperature goes up more than 1.5 to 2.5°C, it is believed likely that approximately 20 to 30 percent of plant and animal species assessed so far will be at an increased risk of extinction ((IPCC), 2007) and can be wiped of which bees which produce honey, snails and fungi for mushroom also stands this risk.

The high rate of deforestation in Ghana can be considered as a contributing factor to the alteration of the rainfall and temperature pattern in the country. Since the high rate of deforestation is at it a high peak in Ghana, we should expect an increase of alteration in climate change. The IPCC has made several predictions for future climate change ((IPCC), 2007). A warming of about 0.2°C per decade is projected for the next two decades; temperature projections beyond this period depend on specific emissions scenarios. Even if the concentrations of all GHGs and aerosols were kept

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constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected. The full range of projected temperature increase, based on six emission scenarios, is 1.1 to 6.4°C by the end of the year.

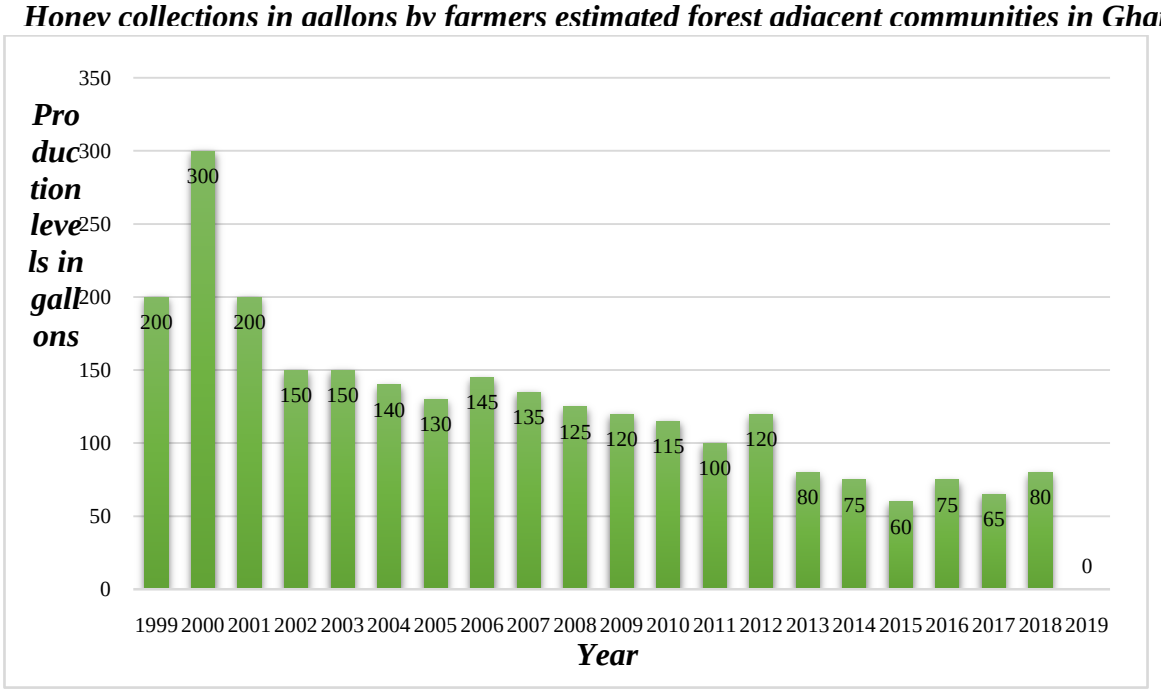

Figure 5: Honey collections in gallons by farmers estimated forest adjacent communities in Ghana.

The above figure shows the production levels of honey in the selected communities adjacent to the forest areas in Ghana. It has been observed that the production levels of honey have been declining continuously from 1999 to 2018.

According to the Intergovernmental Panel on Climate Change Climate (IPCC), by 2020, up to 250 million people living in Africa are likely to suffer from food insecurity as a result of climate alteration which can drive down to crop failure, loss of livestock, and lack of water due long-time drought of which NTFPs will not be an exception. Change Climate and variability are continuously becoming a major constraint to the development of the food and agriculture sector and have also affected production levels of NTFPs in Ghana. The impacts are mainly due to the increasing variability of rainfall resulting in recurrent and longer dry spells that are delaying and shortening growing seasons. In the forest areas development, increasing numbers of forest adjacent communities continue to experience a reduction in available NTFPs for livelihood.

The most important service the honeybee renders to mankind is pollination of fruit crops and production of honey. "The fact that bees are important in the pollination of many species of plants is not new, but the fact that honeybees are becoming indispensable in our agricultural economy may be considered as relatively new. The more bees get trees pollinated the more it also helps in their production of honey. The long period of drought makes all tress shade their leaves and do not flower on time and this really affect the activities of the bees hence affect their production levels. This has become a key factor to the low level of production of honey in recent times in the forested areas in Ghana. A period occurs in the tropics as well as in the temperate zones during which environmental conditions are unfavorable for the bees, and as a result the activity of the colony diminishes (Beekeeping in Africa, 1990). In tropical zones, unfavorable conditions for honeybees may

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occur in different periods and may be caused by different factors: In some areas, the temperature rise so high that the activity of the colony is reduced. Few or no plants are flowering. Only a few bees fly out, and as a result, very little, if any, nectar is collected. In other areas, drought occurs, and the number of flowers, and therefore the amount of nectar available, is reduced considerably. This has adverse effects of honey production.

