

Evidence of Environmental Degradation Due to Agricultural Expansion in The Northern and Southern Highland Agricultural Zones of Tanzania

John Banga Nakei* & Kang Joon Wun**

Abstract: This paper critically analyzes the factors contributing to environmental degradation as well as determines which factors are created by the expanding agricultural activities in the southern and northern highlands of Tanzania. The paper emphasizes that land degradation, agrochemical wastes, and increased farming land size have been described to increase the pressure of environmental degradation whereby the increase of agricultural activities stands as the driving force. It is hoped that from this paper, Tanzania can become aware of these causes and seek ways to ward off further environmental degradation in the future and maintain sustainable agriculture growth. As most of the causes of environmental degradation are preventable, Tanzania should establish both short and long term plans to manage agricultural activities in a more eco-friendly way to promote sustainable development and economic growth. The recommendations given here are among the policy issues to be considered by all stakeholders in addressing

* John Banga Nakei is an Agricultural Officer working with the Environment Management Unit of the Ministry of Agriculture Food Security and Cooperatives, Dar es salaam, Tanzania. He has a Bachelor of Science degree in Agriculture General from Sokoine University of Agriculture, Morogoro, Tanzania graduated in 2006 before pursuing MA rural leadership development for global poverty reduction, Yonsei, South Korea graduated 2012. Currently, he serves as a National Facilitator for the Tanzania's Agriculture Sector Development Program (ASDP).

** Kang Joon Wun is a professor of Environment Sciences at Yonsei University, Wonju campus.

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measures to minimize the impact of agriculture to the natural environment to achieve sustainable agriculture development and to meet MDG goal 7 by 2015.

Keywords: Environmental Degradation, Agricultural Activities, Environmental Sustainability, Land Resources.

Introduction

Over 70% of Tanzanians live in rural areas and rely on agriculture for their income. Growing crops and keeping livestock are central to the Tanzanian economy. The agricultural sector currently grows at 4% against the targeted 7% and contributes to 26% of the Gross Domestic Product (GDP) while providing 80% of employment (REPOA, 2011). The same report revealed that industry and transport grows at the rate 2.1% and 1.7% respectively, but the latter collectively employs less than 8% of Tanzania's population as compared to agriculture. Tanzanians depend hugely on agriculture not only for both domestic food supply but also as a source of income due to the exportation of raw materials for foreign industries (Mdoe, 2002). However, it has been reported that the widespread use of environmental resources can sometimes cause a significant negative impact on the environment (OECD, 2010). Effective environmental conservation and management of Tanzania's natural resources is crucial for sustainable development and livelihoods of its people (NEMC, 2008). Agricultural changes the natural environment into an artificial one, which become unstable without human interventions (UNDP 2011). Such agro-ecological dynamics, compounded by the growth and increasing densities of population, create a constant risk of human suffering resulting from degraded environment. In recent times, there has been an increase in the utilization of arable land as more people engage in farming. Several factors including population growth account for this trend. As the population increases, there will be more environmental tension due to agricultural expansion as a response to food

demand. Contrary to many other economic activities, agriculture has both harmful and beneficial effects on the environment, by changing the quality or quantity of soil, water, air, biodiversity and landscapes.

As a major user and abuser of natural resources, agriculture has a significant negative impact to the environment in many countries. In developing countries, including Tanzania, agriculture accounts for around 40% of total land and nearly 45% of water use and it dominates and shapes the landscape (OECD, 2004). Tanzania's increased food demand has led to improved policies that encourage more production through technological innovation and capital intensification. Farming on environmentally sensitive land (wetlands and water sources), which in some cases has led to environmental harm, has never been given a priority (Munisi, 2003). These detrimental effects include not only water and air pollution, but also the loss of wildlife, habitats, and landscape features. Soil degradation and water depletion are also serious concerns in some areas. On the other hand, environmental benefits may in some circumstances include: water resources conservation and flood control, nutrient recycling and fixation, soil formation, carbon sequestration by trees and soil, wildlife and biodiversity protection, and the provision of recreational services and aesthetic value.

Agriculture interlinks a number of environmental changes including biodiversity loss, and land degradation and water pollution (World Biodiversity Development Report, 2008). It is also highly dependent on predictable climatic conditions as well as ecosystems services such as: genetic resources, water regulation, soil formation, pest regulation, nutrient cycling, and primary production. Agricultural land use change can also reduce carbon sequestration. Even with competing climate change adaptation interests, the impact of biofuels on agro biodiversity is a critical issue for sustainable development. Biofuels have the potential to enhance national energy security as well as economic growth. However, in the absence of a holistic approach, they have already led to increased competition for land and water, increased food prices, deforestation, and have contributed to a loss of habitat and

biodiversity.

For many years, the relationship between agricultural practices and the environment remained stable and favorable. However, this relationship has been upset due to certain forces and agricultural exploitation of natural resources which have led to serious environmental degradation (Sekitoleko, 1993). The timing and magnitude of the problem when it occurred may vary from country to country. However, what is certain now is that there is a global environmental crisis. Tanzania is no exception in this case. In the same report, it is noted that the larger portion of Tanzanian population heavily depends on agriculture for their livelihood, which has had a direct impact on the environment as quoted in several national reports. For instance, “with 80% of Tanzania's population involved in agriculture, the environment is of key importance to the livelihood of the vast majority of Tanzanians” (URT, 2011). Tanzania depends on a robust and healthy environment to support income generating activities and to provide citizens with food, medicines, energy, and building materials. The country is highly endowed with natural resources such as gold/gemstones, fish, forests and wildlife. It has a high richness of biodiversity and natural beauty where approximately 30% of Tanzania's land has been set aside in some form of protection.

Being one of Africa's most ecologically rich countries, Tanzania covers an area of 945,000km² with diverse climatic and physical conditions ranging from arid, semi-arid, and mountainous areas of afro-alpine vegetation, woodland and dry land savanna. About 40% of land is covered by forests and woodlands, which host various types of ecosystems. Deforestation, which is taking place at an alarming rate, has amplified the magnitude of desertification and adversely affected soil fertility, water catchment areas and water flow. Siltation due to soil erosion from farms continues to pollute the ocean, lakes, and rivers; thus, making water unfit for human consumption and destroying the aquatic habitats. This situation threatens biodiversity survival and exposes more risk on ecoagriculture in the country. Different local and international

conservation stakeholders have been working together to minimize these problems, but the threat of environmental degradation in the country is still high.

This paper then aims to find out the causes of environmental degradation that resulted from increased agricultural activities and to see if those factors interlink with each other or are independent from each other. Ongoing environmental degradation measures are being put into place by the government and other stakeholders to address concerns, but there remains a high potential for environmental degradation due to poor agro-practices. In particular, there is increasing uncertainty about policies designed to help alleviate the effects of climate change. The findings from this study will provide the necessary first step towards better policy, regulations, and guidance on mainstream of environmental management in the agricultural sector, especially in this era of fighting against climate change caused by global warming. The study aimed to assess the trend of environmental degradation due to an increase in agricultural activities in Tanzania through:

- Analysis of worsening land degradation due to poor agricultural practices
- Analyzing potential impacts of agro-chemical wastes in farming sites
- Examining the expansion of farming land size for crops like tobacco, cotton, and cashew nuts

The assessment has been guided by questions about the potential of agro-input wastes at farming sites of cash crops like coffee, onion, cotton, tobacco, and cashew nuts. It also analyzes the trends of chemical input application in production processes, the types of land degradation currently recorded, causes of each degradation, impact of each degradation, and asking if whether specific crop production led to such degradation impacts in the locality.

Definition of Environmental Degradation

Environmental degradation is a process through which the natural

environment is compromised in some way, reducing biological diversity and the general health of the environment. This process can be entirely natural in origin, or it can be accelerated or caused by human activities. Many international organizations recognize environmental degradation as one of the major threats facing the planet. Since humans have only been given one earth to work with, if the environment becomes irreparably compromised, it could mean the end of human existence. It is one of the ten threats officially cautioned by the high level threat panel of the United Nations (UNESCO, 2005). The United Nations International Strategy for Disaster Reduction defines environmental degradation as “The reduction of the capacity of the environment to meet social and ecological objectives, and needs”. There are a number of ways in which environmental degradation can work. In a classic case, resources simply become depleted. Air, water, and soil are all resources which are vulnerable to depletion through overuse, as are natural resources like minerals and oil deposits. Habitat pressures which force animals into a small area can also contribute to resource depletion, as the animals consume a high volume of material in a small area (S.E. Smith, 2012). It was further emphasized that, human activities like farming; mining and deforestation largely pose threats to change natural environment to artificial one (NEMC, 2009).

