Welcome to Africa

Proceedings of the Summer-School Workshop 2014

Scientific Cooperation Network
on Climate Change Adaptation
in Eastern Africa

Funded by:

DAAD
Deutscher Akademischer Austausch Dienst
German Academic Exchange Service

Federal Ministry
of Education
and Research

TECHNISCHE
UNIVERSITÄT
DRESDEN

The project
„Scientific Cooperation Network on Climate Change Adaptation“
is part of the higher education program „Welcome to Africa“
of the German Academic Exchange Service (DAAD),
funded by the Federal Ministry of Education and Research.

Project Leadership

Prof. Dr. Jürgen Pretzsch
Technische Universität Dresden
Faculty of Environmental Sciences
Institute of International Forestry and Forest Products
Professorship for Tropical Forestry
Pienner Straße 7, 01737 Tharandt
Germany

Edited by

Maxi Domke, M.A.
Tarig Mahmoud El Sheikh, PhD

Tel.: +49 35203 38-31213
Fax: +49 35203 38-31820
welcome2africa@forst.tu-dresden.de

ISBN 978-3-942934-05-3

www.tu-dresden.de/forst/w2a

Print

ELL Print, Tharandt

Das diesem Bericht zugrundeliegende Vorhaben wurde mit Mitteln des Bundesministeriums für Bildung und Forschung unter dem Förderkennzeichen DAAD Projekt-ID 55516166 gefördert.
Die Verantwortung für den Inhalt dieser Veröffentlichung liegt beim Autor.

“Welcome to Africa”

Scientific Cooperation Network
on Climate Change Adaptation

Proceedings from the Workshop

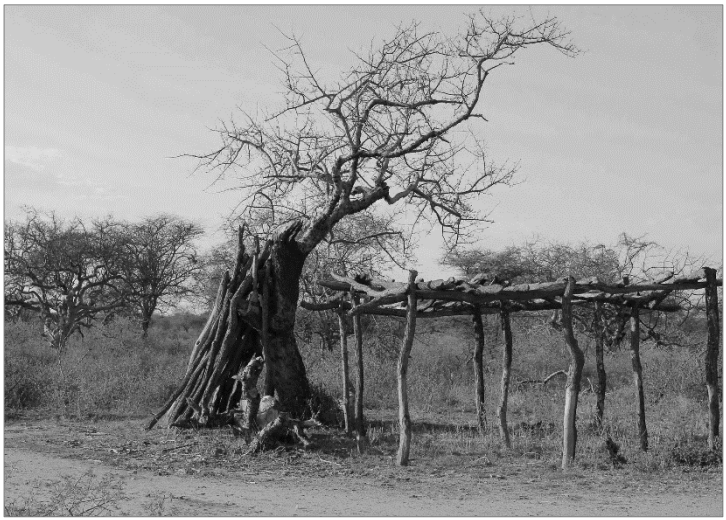
10 – 21 March 2014

Wondo Genet / Addis Ababa, Ethiopia

This publication is a compilation of the papers presented at the annual network meeting and Summer-School of the project "Scientific Cooperation Network on Climate Change Adaptation" within the DAAD "Welcome to Africa" program.
The workshop took place from March 10th – March 21st 2014 at the Wondo Genet College of Forestry and Natural Resources and at selected locations in Addis Ababa and the Southern part of Ethiopia.

We thank all presenters and authors for their participation and fruitful contributions as well as the institutions and organizations that we were able to visit and discuss with their representative.
Particularly, we want to highlight the enormous efforts of the Ethiopian network partners to make the event a success.

TABLE OF CONTENTS



Climate Change
Adaptation and Mitigation

Paradigm Changes in Tropical Forestry and Steps towards a Green Economy: Elements of a Framework for Rural Development in Ethiopia

Jürgen Pretzsch[*]

Technische Universität Dresden, Faculty of Environmental Sciences, Institute of International Forestry and Forest Products, Professorship for Tropical Forestry

Abstract

Worldwide rural regions are increasingly marginalized and affected by impoverishment and outmigration. To counterbalance this, innovative strategies are required on policy as well as on local producer level. To understand current trends of rural development, a hermeneutic research approach is applied. This has led to the formulation of six paradigmatic model development stages (I) pre-colonial, (II) colonial (III) forestry and capital formation, (IV) internationalization, (V) polarization and (VI) globalization. Paradigms are rooted in theories, have impact on policies, are determined by a specific group of scholars and influence practice. In a first step, shifts between paradigms and its consequences for rural development and forest management are outlined and interpreted for the case of Ethiopia.

In a further step, current challenges of rural development are investigated with regard to their roots in previous paradigms. Taken into account are knowledge systems; consequences of the modernization era, in which partly agro-industries were build up and experiences with the polarization stage, which led to the partial involvement of the civil society and rural communities in decision making. The current globalization paradigm is critically reviewed in its validity to explain the development of Ethiopia, specifically in the field

[*] Corresponding author: tropen@forst.tu-dresden.de

of forestry and the shift to a next, future paradigm is investigated. Global governance instruments like conventions as well as environmental service models are mostly based on market mechanisms and hardly reach rural areas and local producers. It is proposed to follow different and alternative development paths, giving more decision power to regional institutions, improving the situation of small farms and building up social capital and small enterprises on a local level. Concepts of a “green economy” are seen as a versatile fundament to discuss future strategies of rural development in Ethiopia.

Keywords: paradigmatic models, globalization, green economy

---

1. Introduction: Challenges in rural development

In contrast to the rapid growth of urban areas and the continuously increasing urban population, rural areas are worldwide under threat. Although urbanization is advancing rapidly, in Ethiopia still a large percentage of the population is living in rural areas based on primary production. Like in most African countries, external and internal causes for the marginalization of rural areas and impoverishment of the population are strongly interrelated, complex and difficult to identify systematically. Common external challenges are the lack of access to international markets, decreasing terms of trade and related instabilities, uneven share of technologies between countries of the North and the South and finally the increasingly visible and destructive consequences of climate change. Internal causes for stagnating rural development are poverty, lack of production means, limited capacity of the administration and deficits in the legal framework and policies, especially related to land tenure. The traditional community structure and local knowledge may accelerate or hinder development. Mostly this is differing from Western globalization targets. Limited development options, social

differentiation between rural people and investors from outside as well as ethnical quarrels, fuelled by lobbyism and corruption, lead to conflicts and structural permanent dysfunctions, which were present in all Ethiopian development stages. International influence was increasing in the last decade, but related conventions and agreements often did not reach the reality of rural people.

On the other hand, rural areas have specific development potentials and offer options, which do not exist in urban areas. Galston & Baehler (1995, p. 3) mention three characteristics of rural areas: (1) They are embedded in nature; (2) have strong social networks and (3) are integrated into historical processes. Linked to strong family bounds, in rural areas a number of traditions have survived colonial and globalization offenses. Rural areas are characterized by strong local knowledge, which may have an important function in solving current challenges like climate change adaptation or regulating land use. These potentials just have to be used in an efficient and effective way, integrating them in rural development strategies (Pretzsch 2014). The conditions for the implementation of a decentralized approach of a Green economy are favorable in rural areas; decentralized energy provision does not require high-level technology development and its implementation is feasible with low cost. The implementation of sustainable and auto subsistent food production chains can be realized easily on a technical level; challenges are the social organization between tradition and modernism, introduction of fair distributional mechanisms and a good regional planning. However, especially in Ethiopia respective institutions are weak.

2. Objectives, definitions and conceptual framework

The introduction indicates, that land use in tropical countries and especially in Ethiopia, is characterized by increasingly complex and often destructive interrelations between rapidly changing ecological

and social systems (Melaku 2003). On an abstract level, the co-evolution approach suits well to portray this dynamics and the related complex processes. Objective of this contribution is to outline the essential elements of such a co-evolution model, to demonstrate the outcomes from the paradigm analysis and - based on this - to reflect on elements of possible paths towards a sustainable land use management in the context of a green economy in Ethiopia. The co-evolution approach was frequently applied to document local and regional land-use changes and respective developments (Norgaard 1994; Berkes et al 1998). In figure 1, the complexity of development is demonstrated in a system model (Pretzsch et al 2014).

The model is composed of the four complexes, the natural system, the interface dealing with management systems, the social system and finally the formal and informal regulations, which include as essentials the government and governance systems as well as the civil society with its informal rules and traditional knowledge.

Ethiopia is characterized by a very specific history, determined by thousands of year lasting land use history, the specific influence of imperial times, short Italian invasion, socialist government and a difficult democratization era afterwards, which is ongoing today.

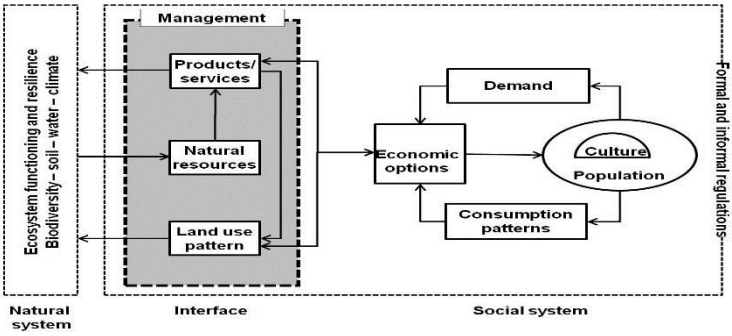


Figure 1: The co-evoluation approach as a global explanatory and analytical model (Pretzsch et al 2014; based on Hurni and Messerli 1981; Norgaard 1994; Berkes et al 1998)

As an analytical approach to understand the strong inter-linkages between natural factors like climate and soil on one hand and the extremely complex rural society on the other hand, with diverting strategies between different tribal groups, the co-evolution approach suits well.

The analysis of the current situation is complemented by the conceptualization of development paths and the attribution of paradigms. This partly permits to learn from the past and to apply the knowledge structured in paradigms for designing future development paths and make respective decisions. Following the definition of Kuhn (1970, p. 175), paradigms are defined as "the entire constellation of beliefs, values, techniques, and so on shared by members of a given community". They follow four characteristics, being (1) rooted in theories; (2) have an impact on policies; (3) articulated by a clearly determined group of scholars and (4) exert influence in practice. In most tropical and subtropical countries six development stages of tropical forestry can be conceptualized, which are embedded in paradigms: (I) Pre-colonial forest use, (II) colonial forestry, (III) forests for national growth, (IV) internationalization, (V) polarization and (VI) globalization of forestry (Pretzsch 2014). As demonstrated in the further analysis, this differentiation does not fit for Ethiopia. However, it represents a useful fundament to conceptualize future Ethiopian forestry development and to derive respective fields of research and necessary discourse.

The analytical framework, which is based on a situation analysis and the paradigm based on a historical revision, still lack a clear orientation towards future development objectives. Here elements of a green economy are subjectively set as targets. UNEP (2011) defines Green Economy as "improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities". The UNEP-Report 2011 introduces in the principles of a green economy, including indications on forestry, and designs a pathway towards its implementation. Some of the

discussed principles are very useful for Ethiopia, because they represent an alternative to the conventional, just capital and high technology driven Western industrialization path. De-central and environmentally sound solutions are mentioned. Oriented by the general targets of a Green economy, some elements of pathways for a future forest development in Ethiopia are discussed.

3. Tropical Forestry paradigms and their change

3.1. Application of the paradigm approach to Ethiopia

The above outlined standard approach to formulate forestry development paradigms, bringing together national development approaches and forestry development (Pretzsch 2014), is tested in its application for the Ethiopian case. It is obvious that it does not fit well, but valuable information might be absorbed from deviations of other case study countries. It must be pointed out, that the paradigm based diagnosis and the outlook can be tackled here just in a superficial way. Further studies are necessary for the discourse on future rural and forestry development strategies. Further research can also be embedded in the framework of political ecology (Peet and Watts 1996; Bryant and Bailey 1997). Few profound studies are available on forest policy development and the forest history of Ethiopia (Melaku 1992; 2003).

