

Forest Transition: Towards Modulating Climate Change

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Abstract: Forest provides crucial and beneficial services to man. Transformation of forest areas to non-forest ones has occurred throughout human history, with its notable far-reaching consequences, which has propelled the need to increase forest area in many parts of the world. This gradual recovery from forest decline; forest transition, is a realistic phenomenon in some countries of the world rather than a theory. Reduction in forest loss does not automatically induce forest transition but rather by conscious efforts at increasing forest cover, driven by sustainability of forest products and services, economic development and globalization, increased environmental literacy, improved agricultural practices, forest policies and programs as well as population decline. Climate change is unarguably a global threat and how to manage it has been the greatest environmental challenge confronting the world. Forests play key roles in altering climate elements which determine the general climate condition. Forest transition is a major way of modulating the climate change phenomenon and its effects. Forest recovery has provided a means of modulating climate change through increase possibility of atmospheric carbon sequestration and moderation of rainfall pattern; major determinants of climate change.

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Introduction

Vast areas of land occupied by dense tall trees and other communities of biota constitute a forest (Olagunju, 2015). Forest provides numerous crucial services that are beneficial to human, which include; provision of ecological, economic, socio-cultural and aesthetic benefits. It conserves and protects biodiversity, it aids carbon sequestration and soil management, it provides food and medicinal products; and serves as source of employment and income. Another major function of forest is its contribution in altering climate elements; which invariably have effects on climate change. Hence, factors that impinge on the forests also indirectly impact on climate change. Throughout history, humans have transformed natural forests to agricultural land, settlements areas, and managed forests among others (Kastner *et al.*, 2011) and there have been interventions in many countries of the world to recover the lost forests, many of which has yielded positive results. Studying the dynamics of forest change from one geological period to another is a potential mainstay in climate change management.

Forest transition concept relates to general patterns of increase utilization of natural forests by human thereby resulting to reduced forest areas followed by reduced rate of forest lost and eventual forest recovery. This return of forests has been termed the forest transition (Mather, 1992; Rudel *et al.*, 2005). Forest transitions have been identified in various settings and many parts of the world with their underlying mechanisms described (Kauppi *et al.*, 2006;

Erb *et al.*, 2008; Meyfroidt and Lambin, 2008). Forest transition has been identified to be associated with socio-economic transformations such as industrialization and urbanization. Early stages in the development of a country is characterized by high forest cover and low deforestation rates, followed by accelerated rates of deforestation and forest cover reduction, before the deforestation rate slows down, forest cover stabilizes and then eventual forest recovering (Angelsen and Ainembabazi, 2014).

Global Forest and Forest Transition

Forests cover over four billion hectares, 31 per cent of the world's total land area (FAO, 2011). According to the Food and Agricultural Organization of the United Nations, global forest cover was reduced by more than 70 Mha since 1990, roughly 0.5% of the global land area (Pagnutti *et al.*, 2013). Worldwide assessment of annual change forest area has revealed some levels of forest transition despite the apparent demise of the world's forests, particularly in the industrialized world; that is, a transition from declining to expand forested area (Lambin and Meyfroidt, 2011).

At the global level, annual forest loss decreased from 16 million hectares in the 1990s to approximately 13 million hectares between 2000 and 2010 (FAO 2011). As shown in figure 2, no existence of forest transition between 2000 and 2005 in almost all African countries as their forest cover still reduced with many up to more than 0.05% while forest transition within these years is evident in Europe and many Northern Asia countries (FAO, 2005). But the report of FAO in

2010 as shown in table 1 revealed that the percentage annual change in forest area of the world between 2000 and 2010 is estimated to be -0.13% compared to the percentage change of the preceding decade (1990-2000) put as -0.20% (FAO, 2010). At continental level during these two geological decades, Africa, Asia, North and Central America have experienced reduced forest loss while it is unchanged in South America but increase Oceania and Europe. Hence, this does not

support that reduction in forest loss will automatically translate into forest transition. For instance, Africa whose percentage change in forest cover between 1990-2000 and 2000-2010 increased from -0.56% to -0.49% (FAO, 2010) has not been experiencing forest transition. Nevertheless, the ongoing forests cover acceleration in many countries of the world has induced forest transition in those regions.