Causes of Environmental Degradations

The study conducted by Jared Skye in 2004 on serious environmental problems in the world identified that, the primary cause of environmental degradation is human disturbance, most of which are due to agro-sylvoecological systems. The degree of the environmental impact varies with the cause, the habitat, the plants and animals that inhabit it.

Danielle Simberloff and Deborah Swackhamer(2004) have further pointed out that, the anthropogenic causes of environmental degradation at the local level include deforestation, overgrazing, unplanned land

management, firewood harvesting and urbanization, and encroachment of wetlands and rangelands for cultivation among others. The root causes of environmental change are both natural (mainly climatic variations and climate change) and from human-made factors, and include interactions between them. Global processes are having a tremendous influence on environmental change in Sub-Saharan Africa; for example, greenhouse gas emissions, global warming, and its impact on climate variability and change. These changes have not only regional to national dimensions, but also local implications as well. In Tanzania, like most of the Sub-Saharan Africa, there is a high dependency on agro-sylvoecological systems, which themselves depend on the state of the environment and local climatically conditions.

Albert Schweiter (2000) said, "Man has lost the capacity to foresee and to forestall. He will end up destroying the earth" and himself. In connection to this, most of human activities including agriculture tend to degrade environment as pointed out by Bogumil and Terminski(2006) in their study "Environmentally-Induced Displacement, Theoretical Frameworks and Current Challenges". In the past eight years, the government of Tanzania has enacted the Environmental Management Act (EMA, 2004) where an environment correspondent desk that gives update information on environment management was assigned to all central government institutions as a tool to ensure environmental sustainability. These are initiatives towards mainstreaming environmental management into government policies, programs, and projects. Accordingly, in July 2007, the Ministry of Agriculture Food Security and Cooperatives through its Environment Management Unit, published guidelines explaining how environmental issues should be addressed and how development programs and projects should be implemented.. By doing so, the Tanzanian government has recognized the detrimental impact of agriculture on the environment and has joined the fight against the threat of global climate change on agricultural sustainability. Moreover, there is the fact that in recent years, agriculture has been given little attention in the United Nations Framework Convention on Climate

Change-UNFCCC (Hailu, 2011). Referring to the Kyoto protocol, agriculture currently accounts for 4% of the totally registered Clean Development Mechanism projects (WWF, 2010). Whether in the context of increasing climate resilience and food security, addressing drivers of deforestation or reducing agriculture related emissions, there is strong pressure to consider the impact of climate change on agriculture and vice versa (Nelson, 2009).

For sound environmental sustainability and growth in agriculture, more food is necessarily needed to meet the fast growing human world population. According to FAO estimates, a 60% increase in global food production and a 100% increase in food production in developing countries will be necessary by the year 2050. Yet, the world's natural resources are already under pressure with the loss of crop diversity, overexploitation of fish stocks, deforestation, degradation, loss of arable land and aquatic ecosystems, and growing competition for increasingly scarce water due to the impacts of climate change. Agriculture is an important part of sustainable development. In many places, unsustainable agricultural practices, climate change, and increasing population pressure have all contributed to severe environmental degradation, poverty, and hunger despite the knowledge and technology to tackle these issues. The current environment status is characterized by massive water resources pollution, soil nutrient depletion, biodiversity loss, and deforestation.

Three Selected Causes of Environmental Degradation in Tanzania

This study focuses much on three major environmental problems in Tanzania that are believed to be amplified by the expansion of agricultural activities in recent times. These are land degradation, agro-chemical wastes disposal, and increased farming size of specific crops, namely cotton and tobacco.

Land Degradation

Land degradation is a process in which the value of the biophysical environment is affected by one or more combinations of human-induced processes acting upon the land. This is considered to be an important topic of the 21st century due to its implications to environmental degradation, sustainable agricultural productivity, and food security. In Africa, an estimated 500 million ha of land have undergone soil degradation since the 1950s, including 65% of the region's agricultural land as reported by the IUCN (2011). It is estimated that up to 40% of the world's agricultural land is seriously degraded (Terminski and Bogumil, 2011). The human impact on deforestation, soil erosion, overgrazing, degradation of water resources, and loss of biodiversity have all resulted into land degradation. In Tanzania, over 300,000 acres of land is degraded annually by increasing deforestation while paving farming area (URT, 2011). Several studies emphasized that poor agricultural practices such as shifting cultivation, lack of crop rotation practices, lack of agricultural technology, and land husbandry techniques exacerbate the problem.

The Global Environment Facility (GEF) and the International Fund for Agricultural Development (IFAD) unequivocally endorsed the principle of partnership at 1992 Rio Earth Summit. This hold the strategic collaboration, linked to a common purpose, broadens the scope and impact of activities to improve the global environment and address land degradation in the context of sustainable development (UNEP, 2011). Through partnerships both organizations can benefit from perspectives and experience beyond their horizons, mobilize additional resources and combine forces to encourage international action to meet global environmental objectives especially in Africa.

The study by Arild Angelsen and Odd-Helge Fjeldstad (2007) in Tanzania revealed that, the adverse socio-economic and environmental effects characterizing the recent developments in the area may be summarized as: changes in the local ecology as a result of poor farming

practices, livestock husbandry, forestry development and haphazard settlement; changes in the hydrology of the area have imposed sedimentation loads on the major river systems with adverse effects on the flows to the areas; competition and conflict in land resource use; overpopulation relative to the available resources leading to increased pressure on the remaining resources; and migration of people to townships hence contributing to increased urban pressure. They further reported several issues concerning the land degradation problem. A number of factors have contributed to overutilization of land resources in the area, resulting in deforestation, caused mainly by shifting cultivation, overgrazing, and wildfires. This has led to the extensive removal of natural vegetation, subsequent soil erosion, and decline in agricultural productivity. In the vicinity of villages, the concentration of people has led to increased soil exhaustion, reduction of grazing land, overgrazing and deforestation, and to more intensive use of land for cropping. Today, these problems are particularly evident by the existence of poor and unproductive soils in parts of the area, long distances covered in search of firewood, widespread red scars on the land, gully erosion, and frequent famines.

In many parts of the world, climatic variations are recognized as one of the major factors contributing to land degradation impacting agriculture performance and management. This shows another linkage between climate change and land degradation. The climate resources and the risk of climate-related or induced natural disasters in a region must be known in order to accurately assess sustainable land management practices. Only when climate resources are paired with management or development practices, then land degradation potential can be assessed and appropriate mitigation technologies developed (Munisi, 2003). As a result, this land degradation claimed to endanger sustainable agricultural productivity and brings more tension to global food insecurity in many parts of the developing world, especially sub-Saharan Africa (Uriel, 2007).

In Tanzania, many institutions are committed to joint efforts to

resolve contributing factors to ongoing land degradation in the country. In September 2011, at the opening of an environment management stakeholder's workshop, UNDP Deputy Country Director, Louise Chamberlain, said that agriculture—which is still the dominant sector of Tanzania's economy, especially in rural areas—has been shackled by productivity decline caused by both land degradation as well as poor water management. This is the international commitment to help the country's priorities for poverty reduction and sustainable development as outlined in the National Strategy for Economic Growth and Poverty Reduction (NSEGPR II, 2010-25).

According to the 2011 UNDP Tanzania office report, currently, land degradation is provisionally estimated to affect at least 40% of Tanzania's population. This situation forced the current government to prioritize overcoming land degradation at its outset by setting up an emergency programme to restore ecological productivity in key watersheds and wetlands – through MKAKATI (Strategy for Urgent Actions on Land Management and Water Catchments). Hunger, poverty and environmental degradation trends have to be reversed if Tanzania is to achieve sustainable development (Maro and Mongi N, 2012). The government of Tanzania has established rules, policies, and laws to address environmental issues, one being the Environment Management Act (EMA 2004). Among other things, the EMA highlights the roles of different stakeholders to ensure reduced land degradation is at priority at public institutions.