3.2. Pre-colonial forest use

On a theory level, the complex nature of pre-colonial societies and their relation to forests is well conceptualized by explanation models from cultural and human ecology (Steward 1972; Bennett 1976; Little 1999). They describe the changing relation between local, mostly clan and community organizations and their ecological environment. Special emphasis is put on different levels of co-evolution, leading to sustainable or destructive land use. Spiritual and religious norms and

institutions have played an important role in guiding rural development (Kelboro 2009). In the very long and rich history of Ethiopia, before increasing Western influence, traditional land use systems and respective local governances systems have played an important role. Production was focused on subsistence use as well as for early market production. The conversion of forest in agriculture dates back to a long cultivation process, which demonstrates the long land use history. The present narrative of forest destruction has to be put in the light of a long civilization history and basic needs satisfaction (Melaku 2003).

The local use of construction wood for huts and firewood for cooking and a great variety of non-timber forest products from a great variety of savannah trees, only few forest products like gums and resins entered early in regional or international markets. Until today, the pre-colonial local forest use strategies, the related property regime as well as management techniques are only partly documented. Profound knowledge on pre-colonial practices and institutions are a pre-condition for the further development of current land use systems or to find solutions towards a sustainable land use management.

In Ethiopia profound Western technology transfers took place without any direct European dominance. Under the Imperium of Menelik II Addis Ababa was established as capital and the construction of the railway to Djibouti was started, based on a contract with France. The first section was ready in 1901 and the whole link was completed and inaugurated in 1917 (Batnicki & Mantel-Niecko 1978; Henze 2000).

3.3. Invasion interregnum and increased Western influence

The colonial forest paradigm generally explains the dependencies between colonial motherlands and colonies and has its theoretical fundaments in imperialism. Often unequal power structure has led

to the imposition of European forest administrations, which hardly integrated the interests of the forest dwellers and farmers (Hobsbawm 1987). Ethiopia experienced just a short period of invasion. The Italian occupation lasted from 1936 until 1941. During this time strong Western influence led to the further development of infrastructure of the country. Policies and legislation were reoriented, absorbing Western European experiences. In this time the first forest legislation was settled, regulating different areas of forest management (Melaku 2003, 59ff; Ayana et al 2013, 188). Beside these steps towards a planned, scientific forestry, the focus was still agricultural development. Mussolini planned to settle millions of Italians in the fertile Ethiopian highland (Henze 2000, 223). In the further process, the Italian colonial administration showed little interest in the development of the country; the whole colonization process proved to create more and more financial deficits for the mother country. Finally, the fascist doctrine of Mussolini, which had strong racist elements, led to active and passive resistance of the Ethiopian population.

3.4. Imperial modernization

After the short colonial interregnum, Haile Selassie came back to power from his exile in Britain (Henze 2000). The subsequent empirical modernization stage has some similarity with paradigm III "Forests for national growth "from the model construct. Capital was needed to build up the infrastructure and to feed the imperial feudalistic systems, which he extended and consolidated to manifest his power. In relation to technology development and innovation, Haile Selassie followed Western modern approaches. The general paradigm assumes that the new national elites needed capital for investments, which was seen as the most important bottleneck for development (Rostow 1960). Because of the lack of productive industries and internal accumulation, the required financial means

could only come from natural resources (Zivnuska 1966). Agriculture was seen as the leading sector of the country on the account of natural forests. They were converted to agriculture. A step ahead were the land classification activities, but the land distribution to members of the armed forces and civil servants created conflicts and finally led a popular uprising against the Imperial Ethiopian state (Melaku 2003, 71ff).

3.5. Technocracy under the socialist regime

From 1974 to 1987, Ethiopia was ruled under a military regime, commonly called DERG: Its chairperson was Major Mengistu Haile Mariam. The underlying philosophy was communism and one of the main first tasks was the abolishment of the feudalistic structure by expropriating large properties and nationalizing land ownership. Again, this historical stage does not follow the initially presented model paradigms. Partly the dictatorial government tried to capitalize from natural resources (paradigm III Forest for national growth) and partly technocrat innovations were implemented (paradigm IV: Internationalization). In the first years of his rule, Mengistu administered the elaboration of large areas of exotic forest plantations, mainly based on Eucalyptus. Strong forest institutions were established and many people assumed that this was “the golden era” of forestry. Finally, general targets of the internationalization and modernization paradigm could not be reached (Preston 1996). Industrialization and extension of market linkages as well as capital investment were rather limited. In the second stage of his rule, Mengistu even gave up his activities in reforestation and focused just on the transformation in agricultural production. Resistance against the authoritarian system increased, and fuelled by the inefficiency of the government during famines in the resettlement actions. With the end of the regime in 1991, democratization of Ethiopia started (Ayana 2013, 192).

3.6. The post-socialist era

With the end of the socialist era in 1995 Ethiopia and the forest sector opened towards more diversification, more nongovernmental organization were integrated in development projects, decentralization led to broader range of institutions and the international environmental debate as well as the international conventions were more perceived in the national debate. This stage followed paradigm V on "polarization". This paradigm, which is rooted in the change of growth orientation to "redistribution with growth" and the implementation of the basic needs approach, has to be interpreted her as replacement of the uniform imperial and socialist strategies towards a multitude of discourses, projects and experiences. The group of involved stakeholders has considerably diversified (Uphoff 1993).

Just the slow democratization and still quite authoritarian government behavior is limiting the free dialogue, the respective experimentation and the necessary raise of trust in the future of rural development and in building up the necessary social capital. It is not very clearly visible how this paradigm is overlapped by the paradigm VI on "Globalization", which is especially visible in the large-scale agricultural projects, partly involving land grabbing practices.

4. Lessons learnt from the paradigm approach

The initially presented six model paradigms do not fit to explain the national and forestry development in Ethiopia. Nevertheless, it was useful to apply the paradigm approach and to discuss deviations from the general model as a base for comparative country studies, to learn from other country development paths studies and use it as a fundament to learn about future forestry development strategies for Ethiopia.

The specific Ethiopian development is characterized by (1) three authoritarian stages, which determined Ethiopian development until the 1990th, (2) a relatively low economic forest resource potential, which is due to a long-term forest transformation and to the climatic conditions. It limits options for forest-based industrialization. Finally (3) the absolute preference of politicians for agricultural development has led to an undervaluation of forest services and products.

In Ethiopia, still rich traditional knowledge exists (Worku et al 2011), the influence of colonization was limited and the importance of forestry was negated by the imperial governors as well as in the second stage of the DERG regime. This has led to a time shift in the implementation of paradigmatic models. Paradigm III “Forestry and capital formation” was just important for agriculture. It has led to further destruction of forest. The forest resources never have played an important role for the industrialization of the country. Rather aspects like livelihood development, broad support of the rural population with forest products and environmental services as well as the function as forests for poverty alleviation and crisis have played an important role.

Paradigm IV on Internationalization was relevant in relation to technocratic development partly in the Imperial era and in the DERG era. The time from the 1991th onwards, which resembles to paradigm IV “Polarization”, permits the chance to head for a “third way” between an endogenous forest development strategy and globalization. The last stage permits is not clearly determined as in other countries and permits to discuss a proper forest development policy for Ethiopia. Until today, the globalization paradigm is not as determining as in other countries (Choussudovsky1997; Rapley 2004). Visible globalization effects are land grabbing and the increasing orientation towards China (Michel and Beuret 2008).

The forestry sector suffers under a lack of self-designed authentic policies and corresponding theories. The discussion of interdependencies with other spheres like national or agricultural development is important for positioning and for the deviation of scenarios for the sector development.

5. Alternative forest development paradigm in the context of a green economy

Although the paradigm discussion was just superficial, it is obvious that the understanding of historical processes is most important for the formulation of future development strategies. As Melaku (2003) has pointed out, a hermeneutical access permits a valuable link between the past and future strategies.

The current situation in Ethiopia suits well for a rapid paradigm change towards a “third way” between forest for livelihood development and economic growth and globalization as well as conservation targets. Sensitization towards the objectives of a Green economy and respective institutional reforms in forestry would permit to build up an authentic forestry sector, which fulfils the demands of Ethiopian rural areas, satisfies urban needs by a commercialization and is connected to international markets and environmental policies. In recent years many initiatives focused on this and often the need for institutional changes was articulated (Kelbessa & Girma 2011).

Aspects of the green economy concept are valuable guidelines for the implementation of such a new strategy. Based on the initially presented co-evolution model (see figure 2), some elements of a Green economy strategy are discussed, which are applicable for Ethiopia.

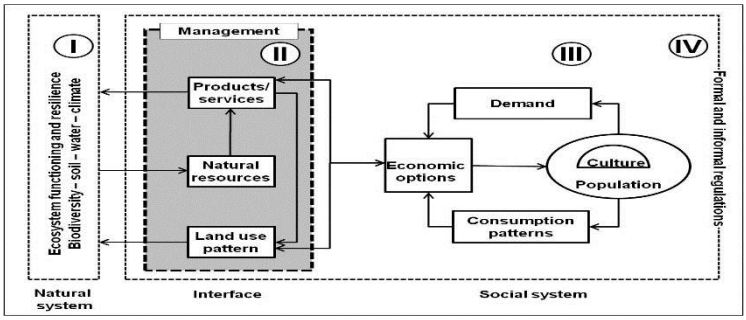


Figure 2: The co-evoluation approach as a global explanatory and analytical model and options of a planned change (Pretzsch et al 2014; based on Hurni and Messerli 1981; Norgaard 1994; Berkes et al 1998)

Related to complex I, which deals with ecosystems functioning, further research is necessary on climate change effects and the ecological resilience of Ethiopian ecosystems. The Green economy concept focuses on a landscape approach, with the combination of different ecological zonation and land use systems, leading to overall high ecological functions. Examples are the combination of fuel wood plantations, which support local energy cycles with annual cash crops and permanent cultures, like coffee. Permanent changes of all system components must be taken in account and scientific research is necessary to learn about the adaptation of functioning agroforestry systems like in Sidama and their stability in front of external ecological or economic shocks. Best practice model have to be derived and presented in positive narratives. It is essential that ongoing degradation and deforestation slows down and rehabilitation measures start on degraded agricultural and grazing lands.

The interface between the ecological system and the social systems, which is indicated as complex II, deals with land-use management, combining land use patterns with natural resources and outcomes of products and services. It follows a technological rationality and special emphasis has to be put on the integration of trees in land use systems, oriented towards the supply of forest products and services.

As a core element of a Green economy, new, innovative managements systems need to be developed. Examples are innovative forms of cooperatives and user associations, out grower schemes, which combine large and small producers and collaborative management of state forests by the local population. Farm based agroforestry needs further development. Another impostand element of the green economy are Innovative product chains and micro-enterprises, which contribute to the creation small and efficient production units, described as “stepping out” by Dorward et al (2005). On a higher level, cluster development leads to the important network effects.

The social system (complex III) deals with demand, consumption patterns, economic options and the involvement of people. Here many models may be derived from the concept of a Green economy: The optimization of nature based value chains, the innovation of product lines or the creation of attractive employment opportunities to reduce out-migration and the linked brain drain. This is possible by the creation of green jobs, which at the same time follow sustainable resource management and long-term employment, implementing respective social targets. After the misuse of social organizations during the DERG rule, new form of associations have to be build up, based on new types of social capital and trust. Necessary is the involvement of broad stakeholder groups and the coordination in networks, linking the rural resource potential with the advanced knowledge of urban elites. The strategy fits well in the Green economy, because the full integration of environmental aspects in any development strategy is essential in Ethiopia.

Complex IV deals with the general policy framework, which currently limits development options because of a limited acceptance of state policies by part of the population. Current narratives on the forest sector development of Ethiopia are negative (Roe 1994). That is why the designing of alternative development paths and opening up positive perspective together with optimistic narratives is essential.

Future steps have to be embedded in the rural history and in the perception of rural people, following the strength of the local culture and taking into account the rich local knowledge. Escobar (2012) proposes a *pluriactive* path in rural development, which is authentic for each local situation and combines all available livelihood means. Currently in Ethiopia local potentials are underused and local knowledge is not integrated in present strategies as it could be. The universities have to play an important role in this change, including the renovation of curricula in this direction.

References

Abdelgabar, O. (1997), Mechanized Farming and Nuba Peasants. An Example for Non-sustainable Development in the Sudan. Spektrum 48, Hamburg.

Ayana, N. A.; Arts, B.; Wiersum, K. F. (2013), Historical development of forest policy in Ethiopia: Trends of institutionalization and deinstitutionalization. Land use Policy 32, 186-196.

