Title: The Shifting Cultivation Nightmare: Effects on Forest Cover Change and Soil Nutrients Dynamics in Tanzania

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1.0 Introduction

1.1 Background

Tanzania has a total area of 94.5 million ha out of which 88.6 million ha are covered by landmass and the rest is inland water. Out of the total landmass, only 4.5% is arable land and 1.1% with permanent crops. Six land uses can be identified including, small scale farming (4.1%), large scale agriculture (0.6%), grazing land (46.9%), forest and woodland (40.4%), urban development land (1.7%) and inland waters (6.3%) (FAO, 2002).

Forests and woodlands are estimated to occupy 33.5 million ha which consist high closed forests, closed and open miombo woodlands and coastal mangrove. Out of the 33.5 million ha, 16 million ha are set aside and gazette as production and protection forest and woodland reserves, 2 million ha as national parks and 16 million ha are unreserved forest lands (Monela and Abdallah, 2007; Zahabu, 2008).

Management of forest resources in Tanzania fall under four regimes namely; Central government management forest reserve which is controlled by the Forest and Beekeeping Division (FBD) of the Ministry of Natural Resources and Tourism, Forests on public lands controlled by Central Government, Local government and Communities, local authority forest reserves controlled by District Councils and private forest managed by owners with technical advice from the central government. Practically, the management of forest on public land is almost non-existent. The forest Ordinance (CAP 389) of 2002 provides weak legal instrument for the protection of forest on general lands. It provides protection on general lands only when trees are cut for commercial purposes without license. Felling by local people for subsistence consumption and clearing for agriculture is allowed, as result forests on general lands are subjected to conversion to other competing land uses, such as shifting cultivation, livestock grazing, settlement and industrial development which interfere with natural regeneration.

Due to poor management of forest on general lands, deforestation in the country has escalated to 130,000-500,000 ha/year (URT, 1998; FAO, 2006). It is estimated that between 1990 and 2005, Tanzania lost 14.9% of its forest cover equivalent to 6,184,000 ha (Mwakaje *et al*., 2010). The main reasons for deforestation are clearing for agriculture, overgrazing, wildfires, mining and

wood extraction for charcoal, timber, poles and fire wood (Iddi, 2002; Monela and Abdallah, 2007; Zahabu,2008). It is estimated that of all factors, shifting cultivation alone contribute more than 50% of the deforestation in Tanzania (Whitmore 1997; Luoga, 200; URT, 2002; Mwampamba, 2009: Nduwamungu *et al*., nd)

Shifting cultivation in the country takes different forms depending on crop species diversity, field size, cultural pattern, population density, social and economic pressure, methods of farm preparation, crops involved and location. However, there are common features for shifting cultivation which include use of fire for land preparation, shift of cropping from one field to another and abandonment of fields. Shifting cultivation is a common practice in lowland areas with enough general lands.

1.2. Problem Statement and Justification

Shifting cultivation is said to be one of the unsustainable land uses contributing significantly to environmental degradation in Tanzania (Luoga, 2000; Zahabu, 2008). Clearing forests for shifting cultivation can contribute to climate change, biodiversity loss, reduced timber supply, flooding, siltation, soil degradation and change of forest vegetation from primary to secondary and eventually to grassland (Holden, 2001).

In the past, shifting cultivation was not considered to be amongst unsustainable agricultural practices due to long fallow period allowing enough time for regeneration (Luoga, 2000). Today due to increased population pressure, high demand of cereals and growth of urban markets for forest products shifting cultivation has been intensified with fallow period reduced from 25 years to less than 3 years (Luoga, 2000; Mwampamba, 2009; Nduwamungu *et al*., nd).

Despite the fact that shifting cultivation was identified long time ago as a threat to tropical forests (FAO 1957) to date there is limited information to demonstrate its impact on forest cover change and nutrients dynamics in Tanzania. The few studies which have been conducted were based on assessment on the impacts of shifting cultivation on biodiversity and carbon in high forests (Mwampamba, 2009) and other researches are based on general overview of the contribution of shifting cultivation to deforestation in Kitulangalo Forest Reserve (Luoga,2000; Nduwamungu *et al*.,nd)

Either, shifting cultivation has always been linked to decline in soil fertility. However, there is limited information with regards to dynamics of essential nutrients in areas practicing shifting cultivation. The information on nutrients dynamics at different fallow ages and cultivation duration is even scarcer (Diekmann, 2004). Also other factors which can contribute to shifting cultivation, such lack of proper farming techniques, site and crop matching, weak land tenure in acquiring land remain largely untested.