Impact from Agrochemical Waste in Tanzania

The use of chemicals has been integrated into every aspect of human life. In Tanzania's agriculture, the safe and effective use of agrochemicals, especially pesticides, has successfully been carried out to solve various problems including hunger; pre- and post harvest losses due to pests (insects, weeds, microbes), infestation, and vectors of human and animal disease (Mabagala, 2008). However, under poor management

this process may pose health risks to human beings and the environment. To support this, a study by Ngowi N.V et al. (2007), was conducted in the northern part of Tanzania on pesticides used by smallholder farmers in vegetable production in June 2008. The results of the study showed a strong indication that pesticides in horticultural forms are associated with human health problems, although health reports have been inadequately documented. The seriousness of the reported health problems depended on the volume and time of the person's exposure to such agrochemicals. This was discovered at onion farming sites in the Karatu district.

According to a study by Nonga, H. et al., 2011, the assessment of farming practices and uses of agrochemicals in the Lake Manyara basin in northern Tanzania have shown high improper usage of inorganic pesticides and fertilizer despite farmer's limited knowledge of pesticides on environmental health and the limited extension services.

Expansion of Farming Land

Farming land in Tanzania has expanded in size. Tanzania has 44 million hectares of land suitable for crop productions. Out of those 44 million hectares, 10.8 million hectares, or 25% of total arable land, are under cultivation according to MAFSC (1992). However, the National Report - Census of Agriculture 2007/2008 shows that 66% of arable land has been under cultivation (NBS, 2012). In addition, the country has 60 million hectares of grazing land suitable for livestock keeping. In Tanzania, the abundance of virgin land or frontier areas suitable for cultivation have over a long time span been able to accommodate a growing population, which may to some extent explain the persistence of traditional extensive farming methods in most areas (URT, 2011).

Due to rapid population growth and agro-product market expansion in Tanzania, farming land has expanded considerably in the past two decades (Tarimo, 2008). The increase in farming land size implies the opening of more virgin land that has not been under cultivation. Because of the liberalized crop market, more farmers in Tanzania get involved in

cash crops such that the increase of farming size became more predominant in cash crop areas than food crop area (MAFSC, 2009). The land size that was under cultivation considerably increased in size as more crops are locally and internationally marketed. Both food and cash crops are equally competing for the same piece of land, hence, market power judges which can win land. According to Tanzania's Ministry of Agriculture, traditional export crops in Tanzania include cotton, coffee, tobacco, cashew nuts, tea, pyrethrum, and sisal. Coffee, tobacco, and cashew nuts are mostly grown in the northern and southwestern part of the country, the area for this study. These areas fall under two different agro-ecological zones thereby experiencing similar negative environmental problems as a result of intensified agricultural activities. Severe forest encroachment cases have become more serious for cash crops such as cotton, coffee and cashew nut (Munisi, 2010). The study conducted in Mahonda, southwest Tanzania showed that existing farming systems can sustain the present population growth rate of 3.7% per year for only a maximum duration of between 10 and 15 years (Monela C.G et al., 2000).

Research Methodology

The study has employed a comparative-historical research design that examines historical events in order to create explanations that are valid beyond a particular time and place by direct comparison of the past period to the present as has been proposed by Alexis de Tocqueville, Karl Marx, Emile Durkheim, and Max Weber.

Generally, it involves comparisons of social processes that are agriculture-based activities across times and places and have directly or indirectly impacted the natural environment. As Edgar Kiser and Michael Hechter (2006) argued, it is important to use a general theory in order to be able to test the results of the research that have been conducted.. Various agricultural activities at the research site will be

analyzed over a period of time. Farming practices including irrigation, cultivation and cropping system pattern, agro-input handling like fertilization, weeding, pest and disease control systems, machinery and farming size.

This thesis argues that there is a direct linkage between environmental degradation and increased agricultural activities and the different crops have their own potential contributions to stimulate environment degrading. Considerately, this thesis argues that agriculture expansion changes the natural environment into an artificial one, which is unstable to sustain Tanzania's rapidly growing population. The current environmental management approaches has not yet saved land resources management efficiently.

Data Collection Method and Analysis

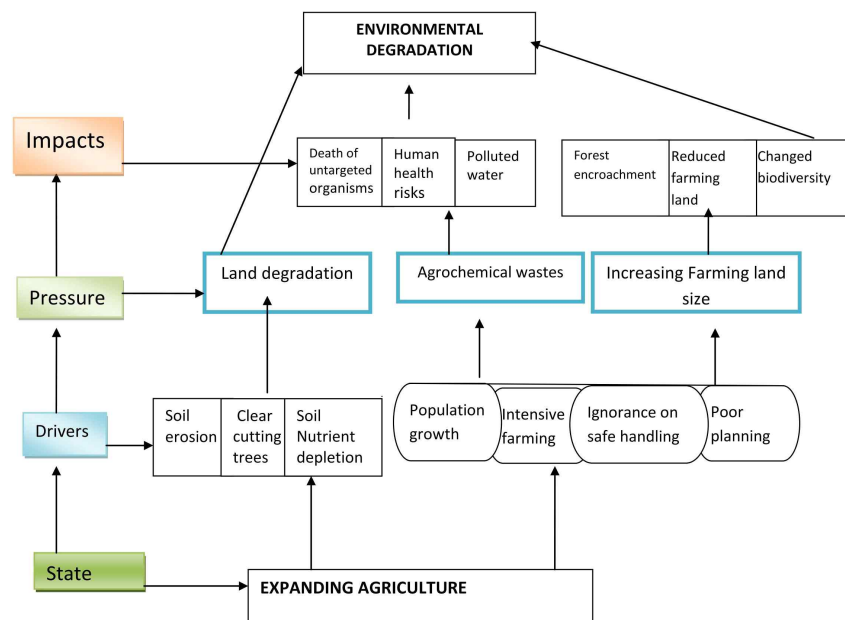
The case study is guided by conceptual framework and research questions specified for the overall conduct of this research. Major sources of the data used were from the Ministry of Agriculture of Tanzania, National Bureau of Statistics, World Bank, UNDP Tanzania Office, National Environment Management Council of Tanzania and various research publications majoring in agriculture and environment. Various government online documents and related memoranda were collected and reviewed. The above sites were visited to collect data at different time intervals and analyzed by comparison approaches.

Analytical Framework

As it has been noticed from literature review, this article is describing the contributions of three selected pressures resulting from expanding agricultural activities as causal agents of environmental and land degradation, agro-chemical wastage, and the increase in farming land size in the northern and southwestern parts of the country. The main

causal agent of degradation in some districts could be one or a combination of two or even three of the above factors. The severity of degradation can be promoted by many factors. For example, land degradation may largely be influenced by the physical and chemical characteristics of soil, rainfall patterns and landscape nature, soil erosion and nutrient depletion, and drying-off of the water bodies like rivers, lakes and swamps.

FIGURE 1. Relationships for the three selected parameters causing Environmental Degradation



Equally, increased agricultural activities that use industrial chemicals leads to agrochemical waste disposal that can negatively impact environmental health depending on the nature of the waste itself (life span and decomposition rate), its volume, and the degree at which it is exposed to decomposition. This not only has risks on the health of non-targeted organisms and human beings, but also causes water

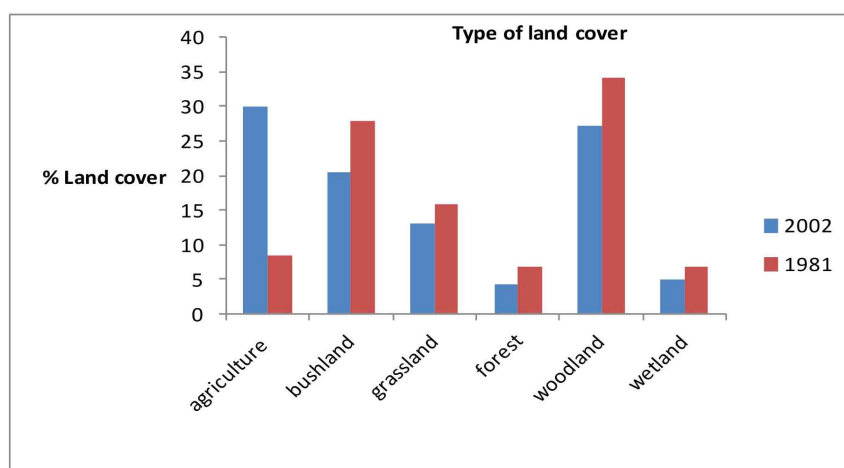
pollution and hence deteriorates water quality. The trend of farming land size has shown a sharp increase in the past decade by over 100% as noted in the literature review. This increase may, however, have a significant influence on the quality of the natural environment in both northern and southwestern Tanzania, thereby affecting sustainable agriculture.