A farmer was asked of the number gallons and money he was getting from the harvesting of honey and this was what the farmer said. "I have been in the honey harvesting job for the past 20 years and it was not like this. In about 10 years past I used to harvest about 70 gallons within a year and that was what I used to pay the school fees of my children from the basic school up to the university but the system has changed I cannot even harvest 20 gallons a year and this is because the rate the youth are cutting down trees in the forest is very bad and this has made the system change, we have long drought and short rainfall and the trees can not flower and this has also affected the production level, cocoa farmers are also using insecticides to spray their farms which is killing the bees and it is very bad. The government needs to do something about it to curb the situation if not then in the next 10 years there will be no honey to save life".

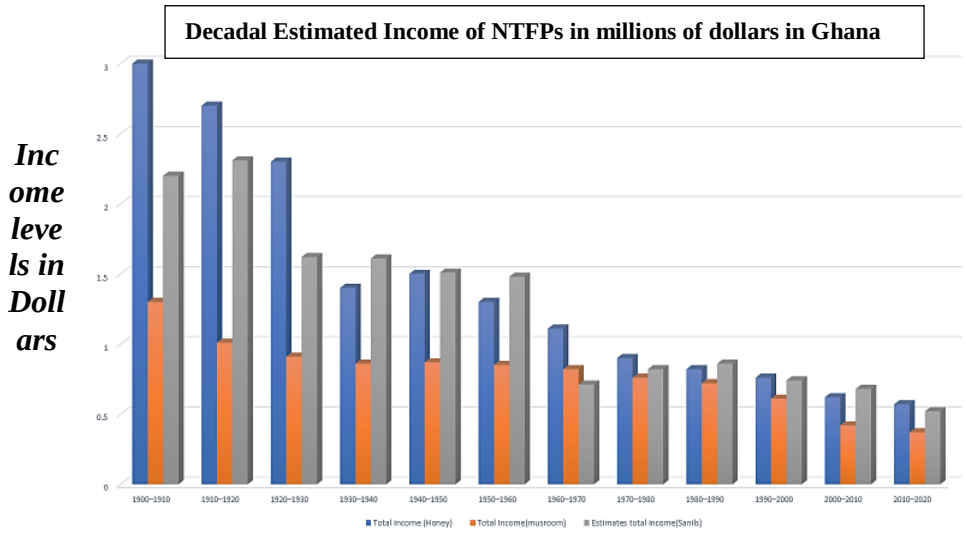

Figure 6: Decadal estimated income.

Income generated by Non-timber forest products for the local communities living adjacent to forest are shown in the figure above. It was observed that there was a total decline of the targeted NTFPs in the selected communities. Hunters and producers contacted stated that, there has been a drastic decline of NTFPs both in the reserved and off-reserve forests. It was observed that in the late 1900 there was a high level of income generated from NTFPs and as the years are going, the income generated from NTFPs is declining.

When one hunter was contacted and this what he said about the changes that have occurred and its effects. "I started hunting and looking for NTFPs like honey, snails and mushroom when I was 17 years when I lost my parents and now, I am 50 I have hunted for NTFPs for 33years. I used to hunt NTFPs both in the forest reserves and off-reserves in this village. During the raining season I can hunt for about 50 bags of snails which is about 3000 pieces of snails on those days of which I used to get money from it. I remember in 1990 I hunted for mushrooms and I got enough money from it. I remember I bought a saloon car from the money I got from the mushroom I sold. It is now very hard for me to even

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get a bucket of snails for about two days hunting in both reserves and off-reserves forest. This is because most of the trees in the forest are logged so the snails and the organisms that helps in the mushroom's productions are all dead, the rains do not come at the right time and there has been a long drought which makes it difficult the snails to survive so now it is a problem. NTFPs was helping us all the year round and we were getting money from it all the time, we used income earned from NTFPs to take of our family but now it is not like that and life is hard here". Traditionally, NTFPs have served to secure the hunger season in rural areas of Northern Ghana. This is as true today as it was in the past

The effects of climate change on NTFPs production in forest areas in Ghana need not be over emphasized, as it is glaring. Late rains and intermittent and long droughts have become more frequent and common. This has posed considerable challenge to farmers and local communities and people living adjacent to the forest, NTFPs hunters and producers as traditional coping mechanisms are increasingly challenged.

2.1.3. Climate change Adaptation and Mitigation

Alteration in Climate in Ghana affects every aspect and sector of our socio-economic development and it is all sectoral inclusive in nature. It outdoes the traditional focus on environmental issues because it affects Ghana's overall well-being and economic growth. It then points to the fact that, the response must be all inclusive, involving all stakeholders in addressing the impacts of climate change on all sectors mostly on natural resources management which our interest will be in the forest, agriculture, and others like economic development, infrastructure, energy and transportation.

