

## Review Article

# Tropical Forest: the cheapest resource to address climate change in Ghana

### ABSTRACT

Climate variability and change has become a global phenomenon with many countries including Ghana working to mitigate the effect or develop strategies for adaptation to climate change. However, tropical forest has been identified to have the capacity to mitigate the impact of climate change and improve the general environment. The forest plays a critical role in the climate system, hydrology and the carbon cycle, and provide livelihood for over 2.5 billion rural dwellers in developing countries. This article therefore seeks to highlights the importance of the forest to potentially help in addressing the challenges of climate change and the need for policy makers, stakeholders and the general public to seriously adopt positive approach to the management of the forest resources. The article was carried out through extensive review of literature, official reports and policy documents. The paper outlines the threat of climate change, the state of Ghana's forest and climate, and the role of the forest to mitigate climate change. It also highlights the socio-economic benefits of the forest in mitigating the changing climate. The documents reviewed showed that the state of Ghana's forest has dwindled over the years through anthropogenic activities and the climate is also changing. It was also established that trees can remove a substantial amount of CO<sub>2</sub> from the atmosphere for storage. The paper concludes with suggested recommendations to employ the service of the tropical forest for climate change mitigation.

*Keywords: climate change, forest resources, climate variability, CO<sub>2</sub> emissions, deforestation, mitigation*

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16 **1. INTRODUCTION**

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18 The issue of climate change has become a global phenomenon with its attendant  
19 consequences. The search for food, clothing, shelter, improved standard of living as well as  
20 technology and energy use has altered the atmosphere negatively through the introduction  
21 of Greenhouse Gases (GHGs) in higher concentrations which cause climate change [1].  
22 The rising concentrations of the GHGs mainly CO<sub>2</sub> in the atmosphere has been attributed  
23 mainly to anthropogenic activities such as the extensive use of fossil fuels like coal, oil and  
24 gas, deforestation, burning of vegetation, loss of wetlands, agriculture among others. The  
25 GHGs are mainly carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), water vapour (H<sub>2</sub>O), nitrous oxide  
26 (N<sub>2</sub>O), ozone (O<sub>3</sub>) and the halocarbons which create a thick blanket in the atmosphere to  
27 prevent infrared radiation (heat) from escaping thus resulting in global warming [2, 3]. There  
28 is high evidence of global warming with Africa being more susceptible to rising land  
29 temperature [3] and this will affect water resources, agriculture, health and the socio-  
30 economic development of many nations. Due to the negative impact of climate change,  
31 many international bodies are therefore making frantic effort to curb the rising global  
32 temperature.

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33 One of the long term goals of the 2015 Paris Agreement was to keep the increasing global  
34 average temperature to well below 2°C above pre-industrial levels and possibly limit the  
35 increase to 1.5°C leading to a net zero GHG emissions. to significantly minimize the risks  
36 and the impacts of climate change. One of the key measures considered was the forest and  
37 its restoration. The forest, apart from its ability to sequester carbon to mitigate the  
38 changing climate, serve as food, water purification, shelter, energy among others for billions  
39 of vulnerable people in developing countries. Despite its importance, research has shown  
40 that the forest has over the years suffered from severe disturbances through anthropogenic  
41 activities such as deforestation, degradation and desertification. Such disturbances have  
42 been a major concern and the European Union (EU) has made commitment to end  
43 deforestation and forest degradation possibly by 2030 globally with over 3 billion euros  
44 invested in addressing deforestation through REDD+ programme [4]. The Sustainable  
45 Development Goal 2015, goal 15.2 also demands the implementation of sustainable  
46 management of all types of forests, halt deforestation, restore degraded forests and increase  
47 afforestation and reforestation by the year 2020. It is estimated that 13 million hectares of  
48 forests are lost annually while continuous degradation of drylands has led to the  
49 desertification of 3.6 billion hectares and this affect poor communities negatively [5].