The increase in agricultural activities is being analyzed to identify which one is more or less worsening the environment. The contribution of agrochemicals application such as in-organic fertilizers, herbicides and pesticides were analyzed. The influence of the increase in farming land size in relation to degradation of the environment is also a key issue of discussion in this study. The farming land size and various crops grown may impose several different impacts to the natural environment; hence, analytical findings can give detail insights. Whether it is cash or food crop, they all variably use land resources and impose a significant impacts for future availability of the same.

Study Findings and Presentation

Land degradation

UNEP reported land degradation as being a top environmental problem before and after the independence of Tanzania. The research by IUCN Tanzania in 2002 revealed that 78% of the total land use in mainland Tanzania favors biodiversity conservation and is ecologically rich as it is covered by woodland, bushland, grassland, and the wetlands (Figure 2). By the end of 2002, woodland, bush and agriculture composed of 27%, 20% and 30% of Tanzania's land respectively as compared to 34%, 28%, and 9% respectively in 1981. Over a period of 20 years, agriculture land portion increased while other land portions decreased. This ultimately reduced the quality of the natural environment.

FIGURE 2. TANZANIA MAIN LAND USE/LAND COVER

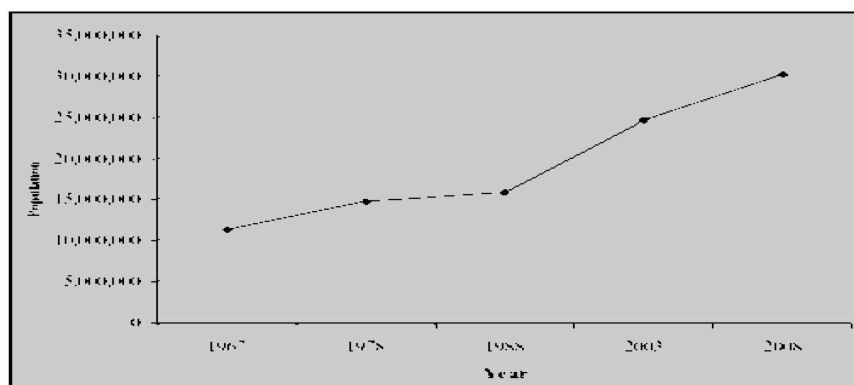
Source: Africover, 2002.

In the 1980s, the study area was mostly covered by wood, bushes, and grasslands with a small area used for farming. Between 1981 and 2002, agricultural land expanded from 9% coverage to 30% (an average of 1% increase per annum) and took over much of the land that was formerly wood and bushland. This resulted in a decrease in wetland areas from 7% in 1980 to 5% in 2002. Similarly, forestland decreased from 7% to 5% in 2002. The findings show that bare soil and forest plantation has not changed much in size because farming activities involve some afforestation for perennial crops like coffee and banana in this area. However, this implies a decrease in the quality of the environment in terms of biodiversity habitat. This is supported by a report by the Ministry of Agriculture in October 2008 showing most of the area in zone II to have severe to very severe land degradation (Figure 6). Based on that report, the land degradation impacts the northeast through the central to southern highland agricultural zones. The main agricultural practices in these areas include small scale farming characterized by shifting cultivation, mono-cropping and keeping large stocks of cattle. This brings problems of pasture scarcity and promotes soil erosion and

ultimately severe land degradation. Mono-cropping is a good example as it causes nutrient mining in any locality. The central and northern regions in the country are also famous for its pastoralist society where the land carrying capacity has been exceeded for over a decade, hence more environmental degradation.

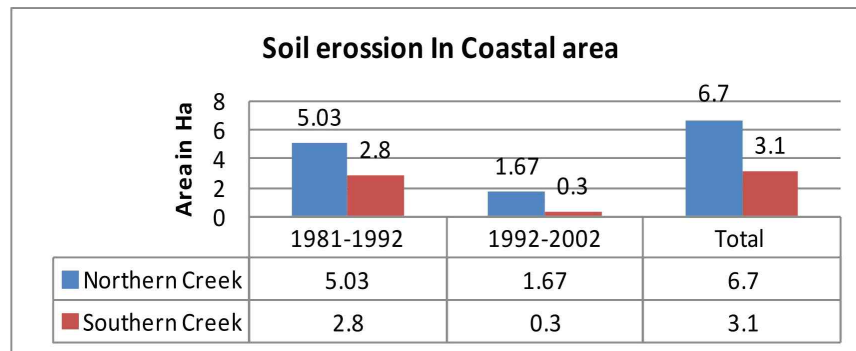
Due to the high population growth rate of Tanzanians, one of the most probable reasons for such agricultural increases can be the growth of farming household size as more people become farmers. Figure 3 below shows the trend of agricultural farming household growth between 1960 and 2010. Over this period of 40 years, farming household increased from 10 million to 32 million between 1967 and 2008 respectively, an increase of 55%. This growth rate becomes significantly higher between the 1980s through the 2000s. As a result, more environmental degradation occurred during the same period as reported in the literature. According to the agricultural census 2003/04, the total area of land allotted to smallholder famers was 11,997,071 ha of arable land on mainland Tanzania; the equivalent of 2.4 hectares per household which is above the national average land utilization of 2.0 ha per household. This includes area under fallow. If fallow is excluded from the total area of allotted land, the land area per household is only 1.9%. The same agricultural census in 2007/08 reports the decrease in average utility to 2.1 ha per household. This implies shrinkage in land availability to household members by 0.3ha per family. However, because Tanzanians rely heavily on agriculture as their main economic activity, more people continue to engage in farming on the same piece of land and cause over utilization of land resources.

FIGURE 3. THE TREND OF AGRICULTURAL HOUSEHOLD POPULATION



Source: NBS, 2008.

Soil erosion is among one of the serious land problems in the study area. During the period of 1981 – 2002, there was a significant change to the shorelines in the coastal area (Figure 4) as shown in map of Tanzania (Figure 7). The soil erosion data from two sites (northern creek and southern creek) in this area were used to analyze the impact of agriculture in land degradation. The total areas eroded were 6.7ha and 3.1ha in the northern creek and the southern creek respectively. The northern creek was the most severely eroded due to being more populated than the south, as evidenced by larger farming households supported by cassava productivity per household, as demonstrated in Table 1 below. Population in the northern creek is almost double the size of southern creek. Crop productivity is also far higher in the northern creek. High soil erosion in the farming area in the north is due to a higher rate of farming activities. Therefore, the high rate of farming in the northern coastal area of Manyema has contributed to soil erosion, land degradation, and ultimately environmental degradation in the region.

FIGURE 4. QUANTIFICATION OF SHORELINE CHANGE IN THE COASTAL AREA BETWEEN 1981 – 2002

Source: Mikocheni Research Centre, 2004.

TABLE 1. HUMAN ACTIVITIES AND HOUSEHOLD POPULATION IN MANYEMI, RIVER PANGANI BASIN

	Northern Creek			Southern Creek		
	1981-1992	1992-2002	Total	1981-1992	1992-2002	Total
Eroded area (ha)	5.03	1.67	6.7	2.8	0.3	3.1
Household (000)	120	189	309	45	64	109
Cassava productivity (ton/ha)	50	40	90	30	16	46

Source: Mikocheni Research Centre, 2004.

Erosion degradation was largely amplified by floods during rainy season. The severity of erosion was severe during the *El Niño* rainfall in 1998 and the subsequent drought that destroyed soil cover and left bare land which was then easily washed away by erosion agents like wind and water. This area is the entrance point of numerous rivers to the Indian Ocean at the coast, therefore, when heavy rain falls in the highlands, many distributaries formed on the ocean shore as a result of high speed running water escaping towards the ocean. The high speed running water marks potential destruction to the river banks, especially in farming areas because soil has been loosen by farmers' cultivation. Further, soil erosion led to siltation problems in lakes and other water bodies in the region.

The river and lake depth decreases and endangers marine life including the fish supply. In the Manyara region, the decrease in fish supply from Lake Manyara (Figure 13) is among the evidence of siltation due to increased agricultural activities in the highlands of the region.