Bartnicki, A; Mantel-Niecko, J. (1978), Geschichte Äthiopiens. Von den Anfängen bis zur Gegenwart in 2 Teilen. Berlin.

Bennett, J. W. (1976) The Ecological transition: Cultural anthropology and human adaptation. New York et al., Pergamon Press

Berkes, F.; Folke, C.; Colding, J. (1998), Linking social and ecological systems. Cambridge University Press, Cambridge.

Bongers, F; Tennigkeit, T. Eds. (2010), Degraded Forests in Eastern Africa. Management and Restoration. Earthscan, London & Washington.

Bryant, R. L.; Bailey, S. (1997), Third world political ecology. Routledge.

Choussudovsky, M. (1997), The globalisation of poverty: Impacts of IMF and World Bank reforms. Third World Network, Penang-Malaysia.

Dorward, A.; Anderson, S,; Nava, Y; Pattison, J.; Paz, R.; Rushton, J. Sanchez, V. (2005), A guide to indicators and methods for assessing the contribution of livestock keeping to the livelihoods of poor. Dept. of Agricultural Science, Imperial College, London, UK.

Eikenberg, K. (1993), Äthiopien, p. 32-53; in: Handbuch der Dritten Welt; Nohlen, D.; Nuscheler, F. Eds. 3rd. Ed., Bonn.

Escobar, A. (2012), Encountering development, 2nd. Ed., Princeton.

Ferguson, N. (2012), Civilization. The six killer apps of Western power, London.

Galston, W.; Baehler, H. J. (1995), Rural development in the United States. Connecting theory, practice, and possibilities. Washington D.C.

Giddens, A. (1998), The third way. The renewal of social democracy. Cornwall.

Heckett, T; Aklilu, N. Eds. (2009), Ethiopian Forestry ar Crossroads: The Need for a Strong Institution. Proceedings of a Workshop 2008, Forum for Envionment, Occasional Paper No. 1/2009; Addis Ababa.

Henze, P. B. (2000), Layers of Time. A History of Ethiopia. Hurst & Company, London.

Heske, F. (1966), Erkenntnisse und Erfahrungen zur forstlichen Bodennutzung der Entwicklungsländer am Beispiel Äthiopien. Forschungsberichte des Landes Nordrhein-Westfalen Nr. 1252, Westdeutscher verlag, Köln und Opladen .

Hober, A. (1995), Paradigms and Politics: The Cultural Construction of Enviornmantal Policy in Ethiopia. World Development 23, 6, 1007-21.

Hobsbawm, E. J. (1987), The age of empire 1875-1914. London.

Jacques, M (2012), When China rules the world. 2nd. Ed. Penguin, London.

Kelbessa, E.; Girma, A. Eds. (2011). Multiple Roles of Forests in Ethiopia Vs Associated Challenges. Maximizing Benefits while Curbing Limitations. In Commemoration of 3rd national Mother Earth Day & 2011 International Year of Forests. Addis Ababa.

Kelboro, G. (2009), Ethiopia – Sacred Groves in Sidama, Southern Ethiopia: Culture-forest experimentation sites? A case study. p. 16-24 in: Development of Innovative Teachings Modules for Higher Education in Tropical Forestry in Ethiopia, Germany, Kenya and Sudan. Results of an Academic Cooperation Project 2005-2008; Darr, B.; Pretzsch, J. Eds. TU Dresden, Insitut für Internationale Forst- und Holzwirtschaft. Heft 17, Tharandt.

Kuhn, T. S. (1962), The structure of scientific revolutions. Chicago

Little, P. E. (1999), Environments and environmentalisms in anthropological research. Annu. Rev. Anthropol. 28, 253-84.

Melaku, Bekele (2003), Forest property rights, the role of the state, and institutional exigency: The Ethiopian experience. Doctoral thesis, Swedish University of Agricultural Sciences Upppsala, Acta Universitatis Agriculturae Sueciae, Agraria 409, Uppsala.

Michel, S.; Beuret, M. (2008), La Chinafrique. Pékin à la conquête du continent noir.Paris.

Norgaard, R. B. (1994), Development betrayed the end of progress and a coevolutionary revisioning of the future. London and New York.

Peet, R.; Watts, M. (1996), Liberation ecologies. Environment, development, social movements, London and New York.

Pretzsch, J. (2014), Paradigms of Tropical Forestry in Rural Development, 7-49, Chapter 2 in Pretzsch, J.; Darr, D.; Uibrig, H. Auch, E. Eds. Forests and Rural Development; Berlin, Heidelberg, Springer.

Pretzsch,J.; Darr, D.; Lindner, A.; Uibrig, H.; Auch, E. (2014), Prospects for Forest-Beased Rural Development, p. 375-384, Chapter 13 in: Pretzsch, J.; Darr, D.; Uibrig, H. Auch, E. Eds. Forests and Rural Development; Berlin, Heidelberg, Springer.

Rapley, J. (2004), Globalization and Inequality. Neoliberalism´s Downward Spiral. Boulder & London.

Rist, G. (2002), The History of Development from Western Origins to Global Faith. 2 nd ed. London, New York.

Roe, E. (1994), Narrative Policy Analysis. Theory and Practice.Durham & London.

Rostow, W. W. (1960), The stages of economic growth: A non-communist manifesto, Cambridge University Press.

UNEP (2011), Green Economy report. Towards a green economy: pathways in sustainable development and poverty reduction. http://greeneconomy/GreenEconomyReport, free release 2011, last access October 2013.

Uphoff, N. (1993), Grassroots organizations and NGOs in rural development: Opportunities with diminishing states and expanding markets, in: World Development, 21, 4, 607-622.

Williams, B. (2011), Adaptive management of natural resources – framework and issues. In: Journal of Environmental Management 92 (2011) 1346-1353.

Worku, A.; Lemenih, M.; Fetene, M.; Teketay, D (2011), Socio-economic importance of gum and resin resources in the dry woodlands of Borana, southern Ethiiopia. Forersts, Trees and Livelihood, Vol. 20, pp. 137-156.

Zivnuska, J.A. (1966), The integration of forest development plans and national development plans. How to make the forestry case at the national level. Proceedings of the 6th World Forest Congress, Madrid.

Climate Change in Ethiopia: Putative Impact, Adaptation and Mitigation

Dong-Gill Kim[*]

Wondo Genet College of Forestry and Natural Resources, Hawassa University, Ethiopia

Abstract

Throughout Ethiopia, farmers commonly perceived an increase in temperature and a decrease in annual total rainfall. Metrological data indicated that rainfall decline in southern Ethiopia, during both rainy seasons of February-May and June-September and spring droughts have occurred more frequently in all parts of Ethiopia. However, there was no evidence that rainfall declined in central and northern Ethiopia. Also, an increase in the frequency or intensity of extreme weather events and positive trends for maximum temperature and warm days were not significant. Cropping farmers commonly perceived decreases in length of growing period and increases in crop damage by pests presumably due to climate change. Pastoralists commonly incurred feed shortages and increasing prevelance of livestock diseases. However, the hazards changes witnessed by the farmers and pastoralists may not necessarily be attributed to climate change; farmers may not be separating the effects of climate change from other conditions such as soil erosion and soil fertility, which are not related to climate change. Climate change adaptation activities such as soil conservation, changing crop variety, tree planting and water harvesting have been conducted in response to temperature and rainfall changes. However, it was reported that over 40% of farmers have done nothing for adaptation. It is expected that mitigation efforts enhancing carbon sequestration and reducing greenhouse gas

[*] Corresponding author: donggillkim@gmail.com

emissions by local communities can provide them economic benefits through currently developing carbon trading schemes.

Keywords: greenhouse gas emissions, carbon trading schemes

---

1. Introduction

Global climate models predict that in a warmer climate there will be an increased chance of summer drying on the African continent with increased risks of prolonged drought (Sillmann and Roeckner, 2008; Dai 2011). Agriculture forms the basis of the Ethiopian economy supporting roughly 42% GDP and 85% employment (Byerlee *et al*., 2007). The nature of Ethiopia's agriculture, primarily rain-fed, means that production is sensitive to fluctuations in rainfall. Chronic food insecurity affects 10% of the population; even in average rainfall years these households cannot meet their food needs and rely partly on food assistance. Historically, short- and long-term droughts often result in crop failures, food shortages, and devastating famines (Wood, 1977; World Bank, 2006) (Fig. 1). Therefore, it is critical to understand climate change impacts and identify strategies for adaptation and mitigation to climate change in Ethiopia.

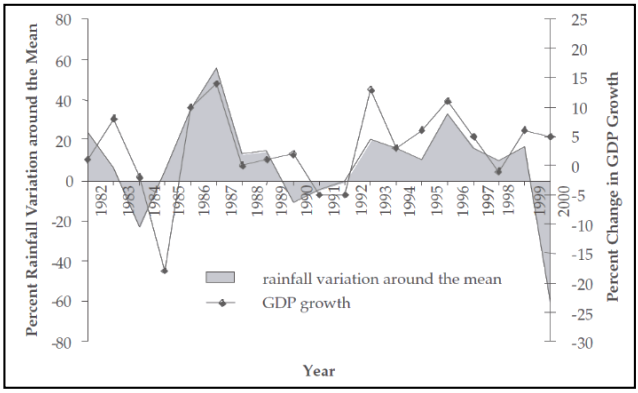


Figure 1: Rainfall variation and GDP in Ethiopia (World Bank, 2006)

2. Climate change in Ethiopia: local farmers´perception and meterological data

Ethiopian farmers commonly perceived an increase in temperature and a decrease in annual total rainfall (Deressa et al., 2008; Amsalu and Adem, 2009; Bewket, 2012). Metrological data collected in Ethiopia show that rainfall has declined in southern Ethiopia, during both both rainy seasons of February–May and June–September, and spring droughts have occurred more frequently in all parts of Ethiopia during the last 10–15 years (Viste et al., 2013). However, there was no evidence that rainfall declined in central and northern Ethiopia (Viste *et al*., 2013). There is little evidence that the frequency or intensity of extreme weather events is increasing in Ethiopia (Tessema and Lamb, 2003; Seleshi & Camberlin, 2006; Mekasha et al., 2014). Positive trends for maximum temperatures and warm days, and negative trends for cool days and cool nights were not significant (Mekasha et al., 2013). The difference between local farmers' perceptions and observed metrological data should be clearly investigated to reveal the main reasons for those differences.

3. Impact of climate change in Ethiopia

Cropping farmers commonly perceived the putative impact of climate change as four different issues (Bewket, 2012; Amsalu *et al*., 2013): 1) decrease in length of growing period, 2) increase in crop damage by insects and pests, 3) increase in crop diseases, and 4) shift in suitable growing areas. However, pastoralists commonly envisaged the impact of climate change as four different issues (Bewket, 2013; Amsalu et al., 2013): 1) shortage of feed, 2) livestock disease, 3) scarcity of water supply for livestock, and 4) mass die-offs of livestock.

Climate change will probably make the prospect of Ethiopian economic development harder in at least two ways (Mideksa, 2010). Firstly, it may reduce Ethiopia's GDP by about 10% from its

benchmark level by reducing agricultural production and output in the sectors linked to the agricultural sector. For example, area for crop production was predicted to be decresed by predicted climate change in Ethiopia (Evangelista et al., 2013) (Fig. 2). Secondly, it may raise the degree of income inequality (increases by 20%), which is likely to further decrease economic growth and fuel poverty.

Women may be more affected than men by the impacts of climate change related problems (Amsalu and Adem, 2009; Amsalu et al., 2013). It was found that droughts increased women's workload, and women became the target of attacks and sexual violence in drought periods due to the absence of husbands and fathers. Women do not have rights for decision-making in critical conditions, and they are even discriminated against by their husbands and family (Amsalu and Adem, 2009; Amsalu et al., 2013).

While there is substantial evidence on the impact of climate change on agricultural productivity, the changes perceived by the farmers and pastoralists may not necessarily be attributed to climate change; farmers may not be separating the effects of climate change from other conditions such as climate variability, soil erosion and soil fertility, which are not necessarily related to climate change (Coe and Stern, 2011).

