

Land Degradation as an Issue in Agro Ecosystems: A Review of Underlying Causes

Adidja, M.W., Ssekyewa, C.,
and Mwanga-Zake, J.W.F.

Faculty of Agriculture,
Uganda Martyrs University,
Nkonzi, Kampala, Uganda.

Corresponding author:
adidjamatabaro@gmail.com,
wadidja@yahoo.com

Keywords:
Land degradation,
agro ecosystem,
human wellbeing,
rural areas,
underlying causes

Abstract

Land degradation is a big issue in agro ecosystems in developing, transition economy and developed countries. This problem negatively affects agriculture productivity and production in rural areas of all countries where most people depend on agricultural activities for their survival. Therefore it impacts food security, poverty, livelihood and wellbeing of rural populations. Factors such as poverty, population growth or pressure, climate change, human activities (intensification of agriculture, industrialization and urbanization), poor awareness and lack of institutions and poor governance (poor policies and management) are causing and increasing land degradation and its negatives consequences on agro ecosystems functions and services. Some of these causes are also initiated and increased by land degradation (vicious circle). This emphasizes the needs to identifying and understanding the root cause of land degradation, consequences and response in order to develop better mechanisms of eradicating or mitigating the unwanted effects.

Introduction

An agro-ecosystem is an integrated region for agricultural production where food production systems are considered as a whole, including their complex inputs and outputs and the interconnections between their components. Basically, an agro-ecosystem is an agricultural and natural resource system manipulated by human beings for their food needs and other valuable products (Krishna, 2014; WRI, 2011). Being an agricultural production system, land is its very important components and plays the key role of supporting and feeding crops for their growth and production. Land is also central in the relationship that links energy, food, water, and environmental health in an interdependent circle. However, this component has been degraded in most parts of the world especially in rural areas where the majority of the population uses agriculture as the main activity to generate income and survive. This degradation has also happened in dry lands due to human activities and climate change and desertification. Continued land degradation during the coming years could reduce global food production, increase food insecurity, hunger and poverty over the world (AU, 2014; FAO, 2015).

Land degradation results from every decline in biodiversity and ecosystem functions, which adversely impacts the provision of ecosystem services and hinders poverty extermination and sustainable development. Land degradation means the decline in the productive capacity of the land (UN/FAO definition) or "the aggregate diminution of the productive potential of the land, including its major uses, its farming systems and its value as an economic resource." This degradation is called

desertification in arid, semi - arid and dry sub - humid areas where productivity is constrained by water availability. Land degradation has also been defined as the reduction of the current or future capacity of land to produce (Oluwole and Sikhhalazo, 2008).

Land degradation affects about 70% of the world's rangelands, 40% of rain fed Agricultural lands and 30% of irrigated lands. Salinity affects 30% of irrigated lands while above 1/4 of the world's land is affected by desertification. The latter affects half of the world's poor people who live in dry land regions with fragile soils and unreliable rain). In addition, land degradation reduces the productivity and production (yield) in those areas. Hence, this problem has been broadly recognized as a major threat to food production and poverty eradication around the world. This situation emphasizes the need to preserve, restore land potentialities and/or control land degradation at national, regional and international level for sustainable improvement of human economy and wellbeing in the world (FAO, 20011, BAI *et al*, 2008, UN General Assembly, 2012). Land degradation has been globally caused deeply by different factors among which: poverty, population growth or pressure, climate change, human activities (e.g. urbanization, industrialization, agriculture and deforestation), weak institutional/poor awareness/poor governance and natural processes (Wakindiki and Ben-Hur, 2002). These factors are summarized in the figure 1(Adidja, 2017) below:

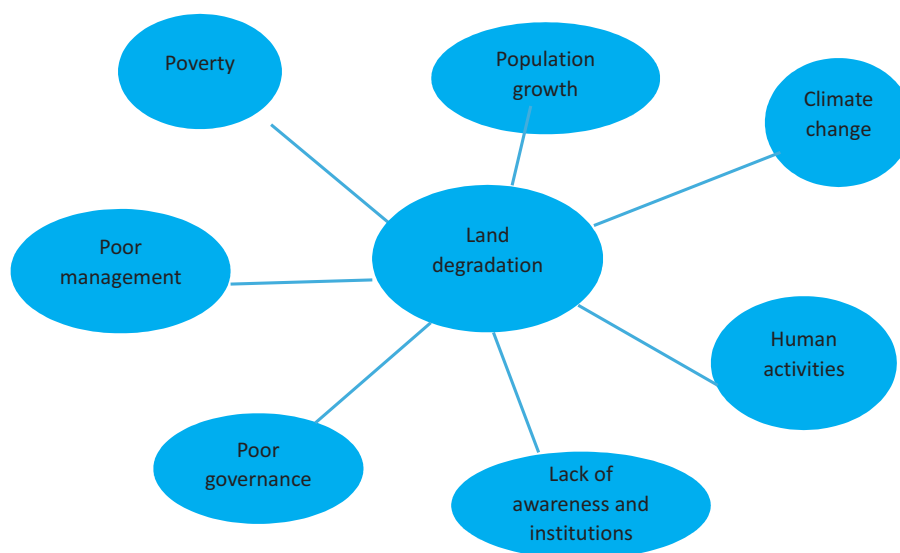


Figure 1: **Factors Causing Land degradation**

This article will present and discuss the underlying causes of land degradation as an issue in agro ecosystem, which can be useful in elucidating the consequences and response mechanisms for proper or long-term solutions to reduce or mitigate land degradation, increase productivity/production, reduce poverty, and improve income and human wellbeing in the rural areas of the world.

1. **Poverty and land degradation**

There are important links between natural resource management and poverty. Many poor people rely on natural resources for their livelihood and survival and are very vulnerable to deterioration of these resources (Heady 2000). The poor are both victims and agents of resources degradation. The poor destroy their resources by putting pressure on it to meet the needed and wellbeing standards compared to the rich (equity) and to satisfy their multiple needs (Anijah-Obi 200; Nwagbara, 2012; NEMA, 2002;

Shiferaw and Holden, 1999b; Nkonya *et al.*, 2004). These linkages are very strong in the rural areas in assumed poor countries where agriculture is the main livelihood activity (Turner *et al.*, 1994). This situation implies that poverty leads to land degradation and land degradation contributes to poverty (Barbier, 2000; Lambin *et al.*, 2001; Eswaran *et al.*, 2001). Thus, poverty can be seen as a consequence of degrading land and, at the same time, as a cause of land degradation. Despite the level of land degradation and government effort to promote use of land technologies, the adoption remains very low—below 30 percent (Nkonya *et al.*, 2004). This situation is due to poverty, which constrains households in rural areas to invest in mitigating land degradation. Social capital affects adoption and diffusion (exchange between those who have adopted and those willing to do so) of land management technologies (Isham, 2000; Reid and Salmen, 2000; Nyangena, 2005; Rogers, 1995). Therefore, land degradation is the major constraint to enhanced agricultural productivity and household welfare whose main source of living is crop agriculture (UPPAP, 2002, Deininger and Okidi, 2001). This poverty problem can be addressed by the identification of its determinants and their inclusion it into the design of government policies and programs as priorities (GOU, 1997). Elsewhere, poverty and adoption of various land management technologies are mutually interrelated: poverty determines the level of adoption of technologies while the level of adoption has implications on land productivity and on poverty. Also poverty and social capital are interconnected. This situation leads to an endogeneity problem, which needs to be considered when drawing conclusions about solutions (Birungi, 2007).