Another farming practice that is bad for the environment is the shifting cultivation agriculture. Most of the household operates on a single piece land for 2 to 3 years before shifting to adjacent woodland once they see that crop yields have declined. It may be left for the fallowing purposes but mostly is due to land availability in reserve areas. Such practices would be sustainable if the population was low and sparsely located, but because of population pressure, arable land for this purpose is no longer available. Many farming communities in the southern highland agricultural zone are practicing this system as shown in Table 2. The percentage of temporary farms indicates the shifting farms; this means a farmer can abandon the piece of farm after 2 years and move to another new piece of land due to poor productivity resulting from nutrient depletion. The Singida and Arusha regions are the mostly affected areas followed by the Kigoma and Mbeya regions.

TABLE 2. FARMING PRACTICES IN NORTHERN AND SOUTHERN ZONES OF TANZANIA

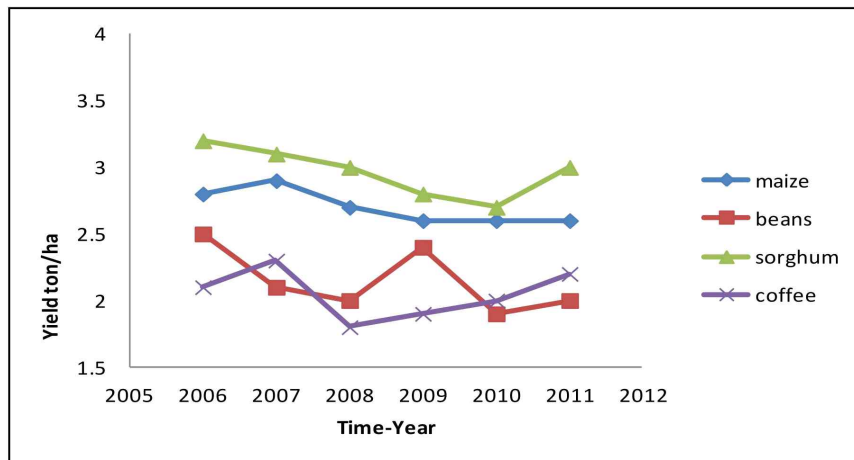
Region	Tabora	Kigoma	Singida	Arusha	Shinyanga	Mbeya
Farms (ha)	23,565	35,658	1,558	56,247	6,542	635,247
Temporary farms(ha)	2,546	5,684	361	10,245	562	89,520
Permanent farms(ha)	21,019	29,974	1,197	46,002	5,980	545,727
% Temporary farms	12	19	30	22	9	16

Source: Agriculture Census 2008.

According to the agricultural census of 2008, 30 out of 100 farms in the Singida region and 22 out of 100 farms in the Arusha regions are unfarmable in the subsequent season due to poor soil fertility, so farmer opt to open new fields into the forest or woodlands. The situation is more serious in the Kigoma region where tobacco farming is the pre-dominant

cash crop and 19% of farms cannot be re-cultivated, so farmers encroach into deep forest areas or any new land. In the study area, agricultural lands are over-cropped. Therefore, in the event of inadequate land practices, particularly fertilizer applications, nutrients in the cropland are quickly exhausted resulting in a significant decline in productivity. From the Ministry of Agriculture crop report in June 2011, sorghum production declined from 3.4 million tons in 2006 to 2.4 million tons in 2010 while beans had largely decreased from 2.5 million tons in 2006 to 1.8 million tons in 2011 as shown in Figure 5 below. One of the reasons for this trend is nutrient depletion due to continuous farming on the same piece of land.

FIGURE 5. CROP PRODUCTIVITY IN THE NORTHERN AND SOUTHERN AGRICULTURAL ZONES

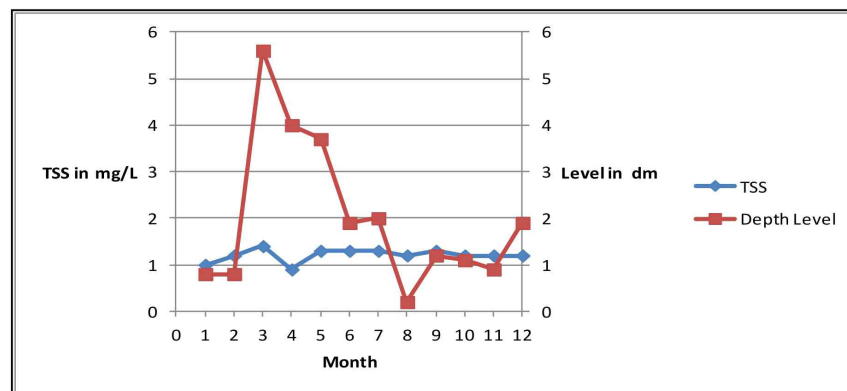


Source: MAFSC, 2012.

Deforestation occurs as more farmers occupy forestland leading to the destruction of water sources, especially in the southern highlands of Mbeya and Kigoma as well as the Arusha and Kilimangjaro regions in the northern zone. This led to two major environmental problems: reduced water quality and water quantity. Reduced water quantity is due to the dry-off of several rivers originating from encroached forests.

However, the quality and quantity of water differs across the seasons of the year. During rainy season, water quantity (volume) increases, but quality deteriorates due to more total sediments (TSS) carried therein (Figure 6). The sediment became higher when it rains from March through August and sometimes in November due to loosen soil on the mountains for being exposed to erosion following the cutting of trees covering the land. As deforestation grows in these mountains, the water quality and quantity from the rivers originated from there has lowered as well and differs from month to month as shown in Figure 6.

FIGURE 6. WATER QUALITY AND QUANTITY VARIATION IN RIVERS FROM MT ULUGURU

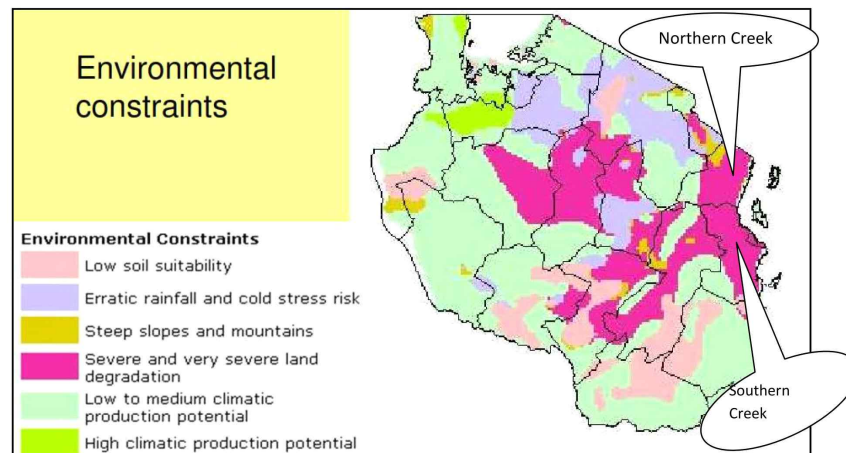


Source: SUA, 2003.

Furthermore, soil water mining is another problem that has led to land degradation where cash crops harvested are exported to other developed regions or countries. Every crop has its specific water consumption ratio (virtual water) for completion of a single life span during which water consumed becomes part of the crop product to be consumed. Since the observed land size is comprised of the crops that are exported, the potential amount of water is also exported, leaving a shortage in local water sources. For example, in the year 2002/2003, Tanzania had exported 49,400 tons of coffee to Europe. Considering

coffee has a virtual water average of 17,000m³/ton, it means the country also exported 839,800,000m³ of water. Coffee production and export in 2011 hit 680,154tons, using 1.156x10¹⁰m³ of water. By year 2015, coffee export is expected to increase to as much as 750,000 tons that will use 1.275x10¹⁰m³ of water. This brings more worries on water availability in the country because currently available water sources are already under reduction trends due to increased land degradation.

FIGURE 7. LAND DEGRADATION STATUS IN TANZANIA



Source: Ministry of Agriculture Tanzania, October 2008.