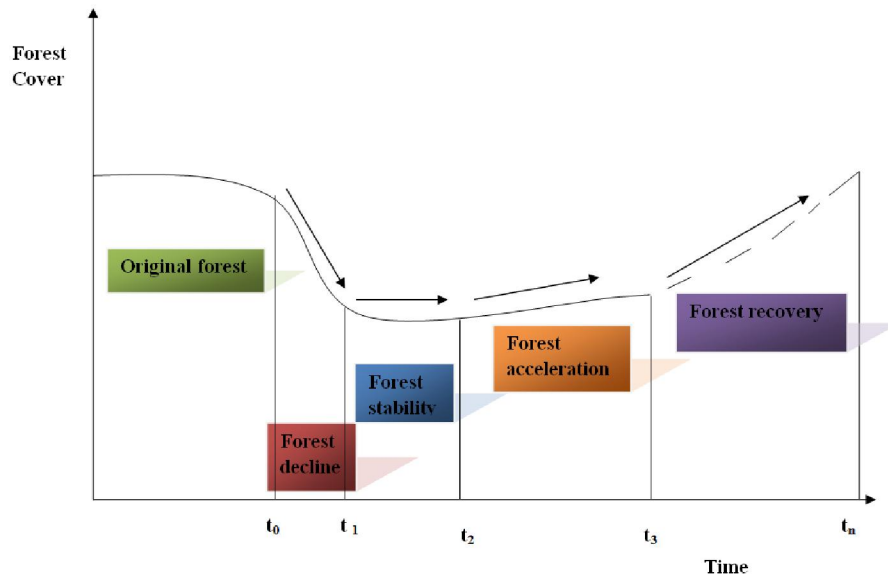


Figure 1: Generalized Forest Transition Pattern

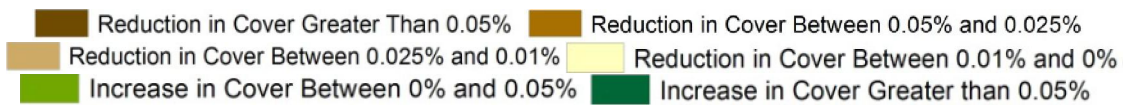
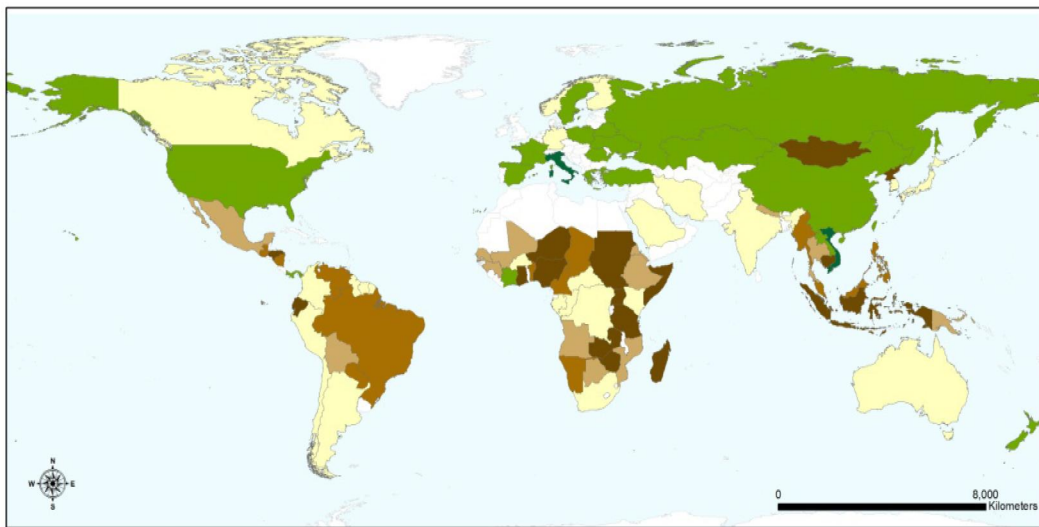


Figure 2: Percentage Change in Forest Cover in Countries with greater than 5 million hectares of Forest between 2000 and 2005

Source: FAO, 2005

Table 1: Forest Transition Phenomenon in Parts of the World between 1990-2000 and 2000-2010

Region/subregions	1990-2000		2000-2010	
	Forest cover		Forest cover	
	1000 ha/year	% change	1 000 ha/year	% change
Eastern and Southern Africa	-1841	-0.62	-1839	-0.66
Northern Africa	-590	-0.72	-41	-0.05
Western and Central Africa	-1637	-0.46	-1535	-0.46
Total Africa	-4067	-0.56	-3414	-0.49
East Asia	1762	0.81	2781	1.16
South and Southeast Asia	-2428	-0.77	-677	-0.23
Western and Central Asia	72	0.17	131	0.31
Total Asia	-595	-0.10	2235	0.39
Russian Federation (RF)	32	n.s.	-18	n.s.
Europe excluding RF	845	0.46	694	0.36
Total Europe	877	0.09	676	0.07
Caribbean	53	0.87	50	0.75
Central America	-374	-1.56	-248	-1.19
North America	32	n.s.	188	0.03
Total North and Central America	-289	-0.04	-10	0.00
Total Oceania	-41	-0.02	-700	-0.36
Total South America	-4213	-0.45	-3997	-0.45
World	-8327	-0.20	-5211	-0.13