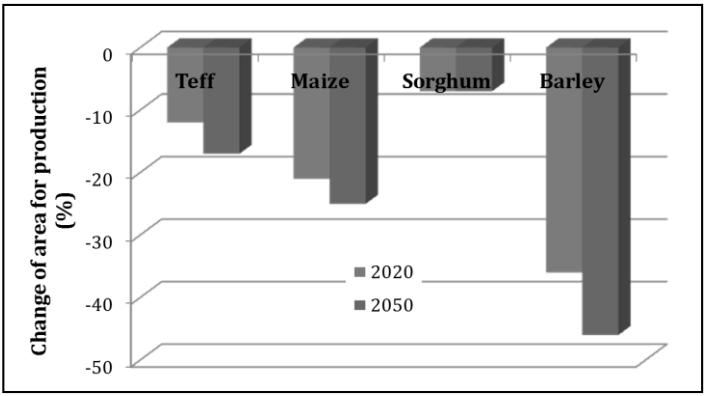


Figure 2: Future prediction of changes of area for crop production in 2020 and 2050 in Ethiopia (Evangelista et al., 2013)

4. Adaptation to climate change in Ethiopia

Adaptation activities such as soil conservation, changing crop variety, tree planting and water harvesting have been conducted in response to temperature and rainfall changes (Bryan et al., 2009) (Fig. 3). However, it was reported that over 40% of farmers have not done any efforts for adaptation. Major barriers to adaptation include a shortage of land, labor, money and information (Bryan *et al*., 2009) (Fig. 4).

Commonly recommended climate change adaptation measures for crop farming in Ethiopia are as follows (Bewket, 2012):

1) Increasing the number of crop type (Crop diversification), 2) Changing the types of crops produced, 3) Adjusting date of planting and harvesting, 4) Use of early maturing crop varieties, 5) Use of pest tolerant crop varieties, and 6) Planting high value fruit trees.

Commonly recommended climate change adaptation measures for livestock farmers/pastoralists in Ethiopia are as follows (Tadege, 2007; Deressa et al., 2011; Bewket, 2012):

1) Reducing the number of animals kept (reducing carrying capacity), 2) Keeping improved animal breeds, 3) Changing the type of animals kept, 4) Practicing improved animal feed, 5) Introduce mixed farming system, and 6) Promote traditional range conservation and management systems (i.e., resource sharing).

Commonly recommended climate change adaptation measures for water resources management in Ethiopia are as follows (Tadege, 2007):

1) Construction of reservoirs for hydropower, irrigation, water supply, flood control, 2) Improve the ground water resource potential and management, 3) Water harvesting, improved water use efficiency, spring and wells development, river diversion, and 4) Building upon the existing traditional irrigation systems by the local communities.

Institutional efforts also need to enhance adaptation to climate change in Ethiopia (Conway and Schipper, 2011). A fundamental shift in thinking is needed across key institutions in Ethiopia. Firstly, climate change is seen as an environmental issue, and what is needed is to consider this a broad sustainability issue that affects all sectors (Conway and Schipper, 2011). Secondly, a disaster-focused short-term view focusing on transient food insecurity is needed. However, it is urgent to have a long-term perspective that emphasizes livelihood security and reduces vulnerability thereby deconstructing and resolving the causal structure of chronic poverty and food insecurity (Conway and Schipper, 2011).

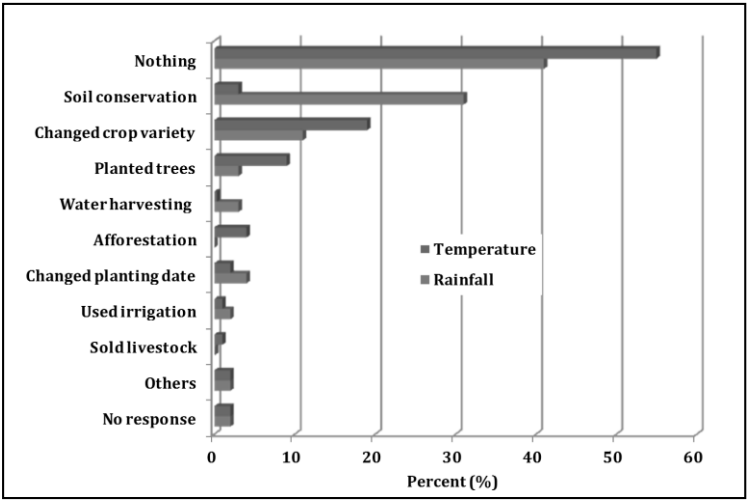


Figure 3: Adaptation to perceived temperature and rainfall change in Ethiopia (Bryan et al., 2009)

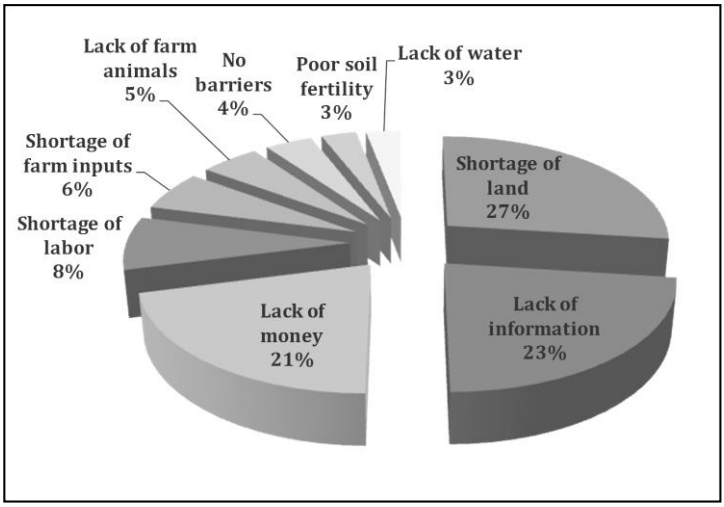


Figure 4: Local farmers´response pn the barrier to adaption of climate change in Ethiopia (Bryan et al., 2009)

5. Mitigation of climate change in Ethiopia

Throughout Ethiopia, reforestation, conservation tillage, optimizing synthetic fertilizer use, retaining crop residues, reducing grazing intensity, and restoring indigenous agroforestry, which are deeply associated with adaptation measures (Snyder et al., 2009; Hristov et al., 2013), are practiced. Local communities can contribute to enhancing carbon sequestration and mitigating greenhouse gas emissions. It is expected that currently developing carbon trading schemes such as Reducing Emissions from Deforestation and forest Degradation (REDD) will provide an opportunity for local communities to obtain economic benefits (Fig. 5). Therefore, it is urgently needed to conduct research and practices aimed at identifying and implementing locally relevant mitigation and adaptation schemes to climate change.

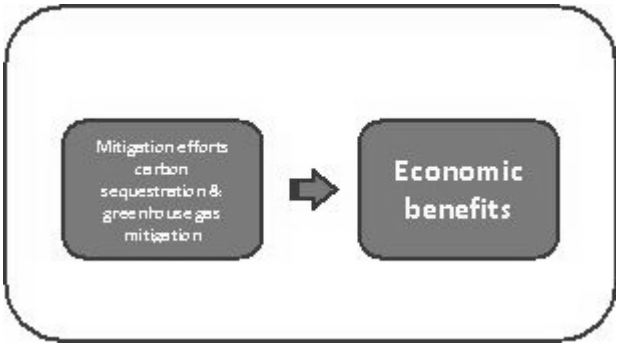


Figure 5: Local farmers´efforts for mitigatin climate change can provide economic benefits through carbon trading

6. Conclusion

Meteorological data and local perceptions indicate that climate change is associated with a decline in rainfall and thereby droughts in some parts of Ethiopia. However, overwhelming local's perception on climate change is far more than meteorological evidence. We need to investigate and reveal the reasons of the difference. While governmental and nongovernmental sectors and locals have made great efforts, substantial numbers of locals have not conducted any measures to adapt to climate change. More efforts are needed to investigate the reasons in more detail and provide a strategic plan to bridge the identified gaps. Beyond current efforts for adapting to climate change, local efforts for mitigating climate change such as enhancing carbon sequestration and reducing greenhouse gas emissions will provide a chance for local communities to gain economic benefits through carbon trading schemes. Therefore, it is urgently needed to conduct research and practices to identify and implement locally relevant mitigation and adaptation schemes to climate change.

Acknowledgement

The author is grateful to Tatum Branaman for constructive and valuable comments and editing.

References

Amsalu, A., Adem, A. (2009) Assessment of climate change-induced hazards, impacts and responses in the Southern lowlands of Ethiopia, FSS Research Report No. 4. Forum for Social Studies, Addis Ababa.

Amsalu, A., Wana, D., Kassa, M., Teklu, N. (2013) Climate change impacts on Pastoral Women in Ethiopia: some evidences from the Southern lowlands. Brief. PHE Ethiopia Consortium, Addis Ababa.

Bewket, W. (2013) Climate change perceptions and adaptive responses of smallholder farmers in central highlands of Ethiopia. Int. J. Environ. Stud. 69, 507-523.

Bryan, E., Deressa, T.T., Gbetibouo, G.A., Ringler, C. (2009) Adaptation to climate change in Ethiopia and South Africa: options and constraints. Environmental Science & Policy 12, 413-426.

Byerlee, D., Spielman, D.J., Alemu, D., Gautam, M. (2007) Policies to promote Cereal Intensification in Ethiopia: A Review of Evidence and Experience. International Food Policy Research Institute. Development Strategy and Governance Division, Discussion Paper 00707.

Coe, R., Stern, R. (2011) Assessing and addressing climate-induced risk in Sub-Saharan rainfed agriculture: lessons learned. Exp. Agric. 47, 395-410.

Conway, D., Schipper, E.L.F. (2011) Adaptation to climate change in Africa: Challenges and opportunities identified from Ethiopia. Global Environ. Change 21, 227-237.

Dai, A. (2011) Characteristics and trends in various forms of the Palmer Drought Severity Index during 1900-2008. J. Geophys. Res. 116, D12115.

Deressa, T., Hassan, R.M., Alemu, T., Yesuf, M. and Ringler, C. (2008) Analyzing the determinants of farmers'choice of adaptation

methods and perceptions of climate change in the Nile Basin of Ethiopia. IFPRI Discussion Paper No. 00798, IFRI, Washington, DC.

Deressa, T.T., Hassan, R.M., Ringer, C. (2011) Perception of and adaptation to climate change by farmers in the Nile basin of Ethiopia. The Journal of Agricultural Science 149, 23-31.

Evangelista, P., Young, N., Burnett, J. (2013) How will climate change spatially affect agriculture production in Ethiopia? Case studies of important cereal crops. Clim. Change 119, 855-873.

Hristov, A.N., Oh, J., Lee, C., Meinen, R., Montes, F., Ott, T., Firkins, J., Rotz, A., Dell, C., Adesogan, A., Yang, W., Tricarico, J., Kebreab, E., Waghorn, G., Dijkstra, J. & Oosting, S. (2013) Mitigation of greenhouse gas emissions inlivestock production – A review of technical options for non-CO_2 emissions. Edited by Pierre J. Gerber, Benjamin Henderson and Harinder P.S. Makkar. FAO Animal Production and Health Paper No. 177. FAO, Rome, Italy.

Mekasha, A., Tesfaye, K., Duncan, A.J. (2014) Trends in daily observed temperature and precipitation extremes over three Ethiopian eco-environments. International Journal of Climatology 34, 1990-1999.

Mideksa, T.K. (2010) Economic and distributional impacts of climate change: The case of Ethiopia. Global Environ. Change 20, 278-286.

Seleshi, Y., Camberlin, P. (2006) Recent changes in dry spell and extreme rainfall events in Ethiopia. Theor. Appl. Climatol. 83, 181-191.

Sillmann, J., Roeckner, E. (2008) Indices for extreme events in projections of anthropogenic climate change. Clim. Change 86, 83-104.

Snyder, C.S., Bruulsema, T.W., Jensen, T.L., Fixen, P.E. (2009) Review of greenhouse gas emissions from crop production systems and fertilizer management effects. Agriculture, Ecosystems and Environment 133, 247-266.

Tadege, A. (2007) Climate Change National Adaptation Program of Action (NAPA) of Ethiopia. Addis Ababa, Ethiopia: NMS (National Meteorological Agency: Federal Democratic Republic of Ethiopia, Ministry of Water Resources).