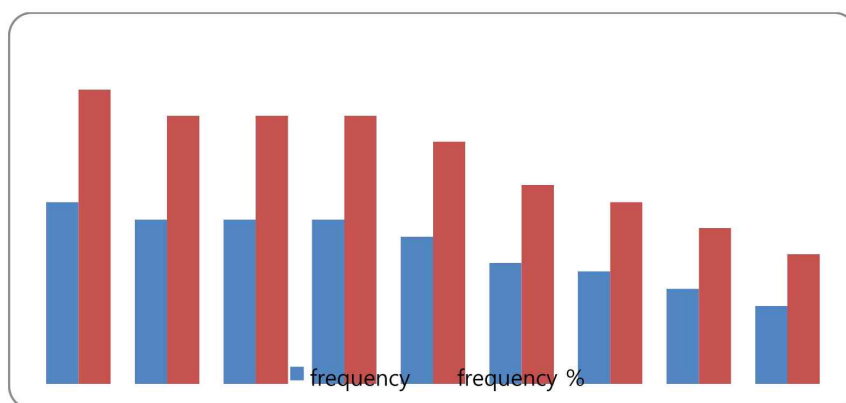
Impact from Agrochemical Waste Disposal in the Country

Like other production processes, agriculture uses different agrochemicals (industrial fertilizers, pesticides, and herbicides) to stimulate growth and/or restrain pest infestation to attain maximum production levels. Under poor practices, application of these agrochemicals results in environmental problems including pollution of water and air and the killing of non-targeted organisms, hence biodiversity loss and general ecosystem disturbance. For example, agricultural activities in the Lake Eyasi Basin in the northern agricultural zone have a long history of intensive pesticide use. The use of

nitrogenous fertilizers, pesticides, fungicides and herbicides were recorded at local shop sale records.

The farming communities are, however, ignorant of the proper use and safe application of these agrochemicals. It is common for communities to use over or under the normal rate of agrochemical dosage. They also do not know how to appropriately throw away chemical wastes including bags and containers. For instance, 7 out of 10 chemical containers bought were found to be unsafely disposed as of June 2012. Insecticides were the most common pesticides used in the country accounting for 770,036 ha or 71% of the total planted area followed by herbicides (203,175, 19%), and fungicides (105,124, 10%). Remnants of pesticides were discarded in the farm by pouring or burying them into the ground. Fifty-five percent of farmers were shown to dispose of empty pesticide containers in farms and waste pits. Most of the farmers applied pesticides with the use of knapsack sprayers that were washed into the rivers. Some research in this area shows that 76% of farmers around this area were unaware of the effects of pesticides to the environment despite that 78% of them uses inorganic fertilizers. This improper handling of chemicals have polluted the environment and resulted in some health problems to both animals and human beings whose livelihood depends on that environment. In 2010, A.V.F Ngowi reported that farmers in this basin were intensively using industrial chemicals for vegetable production and resulted to health drawbacks as shown in Figure 8. The most reported health cases in various health centers included headaches, nausea, dizziness, sore throat, itching and running nose.

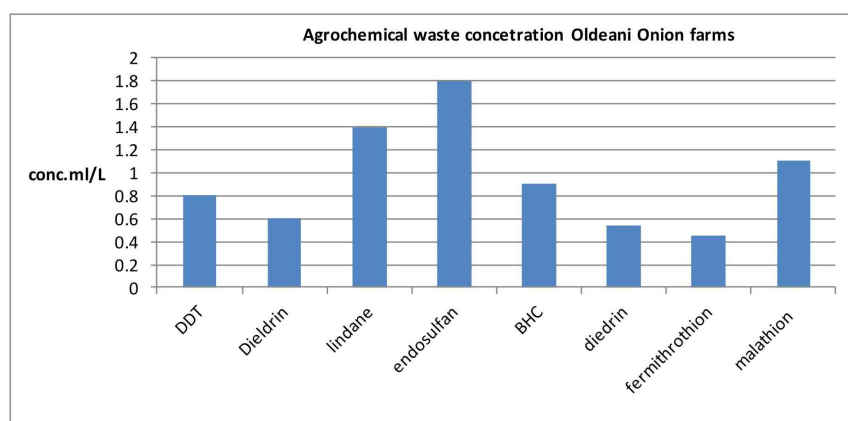
FIGURE 8. SELF REPORTED PESTICIDE-POISON SYMPTOMS IN ONION FARMING IN KARATU DISTRICT, NORTHERN TANZANIA



Source: TPRI 2010.

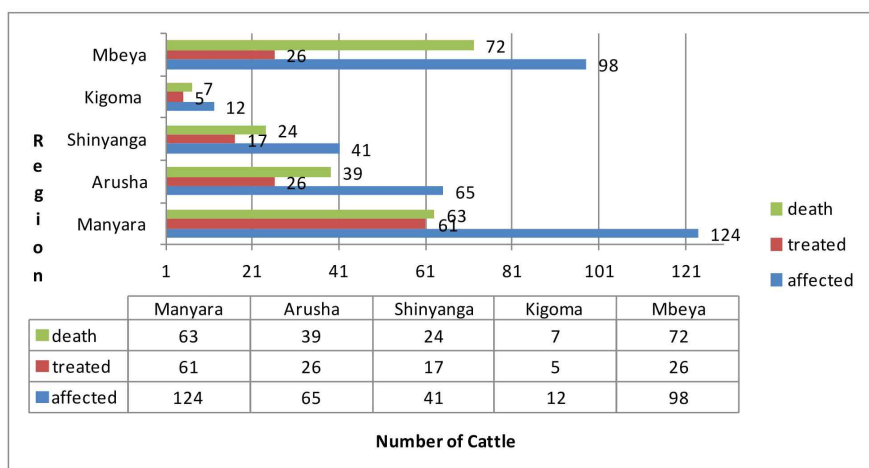
The pollution of pesticides has been revealed by the presence of a number of pesticide components in the soil and water. The improper storage of pesticides resulted in high levels of chemicals in the water including DDT, dieldrin, Malathion, and fermithrothion that polluted some parts of the Manyara and Coastal regions. The following examples explain further the agrochemical pollution on the environment: fish caught in Lake Tanganyika (South Western zone) have been found to contain measurable quantities of DDT and its metabolites. Legumes and cereals collected from Arusha (Northern zone) were found to contain BHC, DDT, dieldrin, fermithrothion and Malathion. A study has furthermore shown that, a sample of maize, wheat, and beans from local markets in the country were found to contain DDT, dieldrin, lindane and endosulfan in high concentrations as shown in Figure 9. Despite such growing evidence, the data that supports a direct correlation between agrochemical waste and human health hazard needs more research.

FIGURE 9. CONCENTRATION OF CHEMICAL WASTE IN MANYARA REGION (ZONE IV) IN 2010



Source: TPRI, 2008.

Additionally, there are cases of animals dying after ingesting indigestible plastic bags left around farming areas. The bags are the leftover materials from agrochemical wastes after being used by farmers without proper disposal. The report from the Ministry of Livestock and Fisheries in September 2011 shows that, in northern zones, an average of 50 cattle die annually and dozens more are left undiagnosed due to ingesting plastics while averages of 20 to 40 cattle die in southern zones (Figure 10). The differences in death tolls are due to livestock population as the North has more livestock than the South West zones, but the volume of waste disposal and access or contact to cattle may affect the level of death incidences. As discussed earlier, the Manyara and Arusha regions are more famous for livestock rearing, but Arusha has fewer death tolls because cattle there are exposed to fewer polluted area than the Manyara region. Similarly, the Mbeya region has few cattle keepers, but deaths tolls are higher than in the Manyara region because cattle graze mostly near their homesteads and farming sites.

FIGURE 10. CATTLE DEATH DUE TO PLASTIC INGESTION, 2011.

Source: Ministry of Livestock and Fisheries, 2011.

Therefore, the presence of agrochemical wastes in the water sources and soil were deteriorating ecological balance and largely threatening the ecosystem and the health of human beings. The reported health problems in this area were correlated with the exposure to agrochemical waste disposal in the farming localities. Farm animals dying from ingesting indigestible plastic bags and other materials are evidence of negative impacts of agrochemical waste in farming communities in both the northern and southern agricultural zones of Tanzania. As agricultural activities increase in the country, the risks of more agrochemical waste to cause aforementioned problems are highly expected. More environmental tension is on the way as more people become engaged in agriculture as the leading production sector in Tanzania.