The IPCC referred to climate adaptation as the ability to respond and adjust to actual or potential change in order to reduce harm or exploit opportunities. Some of the options that are available include: changing the cropping patterns; avoiding further development on wetlands, flood plains, and close to sea level, avoid land degradation; developing crops that are resistant to drought, heat and salt; afforestation programs of degraded land with tree species that have the ability to sequestrate more carbon, policy of cut one plant ten in the forest areas and environmental engineering defenses against diseases; designing and building new water projects for flood control and drought management. Introduction of afforestation programs on degraded land reduction of deforestation and making honey, mushroom and snails farms in the afforestation lands.

Introduction of NTFPs to sequestrate carbon. Forests have the ability to store large amounts of carbon in trees, under-storey vegetation, and soils. It has been estimated, globally that, the forest contains 1.2trillion tons of carbon, which is just over half the total in terrestrial vegetation and soils. Non-timber timber products can contribute directly or indirectly to carbon storage or sequestration. The growing of fast-growing woody NTFPs like bamboo and other shrubs can be used to reduce emitted carbon. In the case of indirect impact, the production of NTFPs like maple syrup or Brazil nuts (in Brazil), and other fruit crops entails a functional forest and an incentive to protect forest ecosystems. Thus, the maintenance of such a forest cover can indirectly help to store and sequester carbon. Although there is the extraction angle (in terms of removal of biomass from the forest) as a limitation of NTFPs contribution to carbon sequestration, it is comparably infinitesimal when their short re-vegetation and re-growth cycles are considered viz a viz those of trees. This also underscores the need to treat NTFPs differently in forest policies in order to harness their potential in forest conservation and carbon sequestration.

NTFPs for food and medicines, and water have been identified as forest-related priorities for climate adaptation strategies. Strategic forest management (SFM) is seen as a way to achieve climate change

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adaptation and mitigation as well as poverty reduction, economic and social development. some of the tools being used are vulnerability maps and the development of adaptation strategies using forest resources. Ghana has adopted the Taungya program as a way to revive the lost forests in the country. Ghana forestry commission should review the program in the transition zone of Ghana forest to promote a taungya system as a climate adaptation strategy. This is where the communities are actively involved in afforestation programs. The taungya system includes many of the elements of an adaptation strategy. The role of forests must be clarified and articulated in national adaptation programs of action (NAPAS). At present most political attention and financing is focused on Reduced Emissions from Deforestation and forest Degradation, (REDD), and, in general, on climate change mitigation.

The world is presently moving from petroleum-based to a bio-based global economy. Biological wastes (including NTFPS wastes), which are usually considered as low-valued materials, are now being transformed to usable forms for the production of eco-friendly and sustainable fuels (Gomez, et al., 2008). This is because most biological wastes contain high levels of cellulose, hemicelluloses, lignin, starch, proteins, and lipids, which provide good options for the biotechnological production of liquid bio-fuels without interfering with the ever-increasing need for world's food supply (Leandro & Andriana, 2009.). NTFPS that can be converted into biofuel include bark, leaves, cork residue, cross-cut ends, edgings, grinding dust and saw dust through; thermal, chemical or biochemical conversion processes. Apart from forest product wastes, *Jathrophacurcas*which is a non-timber forest plant has been documented to have as high as 40% biofuel seed content. It is fast growing, prolific in nature and as well can thrive on marginal soils makes it most suitable for biofuel production.

2.1.4. Conclusion

The evidence presented from this work shows that climate change is having considerable and widespread impacts on forest health worldwide, and, as a result, on the forest sector. Clearly, if such climatic and ecological changes are now being detected when the globe has warmed by an estimated average of only 0.74 °C, it can be expected that many more impacts on species and ecosystems will occur in response to changes in temperature to levels predicted by IPCC. Conversely there are some indications that the interrelated effects of climate on tree hosts and the direct influence on natural enemies may make the overall effect difficult to predict and it is considered by some that not all climate change scenarios will be detrimental. While a fair amount of information is already available concerning the impacts of climate change on the world's species and ecosystems, from the perspective of forests, considerably more information is needed on the impacts on forests, forest pests and the complex relationships relating to climate change.

Non-timber products have the ability provide of income to rural communities adjacent to the forest to alleviate poverty. Alteration in climate has also alter the production levels of NTFPs in Ghana. Increase in temperature, decline of rainfall has become of the major issues affecting the productions level of NTFPs. In Ghana change in temperature and rainfall has affected the production levels of honey, mushroom and snails in production and sales in Ghana. Introduction of NTFPs to sequestrate carbon. Forests store large amounts of carbon in trees, under-storey vegetation, and soils. They have been estimated to globally contain 1.2trillion tons of carbon, which is just over half the total in terrestrial vegetation and soils Non-timber timber products can contribute directly or indirectly to carbon storage or sequestration. The growing of fast-growing woody NTFPs like bamboo can be used to reduce emissions. Introduction of modified Taungya system

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by the Ghana forestry commission for afforestation program of degraded land can be considered as a way to mitigate climate change in Ghana which will also protect and improve the production of other NTPFs.

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