Source: Adapted from FAO, 2010

But the situation of France revealed the possibility of forest transition to be altered by forest decline (Pagnutti *et al.*, 2013). France was believed to experience two forest transitions which were followed by a second period of forest decline. Decline of French population during the time of the Black Death was reported to be cause of the first forest transition while the second was due to agricultural intensification among other factors (Mather *et al.*, 1999).

Causes of Forest Transition

A large number of explanations have been put forward about factors that drive change in forest cover over time. However, the key drivers of forest loss are population growth, poverty, economic growth, land pricing, international demand for timber and other forest products, insecurity of the rights of local people, and incomplete valuation of forest ecosystems (Carr *et al.* 2005; Lambin *et al.* 2001). Angelsen and Rudel (2013) identified five drivers of forest transition which include: scarcity of forest products, impoverished forest environmental services, economic development, forest policies and diminished agricultural rent. But below are the major causes of forest transition.

a. **Sustainability of Forest Products and Services:** The desire for continuous access to products and services rendered by forest is quite often an instigator of forest transition. Exploitation of forest product usually results into their scarcity, a situation which aroused conscious effort of members of a community or a country at large to reduce or stop

forest products exploitation usually through the use of alternatives, afforestation and reforestation, for the benefit of future use. As Lambin and Meyfroidt (2010) found in Vietnam, the economic importance of trees and tree crops contributed to an increase in forest cover. For instance, before 1990s, there was an intense deforestation in the mountains that made up of two-thirds of Vietnam which resulted into the scarcity of forest products such that forest products were expensive and became almost inaccessible. This situation propelled reforestation in the country which resulted into forest transition (De Konlinck, 1999; Castella and Quang, 2001).

b. **Economic Development and Globalization:** Economic development and emerging economies globalization has open opportunities in non-agricultural sector in terms of job creation and foreign exchange earnings. In many developing and developed countries, economic development has led to the migration of rural population to the urban cities such that labour force is driven from agriculture to other economic sectors, leaving behind once cultivated lands which were subsequently taken over by tress through natural regeneration. Also, many rural dwellers depends on firewood as a major source of energy, but their migration to urban area cause a shift in fuel wood as energy source to other means such as petroleum products. For instance, between 1970 and 1990, urbanization in South Korea was very fast and the rural population decreased from 44.7% to 15.4% (Bae *et al.*, 2012). This had a drastic reducing impact

on the consumption of fuel wood and hence resulted into increase in the extent and quality of forest cover.

c. **Increased Environmental Literacy:** Increased environmental education and literacy has played a major role in forest sustainability, understanding the context of environment and the knowledge of how human interactions can influence the environment- a basis for curtailing deforestation and other environmental problems (Olagunju, 2015). It provides public awareness on the dangers of forests impoverishment as well as ensures behaviour change towards conscious efforts of forest improvement through afforestation and reforestation. This is a big force in developed world and is gaining momentum in emerging economies (Kant and Shuirong, 2013).

d. **Improved Agricultural Practices:** Improved technologies in agriculture, higher yielding varieties and expansion of irrigation and disease control are veritable tools to increase agricultural productivity, thereby reducing pressure on new lands for agriculture. For instance, Scotland farmers abandoned croplands of low productivity, concentrating on smaller extents of good quality lands and the abandoned lands quickly regenerated with native forest species (Mather, 1999). Also, agroforestry practice has become increasingly popular across the world. Not only will the practice lead to rapid increase in forest cover but also serve as an additional income option for small farmers even as it relieves the pressure on natural forests by meeting part of the demand.

e. **Government Forest Policies and Programs:** National forest policies play an important role in forest transition. Such policies aim at reducing deforestation, ensuring reforestation and afforestation. As illustrated by Song and Zhang (2010), forest cover in China increased from 8.6% in 1949 to 18.2% in 2003 as a result of central government policies and efforts. Chinese government initiated a program in 1978 aimed to combat desertification in northern China called the Great Green Wall Program by increasing forest cover from 5% to 15% (Xu *et al.*, 2006; Wang *et al.*, 2010). As a result of this initiative, China experienced a national forest transition from a net forest loss to a net forest gain by approximately 1981 (Zhang and Song, 2006).

f. **Population Decline:** Population growth often has been linked to forest decline. Due to rapid population growth, there is an increase in the rate of forest products exploitation especially in the developing countries. Places with population decline due to plague, natural disasters or war, have been documented to experience forest transition especially during these periods of population decline or reduced population growth. For instance, in the 14th and 15th centuries, plague which rampaged through the Europe

in cycles reduced the population of France by one third, which resulted into abandonment of agricultural lands across the countryside, played a crucial role in reversing the trend of deforestation and ensured forest transition during that period.