The water quality analysis of the same lake carried out by Nonga et. al in 2010 has shown a 12% increase of solutes in the lake Manyara water (Table 3). It is composed of high levels of ammonium and phosphate, hence, more alkaline. The probable reason for this can be the application of ammonium and phosphate industrial fertilizers from the uplands of

Manyara region. This was proved by increased electro-conductivity as indicated in the table. Water alkalinity in Lake Manyara increases during rainy season due to high water run-off from farm fields and increased farming activities. This supports research done by the Institute of Resource Assessment (IRA, 2011) which found that almost half of water qualities in rift valley's lakes are deteriorated due to agrochemicals from farming sites. Soil erosion causes siltation and mass of soils reducing water qualities were collected to the water bodies especially rivers, dams, and lakes. Although the figures of NH_3 and NO_3 concentration are still questionable in this data, it gives some evidence to the cause of alkalinity of the Lake Manyara water.

TABLE 3. WATER QUALITY ANALYSIS IN LAKE MANYARA IN 2006 DURING DRY AND RAINY SEASONS.

Water paramter	Annual average	Dry season	Rainy season
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD
pH	9.6 $\pm$ 0.4	9.4 $\pm$ 0.4	9.8 $\pm$ 0.3
Salinity (‰)	14 $\pm$ 7.1	13.1 $\pm$ 7.1	14.4 $\pm$ 7.7
Conductivity (mS/cm)	24 $\pm$ 11.2	21.0 $\pm$ 5.9	26.5 $\pm$ 15.0
Dissolve Oxygen (mg/l)	11.0 $\pm$ 2.5	10.5 $\pm$ 2.0	11.6 $\pm$ 3.0
Ammonium ($\mu\text{g/l}$)	4 $\pm$ 3.1	3.2 $\pm$ 2.9	4.1 $\pm$ 3.6
Nitrate ($\mu\text{g/l}$)	1 $\pm$ 0.8	1.0 $\pm$ 1.0	0.7 $\pm$ 0.6
Nitrite ($\mu\text{g/l}$)	0.3 $\pm$ 0.3	0.4 $\pm$ 0.3	0.3 $\pm$ 0.3
Phosphate ($\mu\text{g/l}$)	36.1 $\pm$ 42.0	16 $\pm$ 9.3	53.2 $\pm$ 52.0

Source: TPRI, Arusha 2011.

Farm Africa, an international NGO in Tanzania, works with the local community forest management in this region. They have also reported that the cause of the dry-off of Lake Manyara's water is due to the extreme deforestation in the Noa natural forest, which is the source of numerous rivers that flow into this lake. This has been amplified by increased farming activities.

The Impact of Increased Farming Land Size

As described in the literature earlier, different crop varies cause negative environmental impacts over time in any locality due to differences in growth requirements and land resources consumption. For

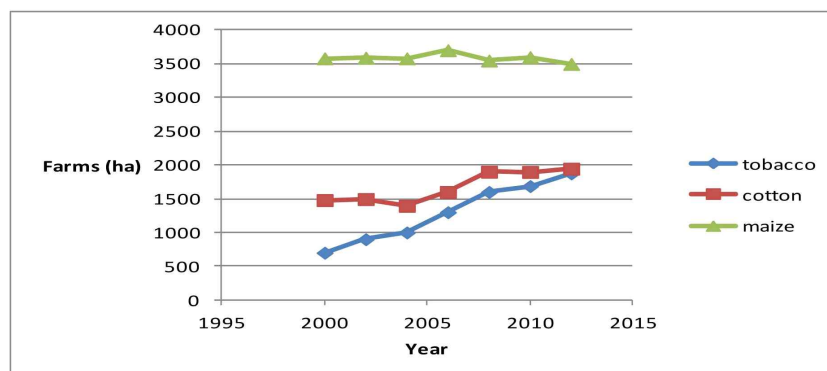
example, tobacco farmers in the study area practice shifting cultivation whereby a piece of land is cultivated for 2 to 3 seasons and left to fallow for the same period of time. The result was an increase in the area of tobacco farming in the southern agricultural zone. Considering the fact that tobacco is a heavy feeder (taking many nutrients from soil sources) cash crop, it causes soil nutrient depletion hence more shifting cultivations. In due course of this, farmers not only clean up all the soil cover to allow tobacco seedlings to grow, but also cut other tree logs from nearby forests reserves for burning the tobacco leaves. The agricultural census of 2007/08 shows an increase in tobacco fields to 16,214ha as compared to 8,624ha in 2003/04 in the southern agricultural zone of Tanzania. Both tobacco and cotton had shown a strong capability to capture more land from 2009 (Figure 11 derived from raw data from Table 4 below) and it is projected to take more land through 2013 due to the current increase in its market in the East African region. Therefore, environmental consequences from these farming activities are guaranteed if proper regulation is not put in place.

TABLE 4. CROPPING LAND IN THE SOUTHERN HIGHLAND ZONES.

Year	Tobacco Area	Cotton Area (HA)	Maize Area (Ha)	Seasonal Rivers	Lost Forest Ha(000)	Cummulative lost forest-Ha
2003	8624	14,361	35,901	16	352	352
2004	9654	14,679	36,453	15	312	569
2005	10245	14,024	36,251	12	287	685
2006	13652	15,668	37,653	12	204	889
2007	15980	17,356	32,356	12	120	1046
2008	16214	19,527	35,038	11	192	1238

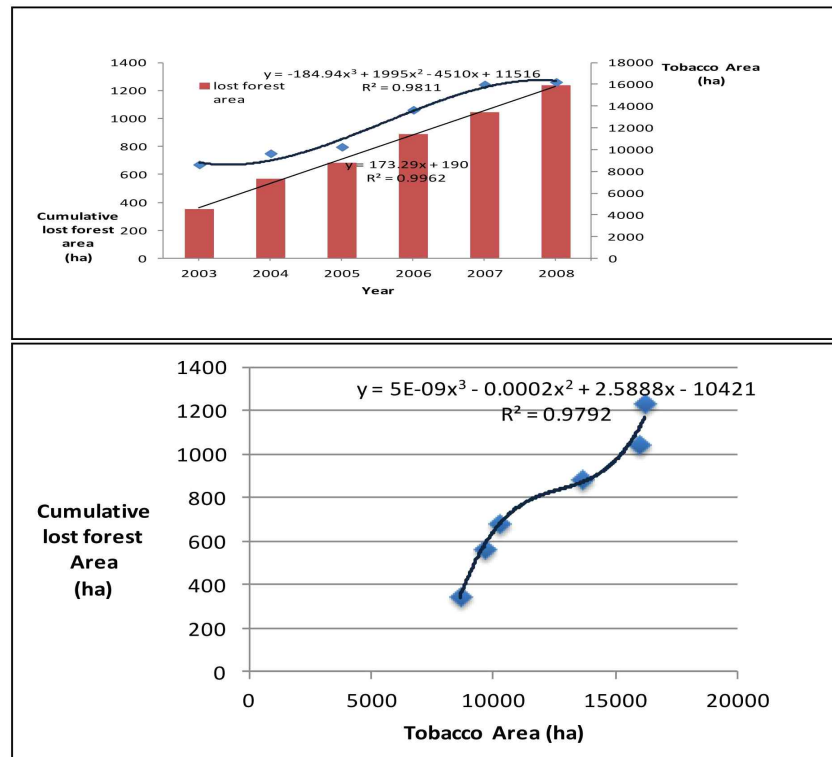
Source: Tumbi Agricultural Research Centre, 2011

FIGURE 11. TREND OF FARMING SIZE IN TOBACCO, COTTON AND MAIZE FIELD IN SOUTHHIGHLANS AGRICULTURAL ZONE



Source: Tumbi Agricultural Research Centre, 2011.

Cotton is another cash crop that has shown great land acquisition in the period 2003/04 according to this census. Maize land coverage seems to have increased before decreasing slightly while tobacco and cotton has significantly increased every year as shown in Figure 10. In the period of three years the farming land size size increased twofold indicating a high degree of land resource consumption in the southern zone. As shown in Figure 12, there is a direct relationship between tobacco land size increase and the deforestation rate. In early 2003 to 2004, tobacco farming was high and led to high loss of forest cover. The rate of tobacco farming suddenly slowed down for three farming seasons before it rose again at the end of 2007. The reason for this was enactment and enforcement of the Environment Management Act in early 2004. But after three years problems, returned due to institutional stagnation in law implementations.