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50 The Reducing Emissions from Deforestation and Forest Degradation (REDD+) has become  
51 a major component of the Paris Agreement in Article 5 which states that (1) "Parties should  
52 take action to conserve and enhance, as appropriate, sinks and reservoirs of GHGs" as  
53 indicated in Article 4, paragraph 1(d), of the Convention, including forests. Also, parties are  
54 encouraged to take action to implement and support agreement under the Convention to  
55 reduce emissions from deforestation and forest degradation, enhance forest carbon stocks  
56 in developing countries and adopt an integral approach towards sustainable management of  
57 forests [6]. Afforestation, reforestation and forest restoration are therefore measures that  
58 can mitigate the changing climate. This article therefore seeks to emphasize on the  
59 importance of the tropical forest and the need for policy makers, stakeholders and the  
60 general public to seriously adopt positive approach to the management of our forest  
61 resources.  
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64 **2. THE STATE OF GHANA'S FOREST**

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Research has shown that global forest reserves are declining speedily which require urgent attention to address the problem. The Sustainable Development Goal 2015, goal 13 demands an urgent action to combat climate change and its impacts. This is a clarion call and Ghana cannot be left out. [FAO \[7\]](#) estimated that an alarming rate of 13 million hectares of forest is lost globally each year from 2000 – 2010 through deforestation. In sub-Saharan Africa, agricultural productivity has mainly centered on widening the area under cultivation [8] and this has also influenced deforestation and forest degradation. About 70-80% of the forest is lost through agricultural expansion [9] in addition to other factors such as population growth and other land use change. According to [10] Nigeria lost about 90% of its primary forest through logging, mining and agricultural plantations and the situation is not different from Ghana.

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In Ghana, it is estimated that 2% (135, 000 ha) of the forest cover is lost annually and about 60% of the forest cover is lost since 1950 [11]. Ghana's forest of about 8.2 million hectares at high forest with a transition zone of about 1.1 million hectares and savanna vegetation covering about 14.7 million hectares between 1900 and 1950 has been reduced to 4.2 million hectares [12]. An average of 46 000 hectares of Ghana's closed forest is lost annually from 1990-2010 and arable land expanded from 2.70 million hectares in 1990 to 4.70 million hectares in 2013 [13]. Recently the Forestry Commission impounded about 19 trucks carry illegal sawn lumber including Rosewood in the Eastern, Volta and Western regions and this illegal activities have been part of the forest degradation activities [14]. A speech read by Prof Mrs. Esi Awuah, former Vice Chancellor of the University of Energy and Natural Resources, also revealed that "between 2005 and 2010, the rate of Ghana's deforestation is about 2.19 percent per annum, being the sixth highest deforestation rate globally for that period. The Forestry Commission also estimated that the cost of environmental degradation is between 5-10% of GDP as at 2010 with about 63% from the forest sector [15].

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[UNDP](#) has estimated that 1.6 billion people depend on the forests for their livelihoods for varied reasons [3]. Cairns and Meganck [16] argued that tropical forests are being harvested at a rapid pace and the use of the forest to sequester carbon will fail unless the economic, social and political needs of the local people are addressed. The consistent degradation of forest resources will heighten atmospheric carbon concentration causing climate variability such as changes in temperature and rainfall pattern which causes floods, droughts, and alter watershed and biochemical processes [17]. Research has also revealed that large-scale and regular burning of vegetation in the tropics also add a great deal of gases, inter alia, carbon dioxide, nitrous oxide, carbon monoxide, methane in addition to aerosols to the atmosphere [18]. Northern Ghana experiences rampant bush burning annually and this also affects the vegetation and soil fertility in the regions. According to [19] incessant fires also affect the growth of woody vegetation. [Whelan \[20\]](#) also affirms that, the burning of forest causes death of individual trees, loss of soil nutrients, changes the surface soil organic layers and land scape among others. Ghana's Readiness Preparation Proposal (GRPP) also identifies the principal drivers of deforestation and forest degradation as agricultural expansion (50%), wood harvesting (35%), population and development pressures (10%), mining and mineral exploitation (5%). According to the [21] Ghana's economy has for a long time depended heavily on its natural resources such as timber, cocoa, minerals among others which contributes about 48% to GDP, 90% of foreign exchange earnings and 70% of total employment, and this may partly be responsible for the rapid degradation of the forest resources. The degradation of our forest also comes with cost to the nation. During the fifth Annual Environmental and Natural Resource Summit in Sunyani, it was revealed that the cost of forest depletion, agricultural soil degradation and environmental health damage in Ghana by 2010 was estimated at 3.7% of Gross Domestic Product (GDP) [22]. This

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115 therefore calls for stringent measures to address issues related to deforestation and forest  
116 degradation.