Tessema, Z., Lamb P.J. (2003) Interannual variability of Keremt growing season over drought-prone part of Ethiopia. CLIVAR,

Contribution to Exchange No. 27, September 2003. http//www.clivar.org-publications-exchanges-selected.htm.url

Viste, E., Korecha, D., Sorteberg, A. (2013) Recent drought and precipitation tendencies in Ethiopia. Theor. Appl. Climatol. 112, 535-551.

Wood, A. (1977) A preliminary chronology of Ethiopian droughts. In: Dalby D, Church RJH, Bezzaz F (eds), Drought in Africa, vol 2. International African Institute, London, pp 68–73.

World Bank (2006) Managing water resources to maximise sustainable growth: a country water resources assistance strategy for Ethiopia. World Bank, Washington, DC.

Effects of Climate Change and Coping Strategies by Smallholder Farmers in Sustaining Coffee Production in Mbozi District, Tanzania

Christina Kifunda[a], Donald A. Mwiturubani[a] and Ezekiel E. Mwakalukwa[b]*

[a]Department of Geography, P.O. Box 35091, College of Arts and Social Sciences, University of Dar Es Salaamirs, Tanzania

[b] Department of Forest Biology, P. O. Box 3010, Faculty of Forestry and Nature Conservation, Sokoine University of Agriculture, Tanzania

Abstract

There is increasing threats on effects of climate change in existence of many agricultural food crops and those with commercial importance in Tanzania. This study assessed changes of rainfall and temperature, coffee yields and document role of adaptation strategies employed by smallholder farmers in sustaining coffee production in Mbozi District, Tanzania. A total of 112 heads of households from the three villages of Shiwinga (42), Iyenga (43) and Itumpi (27) who engaged in coffee production in the past 10 years and beyond were interviewed. Focused group discussion, key informant interviews and transect walk were also employed. The study revealed changes in rainfall and temperature in the study area which led to the decrease of coffee yields. The use of agricultural inputs, expansion of farm sizes and the use of irrigation systems ranked higher than other adaptation strategies. It is recommended that building capacity of the smallholder farmers through getting access to micro-credits at low interest rate may have significant contributions in sustaining coffee production in Mbozi District.

Keywords: adaptation strategies, Arabica coffee, temperature, rainfall

[*]Corresponding author: ezedwa@yahoo.com

1. Introduction

Climate change is one of the most environmental problems of the 21st century affecting lives of many people in the world (Orindi and Murray, 2005). Africa, particularly in Tanzania the impact of climate change on sectors such as agriculture has already been felt by many Tanzanians in the last decade or so (IPCC, 2001;Nindi and Mhando, 2012). Much of the impact has been observed by the majority of Tanzanians living in rural areas who account for over 80% of the total population in the country, with agriculture being their major economic activity. Particularly due to over-dependence on rain-fed agriculture, changes on weather patterns have led to low production of agricultural crops thus resulting in food insecurity and low household incomes (Nindi and Mhando, 2012).

Coffee in particular, is one of the most important export cash crops in Tanzania. Export of coffee contributes 17% of Tanzanian export revenues, and provides employment to large number of families in the regions such as Kilimanjaro, Arusha, Mbeya, Kagera and Ruvuma and to a lesser scale in other regions such as Kigoma, Mara and Iringa (ICP, 2006; Pleyers, 2006). For example, over 75% of the total population in Mbozi District in Mbeya Region makes their living from coffee business. Most of the coffee farmers are smallholder famers who depend mostly on rain-fed agriculture.

Whereas a lot of efforts are being exerted towards the intensification of coffee production, little attention has been put on assessing the negative contributions of climate change on coffee yields, and quantifying role of adaptation strategies employed by smallholder farmers on sustaining coffee production in Mbozi District Tanzania. Thus specifically this study aimed to;

i) quantify changes of temperature and rainfall over the last 30 years,
ii) analyse the effect of changes in temperature and rainfall on coffee production,

iii) identify the adaptation strategies employed by smallholder farmers under variable climate change, and
iv) Investigate the effect of the adaptation strategies employed by the smallholder farmers on sustaining coffee production in the study area.

2. Materials and methods

2.1. Study area description

Mbozi District is located in Mbeya Region in the South-Western part of Tanzania between Latitudes 8°and 9°12' South and Longitudes 32° 7' 30" and 33° 2' 0" East (Figure 1). It lies between 900 and 2750 meter above mean sea level. Rainfall ranges between 1350 - 1550 mm per year. The rainy season usually starts in October and ends in May. The climate condition is moderately hot between August and December. Temperature ranges between 20°C to 28°C (URT, 1997). The population in Mbozi District is estimated to be 446,339 (URT, 2013). The selection of Mbozi District was due to its long history of engaging in coffee production and availability of smallholder farmers who are the main growers of coffee crop in Mbozi District (Chillewa, 2010).

2.2. Data collection

Both quantitative and qualitative data collection techniques were employed. Temperature and rainfall data was accessed from Tanzania Meteorological Agency (TMA) headquarters in Dar es Salaam whereas data on coffee production was accessed from Tanzania Coffee Research Institute (TACRI) and in Mbozi District Agricultural Office.

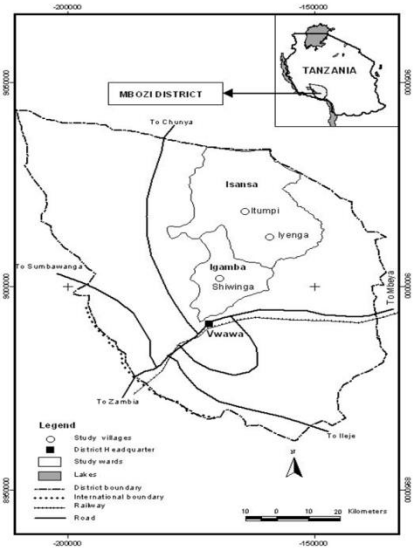


Figure 1: Location of Mbozi District, Mbeya Region, Tanzania Description

A total of 112 heads of households from the three villages of Shiwinga (42), Iyenga (43) and Itumpi (27) who engaged in coffee production in the past 10 years and beyond were interviewed. A separate set of questions was addressed to the key informants such as Village Executive Officers (VEOs), village chairpersons, environmental committee representatives, and few selected elders from the three selected villages. Furthermore, focus group discussion using a group of 5 – 10 people was conducted. Lastly, transect walk was conducted solely in order to cross-check some of the information that were gathered from the above techniques.

2.3. Data analysis

Both qualitative and quantitative data from household interviews was compiled, summarized and analysed by using Statistical Package for Social Sciences (SPSS) software version 12.0 and Excel spread sheets.

3. Results

3.1 General Characteristics of the respondents

With respect to gender, males were 111 (99.1%) and only one female (0.9%) from Iyenga village. Many of the respondents (36.6%) fall within age group 31-40 years and only few (17%) falls within age group 51-60 years. Majority of the households (33 %) showed to have more than nine members per household. For the case of education majority of the respondents had primary education (84.8 %) whereas tertiary education accounted only 2.7%. The main types of crops grown in the study area are coffee, maize, groundnuts, beans and sunflower. Coffee and maize are the only cash crops grown by all respondents (100%) in the study area.

3.2 Trends of climate parameters over the last 30 years

The general trend of rainfall for the past 30 years in Mbeki District is as shown in Figure 2. There is no clear tendency of rainfall decreasing except in some few years i.e. 1993, 1995, 2003, 2005 and 2011. Through household survey about 82.1 % of the respondents indicated that they have been experiencing low rainfall in their villages since 2000s to date, with moderate amount in the 1990s (71.4% of respondents) and high rainfall in the 1980s (65.2% of respondents).

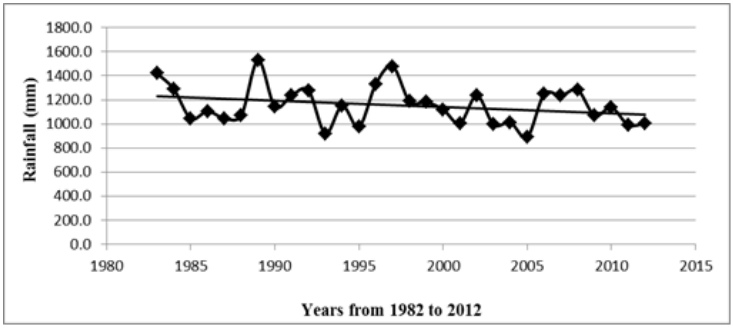


Figure 2: The general trends of rainfall pattern in Mbozi District for the years 1980s to 2012

For the case of temperature the general trend for the past 30 years in Mbeki District is as shown in Figure 3. Results show that there is an increase in maximum temperature in Mbozi District. Data shows that the maximum temperature has increased up to 24.8^{o}C in the years 2000s-2010s.This trend agrees very well with results from the questionnaire survey in which majority of respondents (83%) have claimed to see the same trend of high temperatures increase in the years 2000s to 2010s.

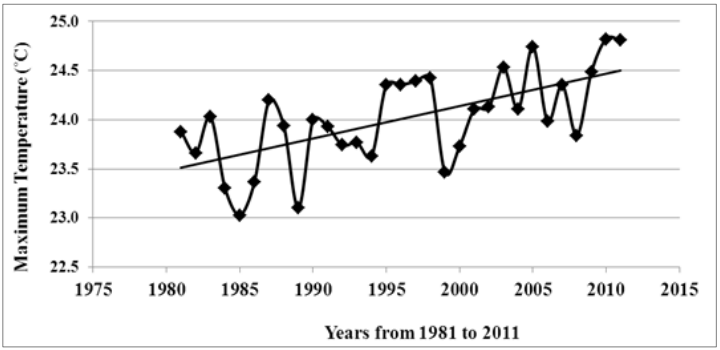


Figure 3: The general trend of Maximum Temperature in Mbozi District

3.3 Trends of coffee production over the last 25 years

The general trend of the coffee yields in Mbozi District for the last 22 years from 1980s to 2012 is presented in Figure 4. Result shows that coffee production in Mbozi District is decreasing per acreage i.e. from 281kgin 1988 to 107kg in 2011. The same trend was also noticed by the respondents in the studied villages. Most of the smallholder farmers (46.4%) say that they have been getting between 250-500 kg of coffee per acre since the year 2000s.

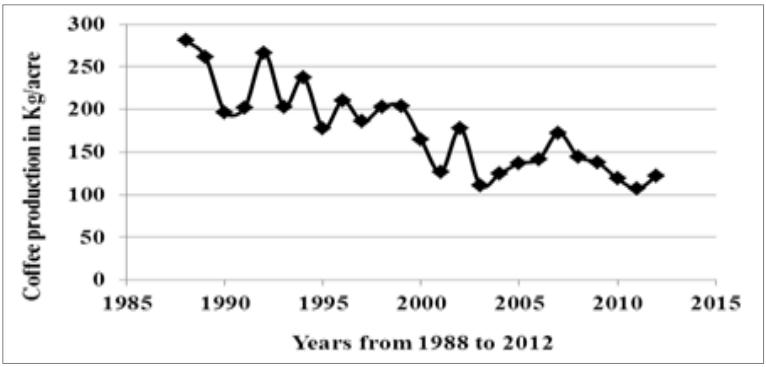


Figure 4: The trend of coffee production per acre in Mbozi District

3.4 Adaptation strategies employed by smallholder farmers

In response to the effect of rainfall and temperature changes in the study area, smallholder farmers, since the beginning of 2000s, have adapted several farming technologies as strategies to cope with the changes of the climate in their area as shown in Table 1. The use of agricultural inputs is leading for employing many respondents (99%) while changing sites or moving to a new area (crop rotation) accounted for only 33% of respondents.

Table 1: Adaptation strategies employed by smallholder farmers to cope with the effects of climate change on coffee production in the three studied villages.