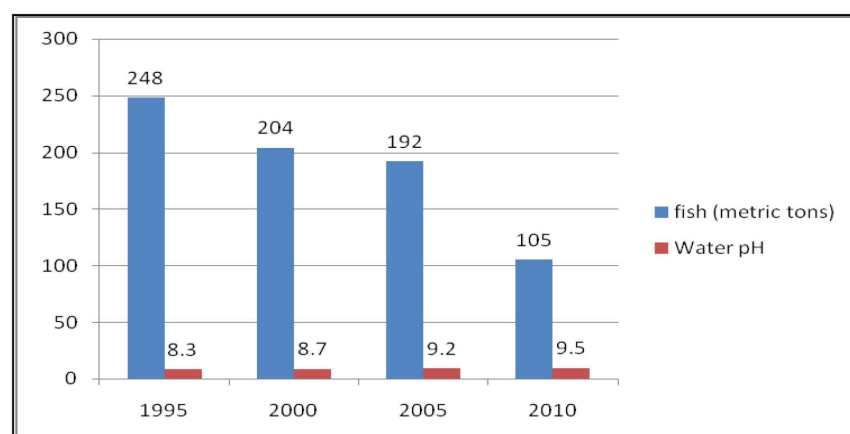
FIGURE 12. TOBACCO FARMING AND DEFORESTATION IN SOUTHERN HIGHLANDS ZONE

Source: Tumbi Agricultural Research Centre, 2011.

On the other hand, numbers of seasonal and annual rivers have dried off resulting to water shortage for domestic purposes. Over 1,200 ha of forest were lost between 2003 and 2004 due to expanding farm land in this area as reported by the Tumbi Agricultural Research Centre June 2010. In the Lake Manyara basin, (northern zone) 2 out of 11 rivers have dried-off and the rest have significantly reduced water flows. The reduced number of rivers and water shortage in many lakes has caused many problems in aquatic life including a potential decline in the fish supply. For example, the fish supply from Lake Manyara in the northern agricultural zone has been reduced by over 100 metric tons in the past 15

years as shown in Figure 13 due to reduced water depth and quality. Improper agricultural practice resulting in the endangerment of this lake is considered to threaten human livelihood. The situation of reduced water quality and quantity endangers the ecological balance in the northern agricultural zone. The life of both farm and wildlife animals is in danger because of a shortage of grazing land in the region as a result of increased farming. Around the Tarangire National Park labeled Tarangire NP, (see the map of Lake Manyara) there are frequent land conflicts between farmers and wild animals coming from the national park area due to water and pasture shortage. Farmers have expanded into the area closest to the national park, thereby affecting water sources for wildlife utilization. As a result, wild animals venture onto farmland in search for drinking water.

FIGURE 13. FISH PRODUCTION TREND IN LAKE MANYARA



Source: Farm Africa, Tanzania Office, 2011.

Conclusion and Policy Recommendations

Conclusion

Under poor management, many agricultural activities tend to degrade the natural environment thereby imposing unfavorable conditions so that human beings cannot easily access land resources. Poor agricultural practices that are either due to ignorance or government failure in resource management have largely contributed to land degradation in Tanzania. Among poor practiced include shifting cultivation mostly done by tobacco farmers in the agricultural zone of the southern highlands. Through shifting cultivation, farmers encroach on forests to open new farm fields and abandon the previously cultivated lands when soil nutrients have been depleted. This roughly takes two to three farming seasons. This results in severe deforestation and land degradation. The agricultural census of 2007/08 shows an increase in tobacco field to 16,214ha as compared to 8,624ha in 2003/04 in the southwestern agricultural zone of Tanzania. Both tobacco and cotton showed a strong capability to capture more land since 2009. Meanwhile, total land under tobacco crop increased to the tune of 20,000ha in this zone, taking the first position in farming activities before cotton and maize. This crop has turns a high profit and a reliable market in the region, thus, more farmers are interested in increasing their investment. This implies that further expansion of tobacco cultivation will greatly affect the deforestation rate.

Therefore, this research concludes that tobacco farming has greatly caused deforestation by forest encroachment and nutrient depletion through shifting cultivation in the northern and south western parts of Tanzania. Furthermore, miss-handled agrichemical application recorded several side effects to living organisms including human and the environment. Health hazards and water pollution is recorded at an alarming rate hence immediate mitigation measures to avoid further land degradation in the region. The water quality deteriorates due to mud

siltation (total sediments in water) eroded from the farming fields after soil being loosen by poor farming practices. This has further resulted in reduce lake and river depth, thus, endangering not only marine biodiversity, but also water availability for domestic and industrial use in the country.

In view of the above conclusions, there is a need for both the public and private sector to invest in managing agricultural activities for a safer environment that would guarantee sustainable agriculture for social livelihood. Below is the list of policy recommendations to achieve sustainable agricultural development.

Policy Recommendations

The sustainable use of land resources and the successful implementation of policies and programs to address the land degradation problems in Tanzania require enabling policies and institutional arrangements that encourage intensification of the smallholder farming systems. These would include such means as:

1. Setting limitations for agricultural lands, encouraging agro forestry farming, increasing the proper use of inorganic and organic soil amendments, provision of permanent watering points, development of low-cost soil cover and water harvesting techniques, expanding draft power, and strengthening local organization and extension services.
2. Promoting technical education to rural farming society so as to diversify their economic activities as a strategy to reduce dependency on the agricultural sector hence a reduction in environmental damage due to agricultural activities.
3. Empowering the farming communities with the appropriate technologies to increase agricultural productivity on small pieces of land to reduce farming expansion.
4. Agricultural activities near water sources should be strictly prohibited through established by-laws and incorporation of government and CSOs. The forests that are sources of rivers should be banned from

human access for efficient management.

5. Agricultural extension officers should reach all famers and effectively provide training on proper handling of agrochemicals. The regular reports on agrochemical waste management should be provided from the local level and forwarded to the central government.
6. Establishing formal local management boards on agricultural and environment managements that will foresee issues pertaining to bad agricultural practices resulting in degradation of the local environment.
7. At the same time, there is also a need for policies that discourage environmentally damaging land use practices, such as uncontrolled intensification in communally-held land and pastoral areas, shifting cultivation on tobacco farming fields, non contour farming along the hills and farming near the forest reserve areas.
8. An improved system that takes into account the land users' perspectives, local variations in ecology and socio-cultural conditions, incorporating proven indigenous practices and knowledge into technical approaches, and ensuring local participation in decision-making and strategies to address land degradation.
9. Sustainable agricultural practices like agro forestry cover cropping, and crop rotation, which are more environmentally friendly, would reduce land degradation especially in the two agricultural zones where this research was undertaken. Policies should encourage individual tree planting, contour plowing, minimum agrochemicals use and in a more informed approaches, intercropping, composting and farm yard manure application.
10. Government promotion of environmentally friendly agricultural practices on a regular basis to motivate famers on good agricultural practices that would sustain the natural environment.

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Appendixes

Appendix 1. CATTLE DEATH INCIDENCES IN NORTHERN AND SOUTHERN HIGHLAND AGRICULTURAL ZONES OF TANZANIA, 2011.

Cattle death due plastic ingestion, 2011.			
region	affected	treated	death
Manyara	124	61	63
Arusha	65	26	39
Shinyanga	41	17	24

Appendix 2. Land utility in Northern and Southern Zones

Cover type	Area in 2002 (sq km)	Area %	Area in 1981 (sq km)	Area %
agriculture	343729	30	98171	9
bush land	234983	20	320542	28
grassland	151128	13	181128	16
forest	47617	4	78245	7
woodland	313871	27	393871	34
bare soil	1411	0.8	982	0.8
forest plantation	1093	0.2	893	0.2
wetland	57768	5	77768	7
Total	1151600	100	1151600	100

Appendix 4. Crop Productivity in Southern and Northern Agro Zones, MAFSC 2011.

Crop Type And Productivity (ton/ha)				
Time year	Maize	Beans	Sorghum	Coffee
2006	2.8	2.5	3.2	2.1
2007	2.9	2.1	3.1	2.3
2008	2.3	2	2.4	1.8
2009	2.6	2.4	2.8	1.9
2010	2.6	1.9	2.7	2

Appendix 4. LAKE MANYARA MAP AND THE RIFT VALLEY ESCAPEMENT

Lake Manyara Watershed: Tanzania