### 117 **3. DEFORESTATION – A DRIVING FORCE OF CLIMATE CHANGE IN GHANA**

118 Deforestation has become one of the major challenges to climate change especially in Africa  
119 where timber and other forest resources are overexploited for economic gains. According to  
120 [1] deforestation is said to be the second most dreadful agent that causes climate change  
121 apart from the use of fossil fuels. The continues deforestation and forest degradation will  
122 therefore intensify climate change events leading to drought, floods, extreme weather  
123 conditions, erratic rainfall patterns, sea level rise among others. The annual contribution from  
124 deforestation and changing land use is 23% of the total emission of CO<sub>2</sub> to the atmosphere  
125 [23].

126 Conversion of forests to agricultural land is estimated to be 13 million hectares annually and  
127 this releases carbon stored in trees as CO<sub>2</sub> emissions into the atmosphere [24]. It is also  
128 estimated that large-scale commercial agriculture is responsible for 40% of deforestation,  
129 subsistence agriculture which provides livelihood to many poor households in Africa  
130 including Ghana account for 33% as well as infrastructure and urban development including  
131 mining account for about 27% in the tropical regions with high population growth [13].  
132 According to [7] deforestation has resulted in the emission of CO<sub>2</sub> between 4-12% globally  
133 and 4-12 billion tonnes of CO<sub>2</sub> equivalent annually of which 9% are all attributed to  
134 agricultural land clearing. Additionally, the annual net global deforestation is said to  
135 contribute about 2 gigatons of carbon emissions to the atmosphere. Carbon loss from  
136 conversion of terrestrial ecosystems to agriculture ranges from 21 to 46% [25]. Carbon  
137 released into the atmosphere from tropical forest harvesting amount to about 11 to 3.6  
138 pentagrams of carbon annually [26] and this is likely to have a devastating consequences  
139 due to such anthropogenic activities. Excessive CO<sub>2</sub> in the atmosphere resulting in climate  
140 variability and change will affect agriculture output, energy delivery, food security and the  
141 socio-economic development of many nations. The impacts will hard-hit the very poor in  
142 society who depends on environmental goods and services for their survival.

### 143 144 **4. CARBON DIOXIDE EMISSIONS - THE ENEMY OF CLIMATE CHANGE**

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146 The sun's energy is the life sustaining resource that drives the earth's climate and weather  
147 [27] and the main source of life for plants and animals. Naturally, the climate system is  
148 designed to be self-sustaining through a balanced reaction of gases that envelope the  
149 universe especially Oxygen (21%) and Carbon dioxide (0.003%). The relationship that exists  
150 between plants and animals also play a key role in the maintenance of the self-sustaining  
151 climate systems. Plants use CO<sub>2</sub> to produce food and release oxygen as a by-product  
152 through photosynthesis while humans/animals use oxygen and give out CO<sub>2</sub> through  
153 respiration. Plants and animals are therefore supposed to co-exist harmoniously to sustain  
154 the climate systems but due to the overexploitation of the natural forest and other activities,  
155 such harmonious co-existence has been affected leading to imbalances of certain chemicals  
156 such as CO<sub>2</sub> in the atmosphere causing changes in the atmospheric parameters.

157 The roots, trunks, stems, branches and leaves of trees store carbon removed from the  
158 atmosphere making the forest an indispensable component of the carbon-energy cycle.  
159 When the leaves fall and plants die, the carbon is transferred into the soil for keep through  
160 decomposition by micro-organisms. This basically implies that the more forest we have, the  
161 more carbon will be removed from the atmosphere for storage and vice versa. Unfortunately,  
162 overexploitation of the natural forest and anthropogenic activities such as deforestation,

163 forest degradation, poor land use management, agriculture and illegal forest mining over the  
164 years have altered the natural cycle of the carbon in the atmosphere [1]. These  
165 anthropogenic activities among others have partly been responsible for the changing climate  
166 through the release of certain Greenhouse gases (GHGs) such as carbon dioxide (CO<sub>2</sub>),  
167 methane (CH<sub>4</sub>), water vapour (H<sub>2</sub>O), nitrous oxide (N<sub>2</sub>O), ozone (O<sub>3</sub>) and halocarbons [3].  
168 The higher concentration of the GHGs especially CO<sub>2</sub> which is a good absorber of infrared  
169 radiation, creates a thickening layer of pollution above the earth, trapping in heat which  
170 eventually causes global warming [25, 28] and climate change. According to Houghton et  
171 al. (1990) cited in [23], CO<sub>2</sub> alone contributes about 55% to global warming. It is estimated  
172 that a km<sup>2</sup> of tropical forest is made up of about 25,000 biomass (existing trees) which  
173 contains about 12,000 tonnes of carbon and 2/3 of this amount is converted into CO<sub>2</sub> [29].  
174 This therefore shows how important the forest is in maintaining a sound environment and  
175 avert or mitigate the challenges on climate change.