Adaptation strategies	Ranking	Shiwinga N = 42	Itumpi N = 27	Iyenga N =43	Overall Response N = 112
Use of agricultural inputs	I	41 (36.6)	27 (24.1)	43 (38.4)	111 (99.1)
Expansion of farm size	Ii	33 (29.5)	22 (19.6)	42 (37.5)	97 (86.6)
Use of irrigation system	Iii	39 (34.8)	14 (12.5)	20 (17.9)	73 (65.2)

Mulching and pruning	**Iv**	11 (9.8)	12 (10.7)	20 (17.9)	43 (38.4)
Planting trees in coffee farms	**V**	8 (7.1)	12 (10.7)	20 (17.9)	40 (35.7)
Crop rotation	**Vi**	3 (2.7)	13 (11.6)	21 (18.7)	37 (33.0)

Note: Numbers in brackets indicate percentage of the response

4. Discussion

This study has revealed presence of unreliable rainfall patterns and increase of maximum temperatures in the study area. Optimal annual rainfall for Arabica coffee lies within the range of 1200-1800 mm per year and temperature not exceeding 24^{o}C and not below 15^{o}C during the flowering and fruiting periods (Descroix and Snoeck, 2004;Ridley, 2010).Mbozi district has the problem of climate variation as minimum temperature could fall to below 15^{o}C. The situation leads to abortion of coffee fruits and flowers especially in the month of September (flowering and fruiting period) hence fall of coffee yields. The results concurred to those by Baker, (2013) who showed that increased temperature and unreliable rainfall lead to coffee flowers abortion and occurrence of diseases like coffee berry disease which inturn leads to extreme poverty to the smallholder farmers. Coffee diseases claimed to attack coffee plants in the study area are Coffee Berry Disease, Coffee leaf rust, Fungus, and Coffee Milberg Disease. It has been suggested that that the incidence of pests and diseases such as coffee berry borer, leaf miner, coffee rust and others will increase as future temperatures rise (ITC, 2010).

The adaptation strategies practiced by smallholder farmers in the study area are more or less similar to those reported by several authors which were adopted by people for the sustainable production of various crops in different areas (Ridley, 2010; Läderach et al., 2010; Smith and Martino, 2007; URT, 2007; Paavola, 2008; ICO 2009; Stärken

and Wandeln, 2007; Nindi and Mhando, 2012). Altering amounts and timing of irrigation and other water management practices has been suggested to be one among good adaptation strategies relevant for smallholder farmers (Läderach et al. 2010). However, the use of irrigation systems for example was observed to be practiced by few smallholder farmers due to lack of capital for buying irrigation facilities like water pump, pipes or using a car for carrying water from the rivers (Smith and Martino, 2007; URT, 2007).

5. Conclusion

The study revealed that there were changes in rainfall and temperature in the study area which could be the main causes for the decrease of coffee yields in Mbozi District. This was due to the fact that increased temperature accelerates the occurrence of pests and diseases in which both are among the big threats to the growth of coffee crop. Unreliable rainfall leads to poor fruiting of coffee especially when there is little or no rainfall at the flowering periods and this situation leads to decrease of coffee yields. However farmers who are capable of irrigating their farms have shown to increased their harvest from 0.5 kg of coffee per coffee tree to 2 kg per coffee tree. This means that a farmer can be able to harvest up to 1,080 Kg per acre as 1 acre of coffee farm is supposed to have 540 coffee trees. Thus this study recommends that farmers need to have access to micro-credits that are provided at low interest rates so as to enable them commercialise their farming activities. Establishment of Servings and Credit Cooperation Societies (SACCOS) is an important incentive to implement this initiative. Financial assurance to farmers will enhance access to farm inputs i.e. improved coffee seedlings and fertilizers and use of irrigation systems which are essentials in sustaining coffee production especially under changing climate.

Acknowledgement

The Authors wish to thank the last Author for financial support. All people from Mbozi district who in one way or another participated in this study is highly appreciated.

References

Baker, P.S. (2013). Coffee and Climate: The Geometry of Change: A Rapid Diagnostic of Coffee Farmers' Production Challenges in the Mbeya Region of Tanzania, http://www.coffeeandclimate.org. Accessed on 20th August, 2013.

Chillewa, L.J. (2010), Mbozi District Council: District Investment Profile. Dar Es Salaam, Tanzania Pg. 10-11.

Descroix, F; Snoeck, J. (2004). Environmental factors suitable for coffee cultivation. In Wintgens, J. N. (editors) Coffee: growing, Processing, Sustainable Production. A guide for growers, traders and researchers. Wiley-Vch Verlag GmbH and CoKGaA, Weinheim, Germany.

International Coffee Organization (ICO). (2009) Climate change and coffee. Report presented to the International Coffee Council. 23–25th September 2009. London, UK. www.plosone.org/.../info%3Adoi%2F10.1371%2 Fjournal.pone.0024. Accessed on 23rd July, 2012.

International Coffee Partners (ICP) (2006) Sustainable Coffee Production and Processing coupled with Income Diversification in Mbozi District, Tanzania. http://www. coffee-partners.org/icp-projects-reader/items/tanzania-mbozi. Html. Accessed on 16th August, 2012.

IPCC (2001) Climate Change 2001: Impacts, Adaptation and Vulnerability, Third Assessment Report, Cambridge University Press. USA

International Trade Center (ITC). (2010) Climate Change and the Coffee Industry. http://www.coffeeandclimate.org. Accessed on 23rd July, 2012.

Läderach, P; Haggar, J; Lau, C; Eitzinger, A; Ovallej, O; Baca, M; Jarvis, A; Lundy, M. (2010) Building a Climate Change Adaptation Strategy: Mesoamerican Coffee. Pg. 3-4.

Nindi, S. J; Mhando, D. G. (2012) Adaptations to Climate Change and Variability among Smallholder Farmers in Tanzania. In: W. Leal Filho (ed.), Climate Change and the Sustainable Use of Water Resources. Pg.153-171.

Orindi, V. A; Murray, L. A. (2005) Adaptation to Climate Change in East Africa: A strategic approach, Gatekeeper Series 117.

Paavola, J. (2008) Livelihoods, Vulnerability and Adaptation to Climate Change in Morogoro, Tanzania. Environmental science and policy 11:642-654.

Pleyers, G. (2006) Fair-trade coffee in Nicaragua and Tanzania: a comparison.www.uclouvain.academia.edu/.../Fairade_coffee_in_Nicaragua_and_Tan. Accessed on 15th October, 2012.

Ridley, F. V. (2010) The past and future climatic suitability of Arabica coffee (Coffee Arabica L.) in East Africa. Durham theses, Durham University. http://etheses.dur.ac.uk/680/.Accessed on 18th October, 2012.

Smith, P; Martino, D. (2007) Agriculture, Climate change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, Cambridge University Press.

Stärken, F; Wandeln, K. (2007) The Role of Women in Adapting to Climate Change in Tanzania. www.gendercc.net/fileadmin/inhalte/Dokumente/news/Tanzania.pdf. Accessed on 17th October, 2012.

URT. (2013) 2012 Population and Housing Census: Population Distribution by Administrative Areas. National Bureau of Statistics, Ministry of Finance Dar es Salaam

URT. (2007) National Adaptation Programme of Action (NAPA). Vice President's office, Division of Environment.

URT. (1997) Mbozi District Socio-Economic Profile. The Planning Commission Dar es Salaam and Mbozi District Council Mbeya.

Climate Photographical Analysis Expressing Adaptive Strategies to Mitigate Impacts of Climate Change in Central Arid Areas of North Kordofan State, Sudan

Tarig E. Mahmoud[a], Mohamed E. Osma[a], Makeen A. Makeen[a], Manal A. Khiry[b] & Hassan I. Ali[c]*

[a] *Gum Arabic Research Centre, University of Western Kordofan, Sudan*

[b] *Faculty of Forestry, University of Khartoum, Sudan.*

[c] *Kenana Sugar Company, Khartoum, Sudan*

Abstract

The current study was conducted in the central arid area, Bara locality, North Kordofan State, Sudan during 2013, aiming at describing vulnerability of natural resource with respect to climate change in the area and to reflect the adaptive strategies that are performed by local people. The study was depended primarily on the data provided by the Comprehensive and Sustainable Agricultural Development Project in Central Arid Area of North Kordofan. Various research tools were used including descriptive statistics, satellite images and digital photographical analysis. The results indicated clearly the severity of desertification, soil degradation and sand dunes formation in the study area. It also expressed natural calamities in terms of recurrent drought episodes, sand encroachment, and unfavorable socioeconomics conditions as aggravated by climate variability pertinent to amount and distribution of rainfall and temperature. However, satellite images in 2013 showed slight improvement in vegetation cover. In view of that, the local communities adopt some strategies to mitigate impacts of climate change in the area such as establishment of home gardens,

* Corresponding author: tarigcom@gmail.com

wind breaks, live-fencing and adoption of tree based shifting cultivation. They tend also to safeguard *Faidherbia albida* as productive tree species for fodder, shade and shelter in social occasions during dry seasons. In addition, *Leptadenia pyrotechnica* shrub is extensively used for sand dunes stabilization due to its high tolerance to successive drought.

Keywords: climate change, adaptive strategies, desertification, satellite images, photographical analysis

---

1. Introduction

The realization of the African Green Revolution and its contribution to food security and economic growth in sub-Saharan Africa is threatened by climate change (IPCC, 2007). Some telling arguments (IPCC, 2007, FAO, 2007, and Williams and Funk, 2011) emphasized the vulnerability of African agriculture and all who depend on it for food security and livelihoods. Based on these studies "Africa is one of the most vulnerable continents because of multiple stresses and low adaptive capacity". The stresses arise from current climatic hazards, poverty and unequal access to resources, food insecurity, globalization trends, civil wars and political conflicts and incidences of diseases such as malaria, tuberculosis and HIV/AIDS". According to FAO (2007), agricultural production and the biophysical, political and social systems that determine food security in Africa are expected to be placed under considerable additional stress by climate change. It is also anticipated that adverse impacts on agriculture sector will exacerbate the incidence of rural poverty (Dinar *et al*., 2008; Levine *et al*., 2011). Farmers in Sudan have always been facing climatic variability at intra- and inter-annual and decadal time scales. Exposure to climate variability and extremes, most particularly drought, poses substantial risks to people living in rural areas (Funk et al., 2011). Thus, coping and

adaptation strategies have traditionally included crop diversification, mobility, livelihood diversification, and migration.

The drylands of Sudan occupy the largest area of the country amounting nearly to 75%, and considered as a home to a rapidly growing population of the country that currently stands at about 30 million people. One of the most important recent issues facing Sudan as well as sub-Sahara Africa is the threat of continued drought and desertification, as ascribed to destruction of natural resources, agricultural lands in addition to political and social disturbances. Many dry-land inhabitants are pastoralists, sedentary, nomadic or agro-pastoralists, combining livestock-rearing and crop production wherever conditions allow. Over years, they have lived with variable rainfall and frequent droughts using a range of coping strategies. Such traditional strategies lack documentation and any enhancement. However, irrational man activities are contributing to deleterious land degradation predicted that climate change will presumably further compound the already tenuous situation (CSADP, 2013). Without significant efforts to address the impact of climate change and land degradation, the livelihoods of the local communities will be jeopardized.

2. Problem Statement

The desertification process in western Sudan, especially in North Kordofan, has increased rapidly and much effort has been devoted to address its causes and impacts. The region is characterized by a fragile ecosystem where the greater is semi-arid with a small portion of rainfall ranges between 75-300 mm annually. The region endures intensive land-use pressures and is highly sensitive to climate fluctuations. Various practices in the region, such as changes in fire regimes, removal of vegetation and over-grazing have been linked to many recognised causes of land degradation and desertification. The increasing of human population and livestock, coupled with the

demands of enlarging areas of traditional farming lead to soil and vegetation deterioration. The trend of clearance of trees for growing annual cash crops together with the low and erratic rainfall is considered as the main causes of desertification in the region. Sand encroachment has moved rapidly ahead of the southern boundary of the dessert and accumulating sand over the formerly consolidated sand soils. This has led to destruction of all vegetation except *Acacia tortilis* and *Balanites aegyptiaca* trees as well as small number of sand dune adapted shrubs. The mobile sand dunes are moving southwards becoming an increasingly serious threat to agricultural lands and several villages in *Elbashiri* and Bara areas. As a result, many adaptive strategies have been introduced by the local communities to mitigate the undesirable impacts of climate change in the area. Accordingly, understanding such strategies mechanisms to cope with the situation and to develop resilience arrangements for local people is crucial.