This study is expected to bridge this information gap. The findings will contribute towards understanding of the dynamics of forest cover and soil nutrition in areas practicing shifting cultivation.

1.3 Research Objectives;

1.2.1 The overall objective: To address the contribution of shifting cultivation on forest cover change and nutrients dynamics in Tanzania through comparison of forests with and without shifting cultivation and forests under different fallow age and cultivation history in selected parts of Tanzania

Specific Objectives;

1. To identify the socio- economic drivers of shifting cultivation
2. To asses nutrients status of fields under different fallow age and cultivation history
3. To asses forest cover change due to shifting cultivation since 1980s,
4. To determine the role of institution for prevention and control of shifting cultivation
5. To assess the perception of local people toward shifting cultivation
6. To assess the effects of crops under shifting cultivation on nutrients dynamics

Research questions

1. Why do farmers practice shifting cultivation?
2. What is the role of formal and informal institutions on control and prevention of shifting cultivation?
3. What is the effect of shifting cultivation on forest cover?
4. How does nutrients and vegetation recovery vary on farms at different fallow periods?
5. How does cultivation period and fallow age correlated to soil nutrient dynamics?

6. Do farmers relate their farming practices to various environmental consequences?

7. How does different crops under shifting cultivation affect soil nutrient?

2.0 Methodology

2.1 Location: The work will be done in 5 regions namely Tabora, Morogoro, Lindi, Manyara, Singida and Tanga (Fig.1). In each region one district will be purposively selected and in each district 3 villages will be selected. The criteria for selection of study locations includes those with; high dependence on forests resources (poverty), have cultural practice of shifting cultivation and close to Miombo woodland which are more vulnerable to shifting cultivation
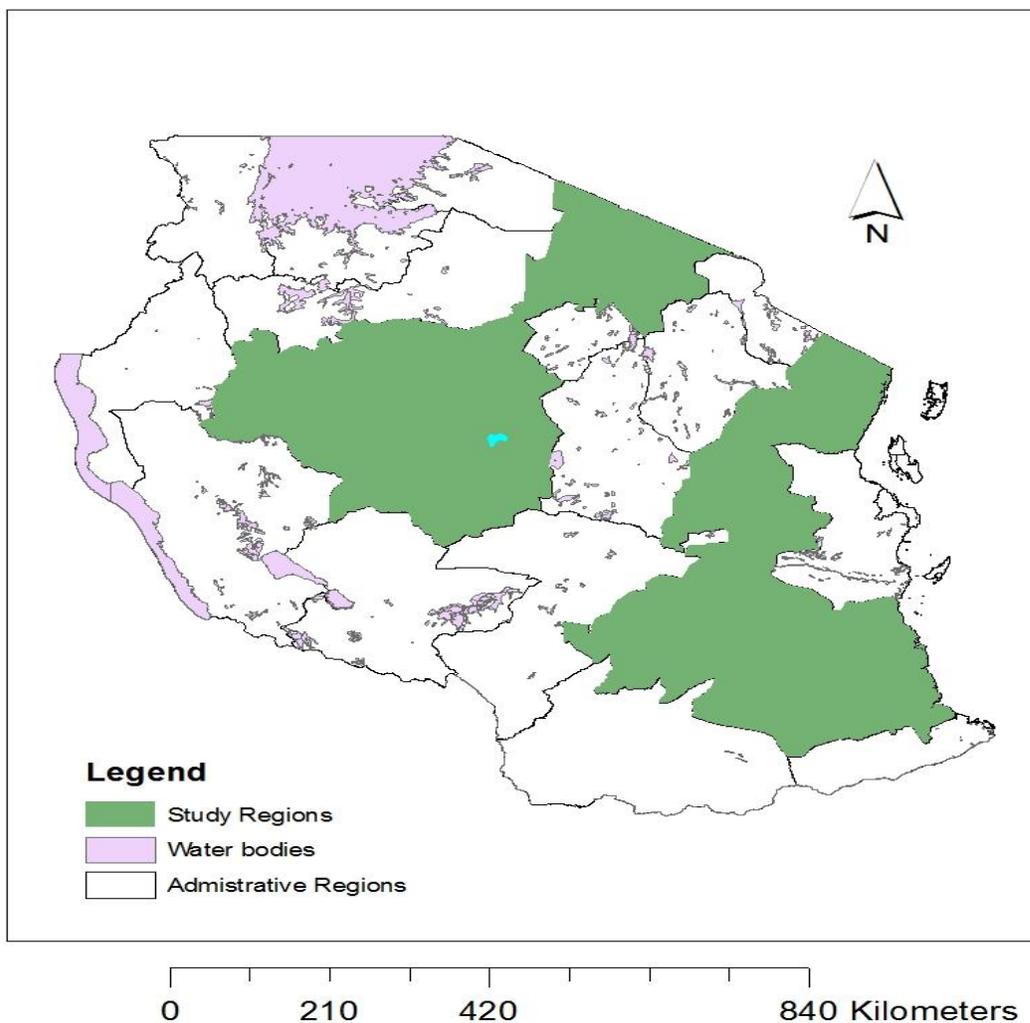