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## 177 5. THE ROLE OF FOREST IN CLIMATE CHANGE MITIGATION

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179 The forest in Ghana has suffered drastic decline over the years through resettlement,  
180 clearing of land for farming and building projects, illegal chainsaw milling and logging, wood  
181 fuel and charcoal production in addition to bush burning, infrastructural development and  
182 mining activities especially in the three regions of the north [30]. The forest is known for its  
183 ecosystem services, biodiversity conservation and maintenance of its cultural heritage for  
184 generations and forms a major component of human existence. The forest plays a vital role  
185 in controlling CO<sub>2</sub> concentration in the atmosphere and global hydrological cycle through the  
186 mediation of surface runoff, groundwater recharge and GHG mitigation strategies [7].  
187 Through photosynthesis, the forest absorbs carbon from the atmosphere thus reducing the  
188 concentration of CO<sub>2</sub> in the atmosphere. CO<sub>2</sub> is also stored in the various parts of the plants  
189 and the more plants we have, the more CO<sub>2</sub> is extracted and stored. According to [31]  
190 every tree stores about 50% of carbon which is extracted from the atmosphere and for every  
191 tonne of carbon stored, 3,667 tonnes of CO<sub>2</sub> is taken from the atmosphere. Lawrence [32]  
192 has also estimated that old-growth tropical forests store between 120-400 tonnes of carbon  
193 per hectare of land. Nair *et al.* [33] also reported that agro-forestry systems like inter-  
194 cropping with about 50 trees/ha can store 100 to 147 tonnes of CO<sub>2</sub> equivalent/ha in semi  
195 and arid lands. An FAO document on building greener cities also suggests that mature trees  
196 can absorb up to 150 kg of CO<sub>2</sub> per year [34]. The forests contain twice as much carbon as  
197 the atmosphere and metabolize more than 14% of atmospheric carbon each year [35].  
198 These facts, unequivocally, make the forest an indispensable resource for the extraction and  
199 storage of atmospheric carbon to mitigate climate change.

200 Apart from the forest serving as carbon sequester, it also provides a cooling effect to reduce  
201 the heat within the environment. Boanoua *et al.* [36] has observed a year-round cooling of  
202 0.8 °C in the tropical areas of Africa due to increased vegetation cover. According to [37]  
203 shading and vegetation cover reduces the mean and variance of groundwater  
204 temperature. FAO document on building greener cities also suggests that trees located at  
205 certain areas can help cool the air between 2-8 °C which will influence the heat island effect  
206 in urban cities [34]. The cooling effects of protecting and restoring forest cover in the tropics  
207 may be even greater than originally estimated.

208 Deforestation and forest degradation therefore inhibit the forest from performing its  
209 multipurpose functions. All the carbons stored in the forest plants find their way back into the  
210 atmosphere when the forest is cleared and burnt. The ability of the forest to remove CO<sub>2</sub> is  
211 denied thus increasing the concentration of carbon in the atmosphere. Burning of the forest  
212 also incapacitate the trees from absorbing CO<sub>2</sub> in the atmosphere. Deforestation and forest  
213 degradation through burning therefore enhance the concentration of CO<sub>2</sub> in the atmosphere

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214 leading to global warming and climate change. Restoration and proper management of the  
215 forest will therefore play a key role in mitigating the changing climate.

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## 217 **6. THE SOCIAL AND ECONOMIC BENEFITS OF THE FOREST**

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219 The social and economic benefits of the forest cannot be overemphasized. The forest, apart  
220 from maintaining ecological balance, provides environmental goods and services to support  
221 the livelihood of millions of poor people in developing countries. The forest provides  
222 medicine, shelter, energy, food, and clothing; enhance soil fertility, water quality and improve  
223 soil structure and texture among others. It is estimated that the forest provide livelihoods to  
224 about 1.6 billion people and a home to over 80% of all terrestrial species of animals, plants  
225 and insects [5]. However, lack of economic opportunity, poverty and hunger compel poor  
226 people in low income countries to exploit the natural resources around them especially  
227 women. Sunderland et al. [38] observed that, women lack the opportunity to generate  
228 adequate income as men even though they tend to commercialize the forest products better  
229 than men.

