RUFORUM Working Document Series (ISSN 1607-9345), 2019, No. 18 (1): 541-548.
Available from http://repository.ruforum.org

Research Application Summary

Dynamics of agricultural expansion into forest habitats in Zambia: A case study from Zambia Copperbelt and North-western Provinces

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Abstract

The natural environment has been continuously reshaped, ever since man settled down and left nomad livelihood in favor of agriculture production. And, in pre-agricultural times, about 50% of the forest that once covered earth now is gone. Expanding agriculture through increased in area under cultivation is the main cause of tropical deforestation. And it is driving by high exponential growth in population which demand agricultural practices to expand its land size at the expense of forest. This paper comprehensively review literature on the overview of land use and land cover change. Also, a review on the drivers and the general impact of land use and land cover change was adopted in this study. Likewise, a review on impact of agriculture and its practices on forest habitats was espoused in this study. The literature revealed that the high transition in forest cover substantially result from expanding agricultural lands. Increased agricultural lands to meet the exponential demand of agricultural products have exacerbate forest degradation. The reviewed studies estimated high growth in agriculture sector which take the form of increased in area under cultivation to recognized high production to meet the demand. From the literature reviewed, it is suggested to sustainably utilize agricultural lands, promote agroforestry, increase intensification, transformation in policy associated with strict implementation for robust forest sustainability.

Key Words: Agriculture expansion, forest, land use and land cover change

Résumé

L'environnement naturel a été continuellement remodelé depuis que l'homme s'est installé et a abandonné le mode de vie nomade en faveur de la production agricole. De nos jours, à l'époque pré-agricole, environ 50 % des forêts qui recouvraient autrefois la Terre ont disparu. L'expansion de l'agriculture par l'augmentation de la superficie cultivée est la principale cause de la déforestation tropicale. Celle-ci est motivée par une croissance exponentielle élevée de la population, qui demande des pratiques agricoles pour étendre la taille de ses terres aux dépens des forêts. Cet article examine de manière exhaustive la littérature sur l'aperçu des changements d'utilisation des terres et de la couverture des sols. De même, une revue des moteurs et de l'impact général des changements d'utilisation des terres et de la couverture des sols a été adoptée dans cette étude. De plus, une revue de l'impact de l'agriculture et de ses pratiques sur les habitats forestiers a été adoptée dans cette étude. La littérature a révélé que la forte transition de la couverture forestière résulte substantiellement de l'expansion des terres agricoles. L'augmentation des terres agricoles pour répondre à la demande exponentielle de produits agricoles a exacerbé la dégradation des forêts. Les études examinées estiment une croissance élevée dans le secteur agricole, se traduisant

par une augmentation de la superficie cultivée pour une production élevée afin de répondre à la demande. À partir de la littérature examinée, il est suggéré d'utiliser durablement les terres agricoles, de promouvoir l'agroforesterie, d'accroître l'intensification et de transformer les politiques associées à une mise en œuvre stricte pour une durabilité forestière robuste.

Mots-clés : Expansion agricole, Forêt, Changement d'utilisation des terres et de la couverture des sols

Introduction

The cultivation of land for getting food crops and cash crops elucidate agriculture. And this practices have been continuously reshaped the natural environment ever since man settled down and left nomad livelihood in favor of agricultural production. As expected, this state of affairs has given rise to human induced changes over the globe. With regard to vegetation, it is estimated that as much as 50% of the forest that once covered Earth now is gone in pre-agricultural times (Bryant *et al.,* 1997). And, the last two decades study revealed that, thus between the years 1980 and 2000, about 83% of all new agricultural land in the tropics came from either intact forests (55%) or disturbed forest (28%) (Gibbs *et al.,* 2010).