2. Population growth and land degradation

Population growth influences land use, land status and land potentials to sustain the livelihoods and wellbeing of present and future generations. **Land use** change includes deforestation and fragmentation of forests, intensification of agriculture and its expansion into marginal areas and fragile ecosystems, as well as urban expansion and infrastructure development. Land degradation affects land resources in tropical, subtropical and dry land regions of the world. It impacts much on the population whose livelihoods depend on agriculture and land exploitation. Rapid population growth impacts natural resources and leads to land scarcity and degradation: demographic pressure implies more intensive use of natural resources, which implies resources deterioration. The growing population put immense pressure on intensification at cost of forests and grazing lands to meet the increased food demand, and hence, leads to deterioration of land resources. In India for example, increasing demographic pressure and the subsequent competition for rare resources stimulates rearrangement of physical (fragmentation or dispersion), and social attributes (land tenure; use/ownership rights) of landholding. This situation creates changes, which deteriorate land productivity and increase food shortage in rural areas by affecting land management practices, land use, conservation technologies, fertilizers, and other inputs. Densely populated countries around the world, experience a growing cultivation of marginal lands and consequently their degradation (Gregersen, *et al.* 1992). The migration on marginal lands has a significant change in the structure of landholding and impacts negatively natural resources. Thus, when farmers/herders try to increase their production in fragile areas, the dynamics of the relationships between human and natural resources change radically. This shift also affects farmer's investments and land use strategies and then leads to increased land degradation: farmers are pushed to occupy mid and upper slopes lands where erosion problems are common with low yields and less interest to invest in conservation because of their characteristics. This leads to spring of low production and low investment (Pingali and Binswanger, 1984). Also the expansion of cultivation on marginal lands has increased their degradation due to the higher seasonal or annual cropping disturbance compared to their traditional uses (e.g long fallow). This situation has limited cropping options and choices too. Land use and crop

selection is a dynamic process affected by external structures and local conditions. When technologies change or degradation occurs, farmers adapt by adopting suitable practices to new conditions or by moving to fragile areas. However, research results suggested that households with insufficient land have to plant ever-increasing amounts of their lands holdings with sweet potatoes and other tubers (Clay and Magnani 1987; Loveridge, *et al.* 1988). These tubers have a higher caloric value than other crops and grow relatively well in poorer conditions such as steeper slopes and protects the land from degradation more than annual crops (Gleave and White 1969). The population growth problem can be addressed either by controlling population's fertility (family planning) or by developing and disseminating technologies to control land degradation while increasing production (Clay *et al.*, 1994).

3. Climate change and poor management

Climate change refers to changes in rainfall patterns, increased frequency and intensity of drought and floods, rising temperatures, and profound ecological changes. The effects of climate change are intensifying the effects of demographic pressure and unsustainable land management practices on land degradation over the world. Therefore, the capacity for the populations to generate livelihoods has become restricted. Land degradation or desertification in the arid, semi-arid and dry sub-humid areas results from climatic variations due mostly to human activities. This degradation induces the reduction or loss of areas of the biological/economic productivity and complexity of rain-fed cropland, irrigated cropland, or range, pasture, forest, and woodlands resulting from land uses or from a combination of processes from such as erosion; deterioration of the physical, chemical, and biological or economic properties of the land; and loss of natural vegetation (WMO, 2005). The climatic changes lead also to water shortages, salinity and compaction which affect negatively the production and productivity of lands (see figure 2).



Figure 2: Water shortage and desertification (ODADA, 2004)

This climate change problem increases low productivity leading to increased food insecurity and poverty (because of low income). Increased poverty impacts negatively the access to adaptation and mitigation measures and the exposure to extreme events in those countries (as shown in figure 3) (UA, 2014).



Figure 3: Uprooted tree by wind in dry lands (ODADA, 2004)

The reactions between climate change and land degradation are very complex and can be self-reinforcing when land degradation contributes to climate warming (loss of carbon stores from soils and vegetation) (Cordova, 2000; Mohawesh, 2015). Also, the degradation by reductions in vegetation cover creates local microclimate (decrease of air humidity, increase of soil temperature and amount of solar radiation). Thus, land degradation combined with climate change can disturb the ecological and land use systems which can lead to food insecurity and water shortage with negative impacts on livelihoods and households adaptive capacity). Recent research suggests that increased global warming could lead to extreme events occurring more frequently and with greater severity in a globally synchronized way. This could significantly reduce our resilience to drought and disruptions to food systems at a global scale. Sustainable land management practices are therefore needed to reduce land degradation due to climate changes with its impacts on natural resources such as land (WMO, 2005). Adaptation practices such as coping, adjustment and transformation can be established. These adaptation options include Climate Smart Agriculture which suggests solutions combining food security, climate adaptation/mitigation while supporting sustainable landscapes and food systems (UNCCD, 2015).