230 Deforestation is directly linked to poverty levels in that as deforestation increases in  
231 developing countries due to population explosion, demand for agriculture lands and  
232 unsustainable forest resource exploitation also increase. However, developed nations forest  
233 keeps increasing while population decreases [13]. Many governments in the continent also  
234 exploit the raw forest timber and other forest products to generate foreign exchange, even  
235 though, some hardly re-invest part of the proceeds to restore the lost forest. In Ghana, the  
236 forest sector generated about US\$283.2 million in 2013 through export [13]. According to  
237 [39] about 40% or 2.4 billion people living in developing countries depend on wood fuel for  
238 cooking and these are mainly women. It is estimated that about 88% of household energy in  
239 Ghana for cooking comes from wood fuel and charcoal [40]. The savannah zone with low  
240 forest resources also provides about 70% of Ghana's total annual firewood and charcoal  
241 requirement estimated at 16 million m<sup>3</sup> [41]. The situation is not only limited to the north but  
242 across the entire country. It is true that the continuous dependence on the forest for energy  
243 and income through various means have adversely affected the forest cover. However, due  
244 to the economic circumstances of many rural dwellers that depend on the forest, appropriate  
245 policies could be developed to specifically assist these rural dwellers to ease the pressure  
246 on the forest. The adoption of urban and peri-urban forestry will also improve nutrition and  
247 food security, ensure climate change mitigation and possible adaptation as well we as  
248 providing ecosystem services. According to FAO, trees in cities could bring substantial  
249 benefits such as provision of food and nutrition, safety of urban biodiversity, mitigate urban  
250 pollution, climate change, regulate urban water and air flows, sustain conducive environment  
251 and increase esthetics, physical and mental health and property value of the cities [34].  
252 However, the underlying cause of illegal logging, felling of trees for charcoal production and  
253 wood fuel as well as poor agricultural expansion must first be addressed to reduce  
254 deforestation and forest degradation. With proper investment and value addition to the forest  
255 products, the challenges of deforestation and forest degradation could be minimized.

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259 **7. CONCLUSION AND RECOMMENDATIONS**

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261 This article has outlined the role of the forest in mitigating climate change and also provides  
262 additional benefits to the economy and society as a whole. The importance of the forest to  
263 mitigate climate change through CO<sub>2</sub> sequestration cannot be overemphasized. Carbon  
264 dioxide which is the major driver of climate change is a threat to our environment and the  
265 forest as a carbon sink can play a key role to avert the negative consequences of the  
266 changing climate. It has already been established that the forest has the capacity to remove  
267 substantial amount CO<sub>2</sub> from the atmosphere and clearing such forest resources will cause  
268 climate variability which may have serious consequences on water resources, food  
269 production, energy and socio-economic development of many African countries.

270 Besides, the forest provides many benefits to the socio-economic and cultural existence of  
271 mankind. Human life and the climate without doubt depend on the forest. The saying that  
272 "the day the last tree will die, the last man will also die" indicates that our human life is  
273 actually linked to nature. Adopting intensive afforestation and reforestation globally and  
274 proper land use and agricultural management, efficient energy use, and frantic effort to  
275 prevent deforestation and land degradation could be the way forward in mitigating the effect  
276 of climate change. Let's therefore protect our forest for posterity. The following are  
277 suggested recommendations to promote the forest resources for climate change mitigation  
278 in Ghana.

279 1. Eliminating Poverty - Poverty is indeed the underlying cause of forest and environmental  
280 degradation. Charcoal production, illegal forest mining and other anthropogenic activities  
281 stem from people's effort to make ends meet. An alternative means of livelihood will reduce  
282 if not eliminate the rate of deforestation in Ghana.

283 2. Empowering local communities - chiefs, opinion leaders and assembly men in  
284 communities can effectively manage the forest around them if given the mandate to do so.  
285 This is a shared responsibility.

286 3. REDD+ Policy - proper adaptation and implementation of the REDD+ will result in socio-  
287 economic and environmental benefits leading to the mitigation of climate change, economic  
288 growth, job creation, livelihoods enhancement, food security, forests conservation and  
289 promotion of sustainable development.

290 4. Enforcement of laws and institutional empowerment - institutions should be empowered to  
291 enforce laws and regulations pertaining to illegal forest mining and trade including land use.

292 5. Woodlots production and agro-forestry - encourage the planting of woodlots for wood fuel  
293 and charcoal production including incentives for agro-forestry promotion to free the forest  
294 from further encroachment.

295 6. Massive afforestation and reforestation including Urban and Peri-urban tree planting -  
296 deliberate planting of trees on all degraded lands including settlements have diversified  
297 benefits.

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