In Sub-Saharan Africa (SSA), agriculture is the largest employer of labour, and it is responsible for over half of the export earnings, and has the potential to play in the development of the continent's (Adekunle *et al.,* 2012). The study further revealed that agriculture sector had supports over two thirds of Africa's poor livelihoods and assumes even greater importance in the continent's poorer countries. The growing concern over the agricultural sector is associated with growing demand for agricultural products necessary to boost economy, ensure food security and income generation and reduce poverty among the rural poor. Study revealed by Maitima *et al.* (2009) in East Africa on the benefits of agriculture emphasized that, the benefits from agriculture sector are not only intended for rural poor but also for the large-scale investors in commercial farming sector.

The exponential growth in human population is parallel to growing needs of food items, and the trend may demands agricultural sector to increase agricultural production through expansion of agricultural land size to meet the growing needs, and that may pose greater threat to the natural environment and biodiversity. Historical, Lambin *et al.* (2003) observed that agricultural outputs have been accelerated by humans chiefly by bringing more land into production, and have made natural vegetation given way not only to croplands but also to native or planted pastures. Increase agricultural land size for the benefits of producing more outputs to meet the growing needs has impacted negatively to the forest habitats. For example, CGIAR (2011) observed that the expansion of tropical agricultural land cover has generated significant negative environmental impacts in the form of changes to the natural forest cover. The development of agricultural sector through increase in area under cultivation has been revealed as the main cause of tropical deforestation, and will probably continue to expand into wetlands and rainforests (Angelsen and Kaimowitz, 2001; FAO, 2003; Gibbs *et al.,* 2010). And, it has been estimated in the UNEP (2003) report that the share of tropical deforestation related to agricultural expansion was at 70% in the 1990's.

The growing demand for agricultural products results from growing population, increasing prosperity as a result of economic development, and changes in consumer preference (Adekunle, *et al.,* 2012). As a result of various players involved in demand from agricultural products, FAO

(2001) elucidated that population growth and agricultural development programs have been the ultimate vehicle of agricultural expansion, and has resulted to forest cover changes. Further explains in the report that the accelerated growth in population has resulted to increase in demand for food, and it is met through intensification and arable land expansion. Similarly, for instance, a net increase of 120 million ha was projected in developing countries to expand crop production over the period to 2030 of which part of this scenario is expected to come from forest clearance (FAO, 2003).

Despite a high forest cover of about 66% of the total land cover of Zambia (Kalinda *et al.,* 2013; FAO, 2015), the country experiences high deforestation and it is driven by centrally planned farm blocks, urbanization, new settlements, road development and mining (Ngoma and Angelson, 2017). These activities have been captured in many literature to pose serious threats to the country's natural forest habitats, as a result of unsustainable practices associated with in particular agricultural activities (CGIAR, 2011; Ngoma and Angelson, 2017). Hence, there is a need to review literature to provide current knowledge on land use and land cover (LULC) change, drivers and impact of changes to LULC, as well as the share of agriculture to forest transition. Therefore, this study review literature on overview of LULC change, drivers of the general impact of LULC change, and the contribution of agriculture expansion to forest degradation.

Literature Review

Overview of Land Use and Land Cover Change. The general recognition is that changes in land use and land cover (LULC) have been due to configuration of multiple factors together with its associated challenges in the past decade. Pauldel *et al.* (2016) explained that land utilization significantly change features of the Earth landscape due to periodic natural and human adaptation. The Authors further explained that the heterogeneity process of LULC make it complex and that they operate in varying form with differences in size and rate.

Land use and land cover are used interchangeably. Generally, Turner and Meyer (1994) explained that land use refers to the manner in which the biophysical attributes of the land are manipulated, and also the intent underlying that manipulation. In the same way, Meyer and Turner (1996) also described "land use as the way in which human beings use the land and its resources". Both definitions are in line with that of the FAO (1995) which defines also land use as *".... the function or purpose for which the land is used by the local human population and can be explained as the human activities which are directly related to land, making use of its resources or having an impact on them".* On the other hand, land cover is defined by Meyer (1995) as the kind and state of vegetation properties such as cropland, forest cover, grass cover, wetland, pastures, roads, urban areas among others. All these properties may be described as the biophysical state of the earth surface.