4. **Industrialization, Intensified Agriculture and urbanization**

The rapid industrial development of recent years has led to a number of shared environmental problems in the world such as severe land degradation (UNEP, 2002). Industrialization is one of the major causes of increased land degradation and depletion while urbanization, deforestation, erosion of the topsoil and desertification are its consequences. The revolution of industry and the large-scale application of science and technology in industries increased industry production which made natural resources consumed in big quantities. Much impact of industrialization is seen in developed countries than in developing ones. Agriculture also increases degradation of the land in the way that crop production requires the removal or modification of the natural vegetation of the land. Thus, arable farming alters the land by adding and removing plant nutrients, reducing acidity with lime, draining excess soil moisture with underground pipes, removing stones, and changing its structure (Grigg, 1987). Both agriculture (over cultivation, deforestation and overgrazing) and development (industrialization and urbanization) cause land degradation and then reduce also productivity and production of this resource while impacting negatively the livelihood and wellbeing of people in the world. Therefore, good policies must be designed with proper planning and good technologies for sustainable management of lands (Ahuti, 2015). These needs will not be met sustainably unless we preserve and restore the productivity of our land. Business as usual will lead to more deforestation. If hunger and food insecurity are to be overcome, an estimated 60% increase in agricultural productivity, including a 100% in developing countries, will be necessary by 2050. However, the world's ecosystems, biodiversity and associated goods and services are also under increasing pressure from the loss of crop diversity, the overexploitation of fish stocks, deforestation, degradation and losses of arable land, growing competition for increasingly scarce water and the adverse impact of climate change. Although land degradation is a generalized risk, some 40% of the world's degraded lands are found in areas with the highest incidence of poverty, which remains overwhelmingly rural. As rural to urban migration is increasing, the urbanization is also taking continuously place. This continuation of urbanization increases land and resource consumption which deteriorates these resources (land) and people's economy. Therefore, planners, governments, planning agencies and others should acknowledge these problems immediately and put environmental perspective into land use planning and decision making process effectively and promptly.

5. **Lack of awareness and Weak institutions**

Most time, lack of awareness, capacity building programs and networking for farmers/resource users, technicians and policy makers on integrated land use systems and technologies lead to poor adoption, use and adaptation of sustainable management technologies and restoration/conservation practices of lands in rural areas. This weakness makes the degradation of lands and poverty to continue increasing in those areas. This situation is reinforced by the lack and weakness of specific institutions to conduct different training program to build public capacities and awareness on sustainable use and management of land and to conduct monitoring and evaluation programs on adoption, use and adaptation of best practices and technologies over the globe. In DR Congo for example, low adoption of conservation practices were observed and identified due to poor awareness and lack of extension services (Adidja, 2012). Government should reinforce people capacities and awareness by organizing different training programs with these priorities and increasing networking within and across farmers.

6. Poor policies or poor governance

Some policies discourage sustainable use and management of land resources while others prioritize other sectors than conservation and agriculture sectors. Insecure land tenure and property rights for example, can also lead to the discouragement to investment in land management practices among the rural poor, and then to deeper poverty (Gabremedhin & Swinton, 2003; Kabubo-Mariara, 2007). Also, institutional arrangements that govern access to and use of resources may also undermine resource management leading to heightening of poverty (Leach *et al.*, 1997rev). Different government must review their policies goals and priorities to increase adoption of conservation and restoration practices. The policies and governance approaches must move away from macro scale level to a greater appreciation of people in places because the land problems are highly differentiated and experienced differently by diverse groups (Means, 1991; chambers, 1997). In addition, these policies must increase the perceived importance of local institutions and poor people in their content which implies the use of community-based natural resources approaches.

Conclusion and recommendation

Land degradation remains a big challenge in agro ecological systems. It mainly results from poverty, unplanned population growth, climate change, human activities, poor management, poor governance/policies, and the lack of awareness and institutions. These factors threaten the proper functionality of these systems and their capacity to provide better services to human being (welfare) and to the environment in general (self-resilience). Thus, land degradation problem reduces the productivity/production/yield of the land, and therefore, people's income especially in rural areas where the majority of habitants rely on agriculture as main activity and source of income over the world. This situation increases, therefore, food insecurity, poverty and hunger while affecting negatively the health and wellbeing of a large number of people in those areas. Therefore, there is a need to control population growth via sensitization campaigns and reinforce adoption/adaptation of best technologies and practices to restore, conserve and manage the lands sustainably in order to improve its productivity and production while reducing poverty, food insecurity and hunger, and therefore, improving people's welfare and conserving/protecting land resource in the world. Also, strong governance approaches and policies must be designed and implemented. These policies must be context specific and must involve the participation of local community in the land management process equitably in order to reduce poverty and promote best management practices and technologies in the affected areas.

