

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 CO₂ 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, CO₂ emissions, deforestation, mitigation

16 **1. INTRODUCTION**

17

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 CO₂ 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 (CO₂), methane (CH₄), water vapour (H₂O), nitrous oxide
26 (N₂O), ozone (O₃) 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.

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 and
36 the impacts of climate change. One of the key measures considered was the forest and its
37 restoration. The forest, apart from its ability to sequester carbon to mitigate the changing
38 climate, serve as food, water purification, shelter, energy among others for billions of
39 vulnerable people in developing countries. Despite its importance, research has shown that
40 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].

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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66 Research has shown that global forest reserves are declining speedily which require urgent
67 attention to address the problem. The Sustainable Development Goal 2015, goal 13
68 demands an urgent action to combat climate change and its impacts. This is a clarion call
69 and Ghana cannot be left out. FAO [7] estimated that an alarming rate of 13 million hectares
70 of forest is lost globally each year from 2000 – 2010 through deforestation. In sub-Saharan
71 Africa, agricultural productivity has mainly centered on widening the area under cultivation
72 [8] and this has also influenced deforestation and forest degradation. About 70-80% of the
73 forest is lost through agricultural expansion [9] in addition to other factors such as population
74 growth and other land use change. According to [10] Nigeria lost about 90% of its primary
75 forest through logging, mining and agricultural plantations and the situation is not different
76 from Ghana.

77 In Ghana, it is estimated that 2% (135, 000 ha) of the forest cover is lost annually and about
78 60% of the forest cover is lost since 1950 [11]. Ghana's forest of about 8.2 million hectares
79 at high forest with a transition zone of about 1.1 million hectares and savanna vegetation
80 covering about 14.7 million hectares between 1900 and 1950 has been reduced to 4.2
81 million hectares [12]. An average of 46 000 hectares of Ghana's closed forest is lost annually
82 from 1990-2010 and arable land expanded from 2.70 million hectares in 1990 to 4.70 million
83 hectares in 2013 [13]. Recently the Forestry Commission impounded about 19 trucks carry
84 illegal sawn lumber including Rosewood in the Eastern, Volta and Western regions and this
85 illegal activities have been part of the forest degradation activities [14]. A speech read by
86 Prof Mrs. Esi Awuah, former Vice Chancellor of the University of Energy and Natural
87 Resources, also revealed that "between 2005 and 2010, the rate of Ghana's deforestation is
88 about 2.19 percent per annum, being the sixth highest deforestation rate globally for that
89 period. The Forestry Commission also estimated that the cost of environmental degradation
90 is between 5-10% of GDP as at 2010 with about 63% from the forest sector [15].

91 UNDP has estimated that 1.6 billion people depend on the forests for their livelihoods for
92 varied reasons [3]. Cairns and Meganck [16] argued that tropical forests are being harvested
93 at a rapid pace and the use of the forest to sequester carbon will fail unless the economic,
94 social and political needs of the local people are addressed. The consistent degradation of
95 forest resources will heighten atmospheric carbon concentration causing climate variability
96 such as changes in temperature and rainfall pattern which causes floods, droughts, and alter
97 watershed and biochemical processes [17]. Research has also revealed that large-scale and
98 regular burning of vegetation in the tropics also add a great deal of gases, inter alia, carbon
99 dioxide, nitrous oxide, carbon monoxide, methane in addition to aerosols to the atmosphere
100 [18]. Northern Ghana experiences rampant bush burning annually and this also affects the
101 vegetation and soil fertility in the regions. According to [19] incessant fires also affect the
102 growth of woody vegetation. Whelan [20] also affirms that, the burning of forest causes
103 death of individual trees, loss of soil nutrients, changes the surface soil organic layers and
104 land scape among others. Ghana's Readiness Preparation Proposal (GRPP) also identifies
105 the principal drivers of deforestation and forest degradation as agricultural expansion (50%),
106 wood harvesting (35%), population and development pressures (10%), mining and mineral
107 exploitation (5%). According to the [21] Ghana's economy has for a long time depended
108 heavily on its natural resources such as timber, cocoa, minerals among others which
109 contributes about 48% to GDP, 90% of foreign exchange earnings and 70% of total
110 employment, and this may partly be responsible for the rapid degradation of the forest
111 resources. The degradation of our forest also comes with cost to the nation. During the fifth
112 Annual Environmental and Natural Resource Summit in Sunyani, it was revealed that the
113 cost of forest depletion, agricultural soil degradation and environmental health damage in
114 Ghana by 2010 was estimated at 3.7% of Gross Domestic Product (GDP) [22]. This

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 CO₂ 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 CO₂ 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 CO₂ between 4-12% globally
133 and 4-12 billion tonnes of CO₂ 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 CO₂ 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 CO₂ to produce food and release oxygen as a by-product
152 through photosynthesis while humans/animals use oxygen and give out CO₂ 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 CO₂ 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 (CO₂),
167 methane (CH₄), water vapour (H₂O), nitrous oxide (N₂O), ozone (O₃) and halocarbons [3].
168 The higher concentration of the GHGs especially CO₂ 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], CO₂ alone contributes about 55% to global warming. It is estimated
172 that a km² 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 CO₂ [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 CO₂ 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 CO₂ in the atmosphere. CO₂ is also stored in the various parts of the plants
189 and the more plants we have, the more CO₂ 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 CO₂ 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 CO₂ 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 CO₂ 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 CO₂ is
211 denied thus increasing the concentration of carbon in the atmosphere. Burning of the forest
212 also incapacitate the trees from absorbing CO₂ in the atmosphere. Deforestation and forest
213 degradation through burning therefore enhance the concentration of CO₂ in the atmosphere

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 m³ [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 CO₂ 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 CO₂ 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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