Climate Change Concept

Climate is the prevailing average weather conditions (such as temperature, rainfall, and wind) of a certain region over an extensive geological period. The climate system is a complex, interactive system consisting of the atmosphere, land surface, snow and ice, oceans and other bodies of water, and living things. The earth's climate is most affected by latitude, the tilt of the Earth's axis, the movements of the Earth's wind belts, and the difference in temperatures of land and sea, and topography. Human activity, especially relating to actions relating to the depletion of the ozone layer such as deforestation, is also an important factor.

Climate change is the biggest global environmental and health threat of the 21st century. Climate change has been defined as a phenomenon created by human beings and nature, which devastates the earth and causes hardship of unpredicted magnitude to the living (Intergovernmental Panel on Climate Change (IPCC), 1990). United nation on Environmental programme, (UNEP) (2000), defines climate change as extreme reactions of the weather phenomenon which creates negative impact on agricultural resources, water resources, human health, depletions of ozone layer, vegetations, soil and doubling of CO₂ in the ecosphere. Medugu (2009) submitted that climate change refers to an increase in average global temperatures caused by natural events and human activities, which are believed to be contributing to an increase in average global temperatures.

Climate change is the result of the buildup of green houses gases in the atmosphere either through increase release of these gases (such as in burning of fossil fuel) or destruction of their sequestration repositories (such as in deforestation). Such gases include carbon dioxide and methane, which warm and alter the global climate thereby causing environmental changes. These effects of the deleterious environmental changes include incidences of stronger hurricane, loss of mountain glacier and snow pack, expansion of ocean, increase drought and flood, increase disease burden, loss of biodiversity and extreme weather conditions.

Forest Transition and Climate Change: The link

The greatest challenge that confronts the world today is how the effects and the phenomenon of climate change can be modulated. Forests play a major role in climate condition. Global deforestation is recognized as one of the core causes of global

environmental change (Klepeis and Turner, 2001; Olagunju, 2015). It drives species extinction and habitat destruction and affects carbon emissions and climate change on several scales (Houghton 2003; Foley et al. 2005). Reducing deforestation has become an international priority, given the impacts on carbon emission and biodiversity loss.

Forest and Carbon Sequestration

Carbon is a major greenhouse effect whose increase amount in the atmosphere aggravates the condition of the climate. Forests transition play roles in the carbon cycle and thus in the climate system:

i. When a forest is cleared, carbon stored in wood and soil is lost to the atmosphere and up to 16% of the current human CO₂ emissions have been reported to be due to deforestation.

ii. About 30% of human CO₂ emissions are absorbed by forests and other vegetation currently. This is sometimes called the “forest carbon sink”, and when a forest is cleared, it ceases to provide this function.

Hence, forest recovery will provide increase atmospheric carbon sequestration and therefore reduce the impacts of climate.

Forests and Rainfall Pattern

Hydrological science has clearly shown that forests play a major role in the global water cycle (Andreassian, 2004). Evaporation of large volume of moisture from the earth surface occurred during the day, and this leads to cooler, moister air in their vicinity and downwind. Large scale deforestation is predicted by climate models to have far reaching effects on rainfall pattern. While deforestation lead to abnormal changes in local rainfall pattern and cause increase in temperature, forest transition will modulate such effects. In addition to modulation of rainfall pattern by forest transition, at a regional scale, rainfall derived from forests can be critical to agriculture and other industries.

Conclusion

Forest transition is a pattern of forest recovery from decline towards original state. It is associated with socio-economic transformation of a geographical area like a country. Forest transition is evident in some countries whose rate of forest loss has been reduced or stop with increase in forest cover. Sustainability of forest products and services, economic development and globalization, increased environmental literacy, improved agriculture practices; government policies and programs as well as population decline are major causes of forest transition. Climate change is a global problem with deleterious impacts on humans. Forest transition has provided a means to modulating the effects of climate through the activities of forest at

sequestering atmospheric carbon and moderating rainfall pattern.

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