Both land use and land cover have been changing over time (Ellis and Pontius, 2007). Therefore, understanding the meaning of change while attempting to analyze dynamic environment is essential. Traditional meaning of change is either wane/reduce or gain/increase. These increase or decrease which relate to land resources manifest through varieties of way. For instance, Meyer and Turner (1996) articulated that "land use (both deliberately and inadvertently) alters land cover in three ways: converting the land cover, or changing it to a qualitatively different state; modifying it, or quantitatively changing its condition without full conversion; and maintaining it in its condition

against natural agents of change". Study by Jones & Clark (1997) indicated the kind of LULC changes in the agricultural context as intensification, extensification, marginalization and rejection. On the other hand, IPCC (2007) also indicated the kind of LULC changes in the context of forest cover as recreation, forest transition to croplands, forest cover which is suitable for wood product and not used to significant extent for other purpose, forest cover where tree cover is desirable in order to protect against sand or soil erosion and areas in terms of vegetative cover.

Drivers and impact of the general LULC change. In human and environment nexus, land and its resources are the most important priority which supports the entire human endeavor. However, Briassoulis (2006) mentioned that human needs dynamically shape land resources. Study by Agarwal *et al.* (2002) also expressed out that resources changes were occurring at various spatial and temporal levels. The spatial and temporal transition of land resources in the terrestrial environment have been fully documented and distilled by FAO (2006). They have reported that the dominant type of land resources changes in line with vegetation change is the conversion of forest to agricultural systems with continuously high rates of 13 million ha been deforested per year in the world. Many studies have shown that the value humans attached or placed on land resources which were supported by natural settings have largely resulted in deforestation, biodiversity loss, soil loss, global warming among others (Mas *et al.,* 2004; Zhao *et al.,* 2004; Dwivedi *et al.,* 2005).

In Africa the causative agents of resources pressure which lead to land resources degradation include, demographic growth, conflicts and wars, inappropriate soil management, shifting cultivation, land insecurity, climatic variations among others. Study by Lambin *et al.* (2003) documented that changes in land resources cover in particular forest cover is driven by synergetic factor combinations which are the result of increased in the pressure of production on resources, changing opportunities created by market, outside policy intervention, loss of adaptive capacity, among others. Other study has mentioned some other causes which are also in part contributed immensely to LULC alteration. For instance, study conducted by Hassan *et al.* (2016) revealed that due to increase rate of agricultural land cover and other shift to different gardens resulted to transition in LULC in particular forest cover. Likewise, a study conducted by Harris *et al.* (2011) also noted logging, construction of dams, roads and cattle ranching as a prominent cause of changes in LULC in the Latin America, Southeast Asia and Africa.

Moreover, it is recognized that rampant subsidizations in the developing countries with the mind of promoting agriculture sector have been noted to account for rapid variations in LULC. For example, studies conducted by Oñate and Peco (2005) clearly indicated that subsidies to reorganize farm activities caused rapid LULC changes based on expected short-term benefits. These activities change land surface processes including physical, biogeochemistry, hydrology and biodiversity (Getnet, 2009).

The above categorization may have been grouped into direct (proximate) and indirect (underlying) causes. In their study, Lambin *et al.* (2003) have shown that interaction between these direct and indirect forces are the consequences of global environmental changes. Proximate factors include human activities or direct actions that directly affect land use and land cover (Ojima *et al.,* 1994). This may take into account of physical action on the land cover including cities and town's expansion, agricultural expansion, opening out of nutrient mining, among others. On the other hand, the underlying factors are those that may be supporting the proximate factors to cause

more change to land use and land cover. According to Leemans *et al.* (2003), for instance, these factors operate more diffusely often by changing one or more proximate causes, and are formed by complex of social, political, economic, demographic, technological, cultural, and biophysical variables that form the basis of human-environment interaction (Geist and Lambin, 2001). The most notable contributors among them may be population growth, social and economic variables.