3. Objective

The objective of this study is to express the adaptive strategies to mitigate the impacts of climate change in the central arid areas of North Kordofan State, Sudan through describing and assessing vulnerability of natural resources and the adaptive strategies that are performed by local people.

4. Methodology

The study was carried out in selected parts of the central arid areas of North Kordofan State, season 2013. The study area covers some regions in Bara and *Kheiran* area namely; Bara, Bara Rural *Kheiran* and Damira *Kheiran*. Primary data and information were collected through focus group discussions within the 3 locations of the study area

covering 120 respondents. Personal observations were made with the aid of digital devices (*Digital camera and GPS*).

Secondary data were obtained from the Comprehensive and Sustainable Agricultural Development Project in Central Arid Area of North Kordofan (SADP, 2013). In addition to that the satellite images were obtained from Global Land Cover Facilities (GLCF), Maryland University, USA.

Various research tools were used including descriptive statistics, satellite images, and digital photographical analysis. The photographical analysis as a main analytical tool used in this study allows researchers to work with primary sources in a non-traditional way.

5. Results and discussion

The results showed that the rainy season in the study area is extended from June to September. Rainfall increases from approximately 100 mm per year in the most northern areas to 200 mm in the middle zone and 300 mm in the South, although rainfall is unreliable, with large variation across years. In view of that, the time series data revealed that the average annual rainfall for the period 1908 – 1964 was 275 mm compared to 180 mm for the consecutive period 1965- 2004. In the last season (2012/13) the annual rainfall average increased to 300 mm southward Bara locality. In the belts of sub-Saharan region, the rainfall ranges increased (2005-2012) from 200 mm to 450 mm/year southward (Kheiralla *et al*. 2012).

The photographical analysis exhibited the severity of desertification, soil degradation and sand dunes formation in the study area (Figure 1). It also expressed the natural calamities in terms of sand encroachment, and unfavorable socioeconomics conditions aggravated by climate variability pertinent to amount and distribution of rainfall and temperature.

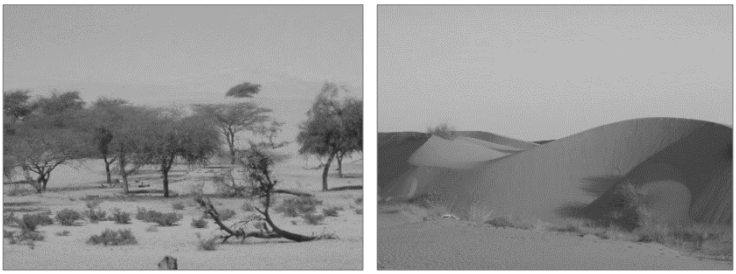


Figure 1: Soil degradation and sand dunes formation in *Kheiran* area, Bara locality (Source: study field survey, 2012/13)

Crops grown in the area include pearl millet, sesame, watermelon seeds in sandy soils whereas; vegetables and fruits are grown primarily in the low land. In most years, the study area experiences crop failures due to successive draught episodes and unfavorable land use practices (Figure 2). It is apparent from the digital photos that most of grain heads are aborted due to dry spells or attacks of pests and diseases. The long term decline in rainfall has led to competition on grazing land. Pastoralists move seasonally from the northern to southern parts of the study area. There are more local livestock movements within more southerly agro-pastoral areas, leading to disputes between agro pastoralists and pastoralists over grazing areas and rights and access to water points.

Figure 2: Crop failures and shifting-cultivation witnessed in Bara locality (Source: study field survey, 2012/13)

Vegetation Cover Changes

The vegetation cover for *Kheiran* area near *Elbasheeri* village in Bara locality was assessed using two Landsat satellite images for the years 1986 and 2013. The images description showed slightly improvement in vegetation cover density in 2013 compare to 1986, as indicated by the visual interpretation of the green color between the two images (Figure 3). This result reconciles with the photographical analysis which manifest apparent improvement in vegetation cover in the area with better natural regeneration (Figure 4). This observation is likely to be in line with Kheiry (2007) as concluded that the mixture of trees and shrubs on sand soil of *Kheiran* exhibited a decrease (-8.3%) over the period (1987 to 2005), which implies removal of shrubs and trees from the agricultural lands. The grazing lands showed a significant increase over the period by 88%. This increase in pastures happens, most likely, at expense of crop lands and forests.

(a) Landsat image Sept 1986 (b) Landsat image Dec 2013

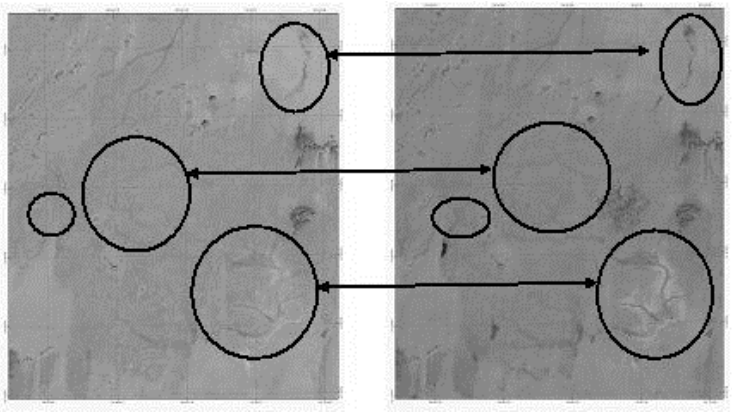


Figure 3: Visual interpretation of Landsat images for two years (1986 &2013) (Source: www.landcover.org, Global Land Cover Facility 2013)

Figure 4: Improved vegetation cover in the study area in 2013
(Source: study field survey 2012/13)

The rain-fed agriculture revealed a decrease (-12.5) in the total area cultivated with millet, sorghum, sesame and watermelon. As illustrated in Figure (5), the reduction in areas of rain-fed agriculture or shifting cultivation is mainly due to increasing livestock populations and pressure on cultivable and grazing lands, and the declining of fallow rotation period. Accordingly, these arguments unequivocally prove existence of climate change impacts as reflected in land degradation and desertification risks in the study area.

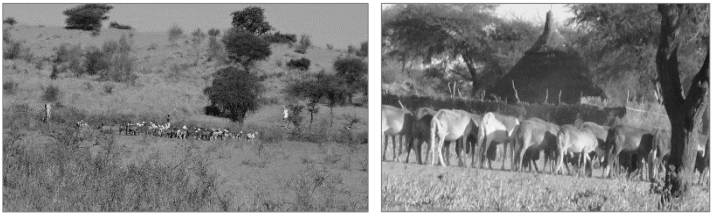


Figure 5: Grazing livestock in the study area (Source: study field survey 2012/13)

Coping strategies

Local communities in the area tend to conserve *Faidherbia albida* as productive tree species for fodder, shade and shelter (Figure 6). It is always the case in social occasions and meetings during dry seasons.

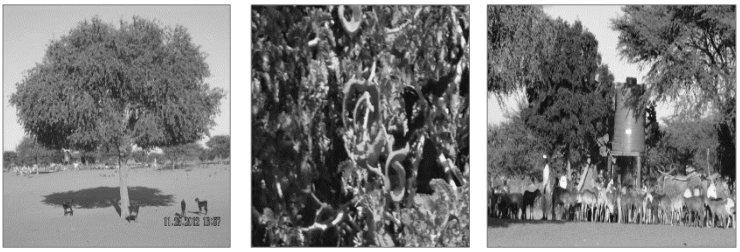


Figure 6: Adoption of Faidherbia albida for fodder, shade and shelter in study area (Source: study field survey 2012/13)

Additionally, they adopt many strategies such as home gardens, wind breaks, live fencing, agro-forestry systems in terms of tree based shifting cultivation. The tree species *Leptadenia pyrotechnica* is commonly used for both sand dunes stabilization and houses construction in the study area (Figure 7).

Figure 7: *Leptadenia pyrotechnica* is a multipurpose shrub in Elkhieran, Bara Locality. (Source: study field survey 2012/13)

The study also emphasized the importance of community participation program, particularly women group work (Figure 8). They tend to cultivate *Acacia seyal* and *Leptadenia pyrotechnica* *Leptadenia pyrotechnica* trees for combating sand dunes formation in the *Kheiran* areas. This program is running on the basis of food for work, funded by some NGOs in collaboration with the Forest National Corporation (FNC), Sudan (CSADP, 2013).

Figure 8: Women participation in tree planting based on group work in Kheiran area (Source: study field survey 2012/13)

The study also observed some important coping strategies in the study area include:

i) stocking/selling of firewood,
ii) increased migration in search of seasonal agricultural labor in the semi- mechanized areas of Gadaref, Blue and White Nile as well as parts of South and Western Kordofan states,
iii) well-off householders provide informal credit “shail system” against expected crop harvest and
iv) better-off groups increase livestock sales to obtain more income especially, for sheep, goats and camels. This strategy gains much importance when livestock weights are adversely affected during drought periods.

6. Concluding Remarks

Based on the acquired results and discussion, the study concluded that the land degradation and desertification risks as a result of climate change in the study area are well perceived. Accordingly, the adaptive strategies performed by local communities should be encouraged and promoted to cope with the situation and to develop resilient arrangements for local people in the semi-arid dry land. These, besides official and non-official efforts could help in mitigating impacts of climate change in area in the long-run.

Acknowledgements

The authors of this paper expressed their gratitude and thanks to Welcome to Africa Scientific Cooperation Network on Climate Change Adaptation Project, Comprehensive and Sustainable Agricultural Development Project in Central Arid Area of North Kordofan State- Sudan, and Wondo Genet College of Forestry and Natural Resources, Ethiopia.

References

CSADP (2013) Comprehensive and Sustainable Agricultural Development Project in Central Arid Area of North Kordofan. Project Document. Ministry of Agriculture & Animal Wealth, North Kordofan State, Sudan.

Dinar, A. Hassan, R. Mendelsohn, R. and Benhin, J. (2008) Climate Change and Agriculture in Africa: Impact Assessment and Adaptation Strategies. Earthscan, London. UK.

FAO (2007) Climate Change and Food Security: A Framework for Action. Report by an Interdepartmental Working Group on Climate Change. FAO, Rome, Italy.

Funk, C. Eilerts, Verdin, J. Rowland, J. and Marshall, M. G. (2011) A climate trend analysis of Sudan. U.S. Geological Survey Fact Sheet 2011–3072. Available at: http://pubs.usgs.gov/fs/2011/3072/pdf/FS2011-3072.pdf).

IPCC (2007) IPCC 4th Assessment Report - Climate Change 2007. Working Group II on "Impacts, Adaptation and Vulnerability". Available at: http://www.ipcc-wg2.org

Kheiralla, K.M. Mergani, M.M. Mohamed, N.E. Abdelgalil, M.Y. (2012) Mathematical Modeling of Bara Groundwater System Central Sudan. J Ecosyst Ecogr, 2, 120.

Kheiry, M. A. (2007) Spectral mixture analysis for monitoring and mapping desertification processes in-semi-arid areas. Applications of remote sensing in monitoring dry-lands, North Kordofan state- Sudan. Rhombos-Verlag publisher. Berlin, Germany.

Levine, S. Ludi, E. and Jones, L. (2011) Rethinking support for adaptive capacity to climate change: the role of development interventions. London: ODI. Available at: www.odi.org.uk/resources/details.asp?id=6213&title=accra-adaptive-capacity-development-interventions.

Williams, A.P. and Funk, C.C. (2011) A westward extension of the warm pool leads to a estward extension of the Walker circulation, drying eastern Africa: Climate Dynamics, in press. Available at http://www.springerlink.com/content/u0352236x6n868n2/.