References

- Ádám, K., 2009. The global problem of land degradation and desertification. *Hungarian Geographical Bulletin* 2009. Vol. 58. No 1. pp. 19–31. Degradation and Sustainable Development: A Discourse, Global Journals Inc. (USA) Online ISSN: 2249-460x & Print ISSN: 0975-587X.
- Ahuti, S., 2015. Industrial Growth and Environmental degradation. *Environmental Science*, E-ISSN: 2454-9916, vol-9.
- Bai, ZG, Dent, DL, Olsson L, Schaepman ME., 2008. Global assessment of land degradation and improvement. Identification by remote sensing. Report 2008/01, ISRIC – World Soil Information: Wageningen.
- Batistella, M., Valladares, G.S., 2009. Farming expansion and land degradation in Western Bahia Brazil. *BiotaNeotrop*. 9 (3).

- Chambers, R. (1997) *Whose reality counts?*, London: Intermediate Technology Publications.
- Daniel C., Guiz, M., Wallace, S., 1994. *Population and Land Degradation*, Departments of Agricultural Economics and Sociology, Geography, and Resource Development Michigan State University.
- Dasgupta, P. 2000. Population and resources: An exploration of the reproductive and environmental externalities. *Population and Development Review* 26 (4): 643–689. *Development Economics*. 5, 3, 241-258.
- Duraiappah, A., 1996. *Poverty and Environmental Degradation: a Literature Review and Analysis*, CREED Working Paper Series.
- FAO, 2011. *The state of the world's land and water resources for food and agriculture (SOLAW) - Managing systems at risk*. Food and Agriculture Organization of the United Nations, Rome and Earthscan, London.
- FAO, 2015. *Agroecology to reverse Soil Degradation and Achieve Food Security*.
- Gebremariam, A., 2010. *Farmer's Awareness about Land Degradation and their Attitude towards Land Management Practices*. Addis Ababa University College of Education Department of Geography and Environmental Education.
- Grigg, D., 1987. *The Industrial Revolution and Land Transformation*. Land Transformation in Agriculture Edited by M. G. Wolman and F. G. A. Fournier, SCOPE. Published by John Wiley & Sons Ltd. 91 1 | Issue: 5 | Dec 2015 E-ISSN: 24
- Heady, C. (2000). *Natural resource sustainability and poverty reduction*. Environment and
- Mearns, R. (1991) "Environmental implications of structural adjustment: reflections on scientific method", IDS Discussion Paper DP284.
- Mohawesh, Y, Taimeh, A., Ziadat, F., 2015. Effects of land use changes and soil conservation intervention on soil properties as indicators for land degradation under adoi:10.5194/se-6-857-2015 Mediterranean climate. *Solid Earth*, 6, 857–868.
- Ozturk, M., Ruhi, A., Celik, M., S., 2011. *Urbanisation, Land Use, Land Degradation and Environment*. Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), :Daya Publishing House.
- Rattan L., 2015. *Restoring Soil Quality to Mitigate Soil Degradation*. The Ohio State University, Columbus, OH 43210, USA; E-Mail: lal.1@osu.edu; Tel.: +1-614-292-9069, Academic Editor: Marc A. Rosen, ISSN 2071-1050.
- UN General Assembly, 2012. *High-level meeting on addressing desertification, land degradation and drought in the context of sustainable development and poverty eradication*. A/65/861.
- UNCCD, 2015. *Climate change and land degradation: Bridging knowledge and stakeholders*, Outcomes from the UNCCD 3rd Scientific Conference. 9-12 March 2015, Cancun, Mexico.
- WMO, 2005. *Climate and Land Degradation*. WMO-No. 989© 2005, World Meteorological Organization. ISBN 92-63-10989-3.