Globally, 1,964.4 million ha of land is affected by human-induced degradation (Rojas and Scavuzzo, 2013). As Kates *et al.* (1990) put it *"The lands of the earth bear the most visible if not necessarily the most profound imprints of humankind's actions".* The notable report on the profound imprints of human actions which were directly related to the changes in LULC can be found in the work of Briassoulis (1994) and Jongman (1997) as land degradation, soil degradation, desertification and floods. Moreover, Meyer and Turner (1996) mentioned "stratospheric ozone depletion, global climate change, greenhouse effect, and eustatic sea-level rise as a consequence of climate change.

Studies on LULC Change and Impact to Forest Habitat in the Republic of Zambia. Zambia is endowed with most of the natural resources which occupy a vast geographical area. Land resources in Zambia have historically and traditionally been recognized to be mediated by diverse human activities placed on these natural endowment. Human undertake various activities to exploit these resources. It is these activities that actually lead to alteration in land resources cover. On one hand, the most historical land cover change in Zambia has been deforestation (Vinya *et al.,* 2012), thus conversion of forest to other land use and cover. Study by Vinya et al. (2012) further explained that the ultimate driving factors which influence forests cover transition are agricultural expansion, charcoal production, fuel wood collection, wood harvesting, settlements, urbanization, urban expansion, and fires among others. According to Leeman *et al.* (2003) these characterizations operate more diffusely in the science of land use/cover change in the developing world.

On the other hand, the key threats to Zambia natural resources have been identified by USAID/ Zambia (2008) as human-caused and include unsustainable agricultural practices and expansion, mining operation and expansion, poor governance, illegal off-takes, climate change whether natural or human induced among others. Zambia economy is dependent on agriculture and other related sectors especially forest, fisheries and mining. Due to high population growth rate, couple with heavy reliance on rain fed agriculture, it has been estimated that around 80% of the rural population makes a living through subsistence farming (USAID/Zambia, 2008). According to the Zambia's Fourth National Report on Implementation of the Convention on Biological Diversity (CBD), about 249 Forest Reserves (51%) are either encroached or depleted due to over-exploitation of wood products, settlement, cultivation and inadequate natural resources governance, and have resulted to loss of forest reserves whose numbers have reduced and changed to other land uses (Campbell *et al.,* 2010). The high dependence on natural resources such as land, forest, water as well as agriculture have led to forest degradation and deforestation (Salo *et al.,* 2000; Titeux, 2016).

Studies conducted by Petit *et al.* (2000) using remotely sensed data with GIS in the South-eastern Zambia indicated that cultivated lands and bare soil areas have continued to exhibit an upward trend. Furthermore, that these changes were at the expense of forest and other natural vegetation. Likewise, Limpitlaw and Woldai (2000) also reported the exponential increased in agriculture

lands in the Copperbelt at the expense of forest lands.

Conclusion

This study reviewed literature on overview of LULC, drivers and general impact of LULC, and agriculture impact on remnant forest cover. The literature reviewed results showed that agriculture expansion is the ultimate vehicle of LULC change through expansion of its cover on the expense of forest cover. And, over the years the conversion of forest cover ultimately resulted from expanding agriculture land. For more environmental friendly practices in case like Zambia, associated with exponential population growth only relying on expanding agriculture lands cover, it is suggested to reduce forest conversion with more emphasis on sustainable agriculture intensification, adopt agroforestry practices, strengthening institutional and educational assistance to rural farmer's awareness on their negative impact on forest cover. Policy reforms and ensure strict implementation stand the chance of mitigating agricultural expansion impact on forest conversion.

Acknowledgment

The authors would like to gratefully thank the Social and Environmental Trade-offs in Africa Agriculture (Sentinel) of the Global Challenges Research Fund (GCRF)-UK through the Regional Universities Forum for Capacity Building in Agriculture (Ruforum) for PhD research grant. This paper is a contribution to the 2019 Sixteenth RUFORUM Annual General Meeting, Cape Coast Ghana.

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