Figure1: Map of Tanzania showing Potential study regions

2.2. Data Collection

2.2.1. Measuring forest cover change due to shifting cultivation

Data will be obtained through combination of remotely sensed and ground acquired data through inventory. Satellite images or aerial photos covering time periods: 1985-1995; 1995-2005 and 2005-2015 will be selected; the time span represent the time the country had major political changes are sufficient to have influenced the behavior of local farmers. For example in 1985-1995 'free market', 1995-2005 'investment' and in 2005-2015 'agriculture first' also in these time periods 1985-2000 there has been influx of massive refugees from Rwanda, Burundi and DRC in the western regions of Tanzania and also there has been remarkable movement of agro pastoralists from northern to southern part of the country.

Ground vegetation survey will be carried out on areas with shifting cultivation and nearby forest without shifting cultivation 'primary forest'. Tree basal area (BA/ha) and number of sterm per hectare (N/ha) will be recorded. These parameters are selected because they best describe forest cover (Mwampamba, 2009).

2.2.2. Measuring impacts of shifting cultivation on soil nutrients dynamics

Soil samples will be collected in forests with and without shifting cultivation assuming that the areas without shifting cultivation represent time zero of areas with shifting cultivation. Also areas with different fallow age and cultivation history will be assessed.

Soil corer will be used to sample soil. Soil samples will be assessed at 30 cm depth dividing it into 0-15 cm 'upper layer; and 15-30 cm 'lower layer'. In the field, samples will be passed through 9 mm sieve and air dried before packed for laboratory analysis. Soil samples will be parked well according to areas with or without shifting cultivation and different fallow periods then transferred to laboratory for analysis.

In the Laboratory, the following parameters will be assessed; Soil bulk density, pH, Organic matter and concentration of essential nutrients such as Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca) and Sodium (Na). Also toxic element such as Aluminium (Al) and Manganese (Mn) will be assessed.

2.2.3. Social –economic data

A combination of participatory rural appraisal (PRA), structured interviews and checklists for key informant techniques will be used. PRA methods will include participatory resource mapping, Transect walks and matrix scoring. PRA participants will include representatives from village governments, the eldery people, the youth and the women. Key informants will consist of districts, ward and village authorities. Structured questionnaire interviews will be administered to heads of randomly selected households (5%-10% but the sample should not be less than 30 units) from villages adjacent to the study forests. Selection of the villages will be based on proximity to the forest areas with shifting cultivation. The major issues to be discussed during PRA, Interviews and checklists for key informants include, cultivation history, the role of formal and informal institutions for prevention and control of shifting cultivation, major socio-economic drivers of shifting cultivation, knowledge/awareness of the impact shifting cultivation on environment

2.3. Data Analysis

2.3.1. Data on forest cover change

Aerial photos or satellite images will be processed using Erdas Imagine and ArcGIS software. Prior to analysis of Images, Interpretation key will be developed to make sure that changes of forest cover due to other factors such as wildfires or charcoaling are isolated

Analysis of Variance (ANOVA) will be used to determine difference in basal area (BA/ha) and (N/ha) between nearby 'primary' forest and areas under shifting cultivation. Where difference obtained, Student's t-test will be used to determine the difference between treatment means.

2.3.2. Data on soil change due to shifting cultivation

By using SAS Software, Analysis of variance (ANOVA) will be used to find any significant different in pH, bulk density, organic matter and nutrients content between areas with and without shifting cultivation. Where significant results, t-test will be used to find the difference between treatment means,

Pearson correlation between fallow periods (time) and nutrients dynamics will also be conducted to determine any contribution of fallow time to site productivity

2.3.3. Analysis of Social-economic data

Descriptive statistical analysis will be used to analyse the causes/drivers of shifting cultivation followed by inferential statistical analyses to determine the role of decision argents in prevention and control of shifting cultivation and perception of local farmers toward shifting cultivation. Data will be analysed with a help of Statistical Package for Social Science (SPSS) tool. Chi-square tests and Kruskal Wallis tests will be carried to compare decision variables

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