Buffer Zone and Collaborative Land Management

Monitoring Deforestation and Degradation processes and Land Use Systems in Umabdalla Natural Forest Reserved, South Kordofan, Sudan

Osman E. A. Abdelkareem[a], Elnour A. Elsiddig[b], Hassan E. Adam[a], Elmar Csaplovics[c] and Elhaja M. E.[a]*

[a] *Faculty of Natural Resources and Environmental Studies, University of Kordofan, Sudan*

[b] *Faculty of Forestry, University of Khartoum, Sudan*

[c] *Institute of Photogrammetry and Remote Sensing, Technische Universität Dresden, Germany*

Abstract

The current study conducted in *Umabdalla* natural forest reserved, South Kordofan State, Sudan. The study aimed at estimating the changes in the forest cover over successive period comprising the land use system and population dynamic of the tree species, also to investigate the causes of forest gaps and extend of development in to large area deforestation. A successive forest inventories during the years 1998 and 2007 curried by the Forest National Corporation and year 2011 by the author to the forest including 248 sample plots (of 0.1 ha each) were conducted. Trees and area of gap were measured. 100 questionnaires distributed among respondents and analyzed. Remote sensing data from Landsat TM 1992, ASTER 2005 and 2012 imagery covering the forest area were acquired and integrated with in-situ forest inventory data and ground truth points. Supervised classification was employed in data analysis using ERDAS version 9.1. The results showed that the forest is rich in tree species; 53 species were recorded. However, the study revealed a significant variation ($p > 0.05$) in the number of trees per hectare in the forest between the

* Corresponding author: osmanraasta@yahoo.com

three periods. The analysis of the social survey data showed different causes of forest gaps among which trees cutting and fires scored 40% and 23%, respectively. Remotely sensed data classified the land use system into seven classes namely, gap within sandy soil, special soil (*Tollay*), dense vegetation, burned soil (fire), medium dense vegetation, rocks with scattered trees, and gap within clay soil. The area of gaps in the clay soil decreased during 1992, 2005 and 2012 gradually by 38%, 25% and16%, respectively, as well as the fires decreased in the same years by 7%, 5%and 3%, respectively coupled with an increase in the area of medium dense vegetation at the expense of the dense vegetation.

Keywords: forest gap, remote sensing, land use, South Kordofan, deforestation, degradation

---

1. Introduction

The semi-arid zone of the Sudan extends between latitudes 14° and 17° N and the low rain fall woodland savannah extends between latitudes 10° and 14° N and these two zones are the most densely populated zones and the most vulnerable to deforestation impacts, causing forest cover decline and increase the vulnerability of the ecosystem to desertification processes leadings to a serious threats to the woodlands (Elsiddig, 2007). On other hand, the dry lands are faced with serious environmental and socioeconomic problems such as drought, deforestation, desertification, poverty, famine and migration (Kheiry, 2007). After separation of South of Sudan in 2011, the area covered by forests and woodlands is estimated by the Forest National Corporation (FNC) as 21,826,166.62 hectares (ha), equivalent to 11.6% of the area of Sudan (Badri, 2012). Gap creation within forests and woodlands is caused by many factors leading to deforestation which threatens the environment.

Remote sensing is very useful tools for mapping the extent of forest cover and of a central importance to forest conservation and management planning. Remote sensing has being used to assess forest condition and the environmental services provided by forests such as assessment of forest composition, the degree of canopy cover, tree density, the pattern and intensity of natural and anthropogenic disturbance, and forest fragmentation, among many other variables. Remote sensing data can be collected from a wide variety of ground-based, airborne, or satellite sensors, which vary markedly in their spectral characteristics, resolution, and scale (Newton, 2007).

1.1 Objectives

The current study aimed at:

i) Estimating the changes in the forest cover over successive period comprising the land use system and population dynamic of the tree species;
ii) Investigating the causes of forest gaps and extends of development in to large area deforestation.

2. Methodology

2.1 Study area

The study area is located in Southern Kordofan State. The state lies between latitudes 9° and 12° N, and longitudes 27° 25 and 32° E, with a total area of 135696 km² (Figure 1). This state is dominated by the Nubba mountain series as the main geographical feature. The southern part of South Kordofan is located in a high-rainfall savannah while the northern part is situated in a low-rainfall woodland savannah (Mohammed, 2011). The annual rainfall ranges from 400-800 mm and increasing from north to south. Rainfall begins in April and ends in November. Soils in the study area are shallow and usually

variable with regards to physical characteristics and mineral contents. Loamy and alluvial soils deposits are limited to seasonal streams and valleys locally known as Khors and Wadies respectively. Light and cracking clays are reasonably fertile, characterized by the traditional production system (Ali, 2005). The geology of the area is characterized by basement complex formation, which is the oldest and most extensively found. The Nubian sandstone overlies the basement complex in the majority of the area (WSARP, 1982).

The Population in the Nubba Mountains is about 2.87 million inhabitants (census, 1993), however; the various Nubba people make up some 90% of the population of the area and the other 10% are Baggara (cattle herders) mainly Arabs (Sanjak, 2000). The economy of the region is predominately dependent on agriculture and animal production, which contribute 30% and 70% respectively. The main crops include sorghum, millet and maize as food crops and sesame, groundnut, gum arabic and horticultural products as cash crops. Forestry activities are widely practiced mainly for supply of fuel wood and construction materials for local and commercial consumption (Ali, 2005). The vegetation composition of South Kordofan State varies depending mainly on soil type, texture and the pattern and distribution of rainfall. On rocky uplands and mountainous terrain *Ficus populifolia* and *Ficus glumosa* "Gomez" are the most dominate tree species. On mid-slope and hilly land *Sterculia setigera* "Tartar", *Boswelia papyrifera* "Luban", *Terminalia brownii* and *Combretum hartmannianum* "Habil" are dominant tree species. Associated species include *Anogeissus lieocarpus* "Sahab", *Terminalia laxiflora* "Darot", *Sclerocarya birrea* "Humeid", *Dalbergia melanoxylon* "Babnus", *Commifora africana* "Gafal", *Albizia amara* "Arad" and *Prosopis africana* "Abusurog". At foot slopes, *Sclerocarya birrea* and *Lannea humilis* "Layoun" are most dominant, *Tamarindus indica* "Aradeib", *Adansonia digitata* "Tabaldi', *Ziziphus spina-christi* "Sidir" and *Dichrostachys glomerata* "Kadad" (El Tahir et. al, 2010).

2.2 Umabdalla Natural Forest Reserved

Umabdalla Natural forest reserved lies between latitude 11º 41' 52.5'' – 11º 46' 40.8'' N and longitude 30º 50' 8.4'' – 30 º 54' 9.4'' E., within the vicinity of Rashad town 37 km to the south-west, in the eastern Nuba Mountains, Southern Kordofan State. The total forest area is about 10463.8 feddans equivilent to (4396.55ha), of which 10048.1 feddans (4221.89ha) are natural forest in which the current study was carried out. Other area of 174.66 ha constitutes plantation blocks mainly occupied by, *Khaya senegalensis* and other tree species.

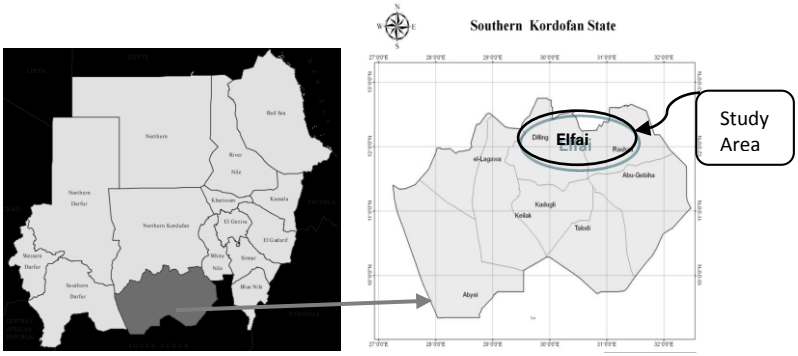


Figure 1: Location of the study area in Sudan map and South Kordofan State (Adapted from FAO 2012 and Koli 2010)

2.3 Material and methods

2.3.1 Reconnaissance survey

The reconnaissance survey was covered different aspects such as boundaries, tree composition, topography, soil types, cuttings, grazing, nomad settlement inside the forest, the damage by pest and diseases as well as the gaps in the forest.

2.3.2 Forest inventory

Systematic random sampling applying survey lines with 400m interval was adopted by the author in the year 2011followed the same procedure of the previous (1998/2007) inventories which carried by the FNC. A circular sample plot with an area of (0.1 ha) (radius 17.84 m) along the survey lines with 200 m between them were located. Diameter at Breast Height (DBH) and height (m), in each sample plot were measured, in addition, all tree species in the sample plot were identified and recorded.

2.3.4 Social survey

A social survey in the study area for the local people who have direct contact with forest was conducted; hundred respondents from different villages around *Umabdalla* forest were randomly selected and interviewed, also focus group discussion with some FNC staff, leaders and key informants was done.

2.3.5 Remote sensing data

Data Acquisition and Processing including the followings:

- Satellite imagery covering the study area these were Landsat4 Thematic Mapper (TM) 1992, ASTER (2005) and ASTER (2012);
- Image radiometric and geometric correction;
- Image enhancement;
- Transforming and interpreting data from field and existing forest inventories;
- Classification of forest cover;
- Production of forest cover map.

2.3.5 Data analysis

The inventory data was entered in the computer in to Microsoft Excel and saved in special format and analyzed by both Excel 2007 and Statistical Package for Social Sciences (SPSS version 18). While, social data from the questionnaires was entered in the computer and analyzed with the aid of SPSS version 18. Remote sensing data was analyzed by ERDAS version 9.1 and Arc GIS version 9.2 beside visual interpretation.

For the purpose of this study an intensive and up to date literature review was gathered from books, local and international journals, related previous scientific research findings, periodicals, Google scholar. In addition, to FNC annual reports and FAO working papers.

3. Results and discussion

The reconnaissance survey showed that the forest is rich in species diversity (53 species) varying in different densities (figure 2). The general trend of stocking density of trees is increasing with significant different ($p > 0.05$) during 1998-2007 and 1998 – 2011, while no significant different during 2007 -2011 (figure 3) and (table 1).

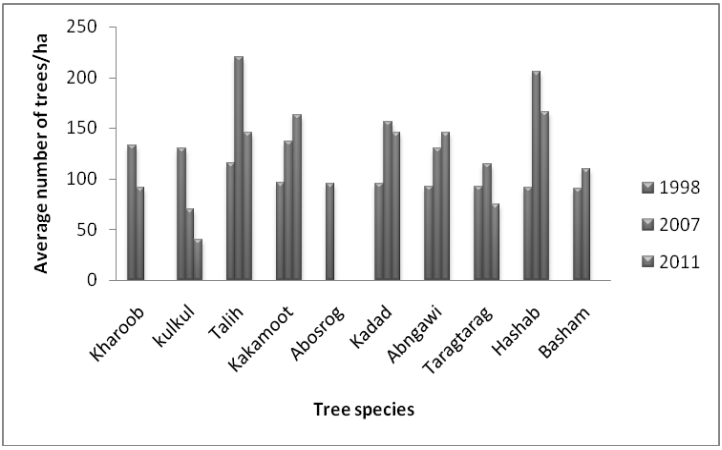


Figure 2: Top dominant tree species in Umabdalla natural forest reserved during the years 1998, 2007 and 2011

Table 1: Differences in the number of trees per plot (0.1 ha) in Umabdalla Natural Reserved Forest during the years 1998, 2007 and 2011

(I) Year (J) Year	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
1998 - 2007	-3.286*	0.182	0.000	-3.64	-2.93
1998 - 2011	-3.463*	0.264	0.000	-3.98	-2.95
2007 - 2011	-0.177	0.264	0.502	-0.69	0.34

* The mean difference is significant at the 0.05 level.

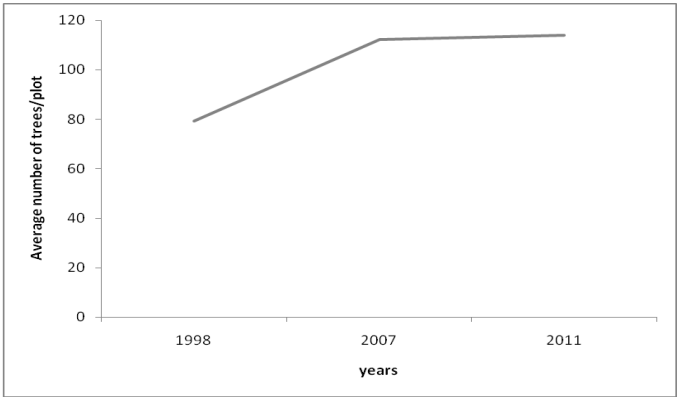
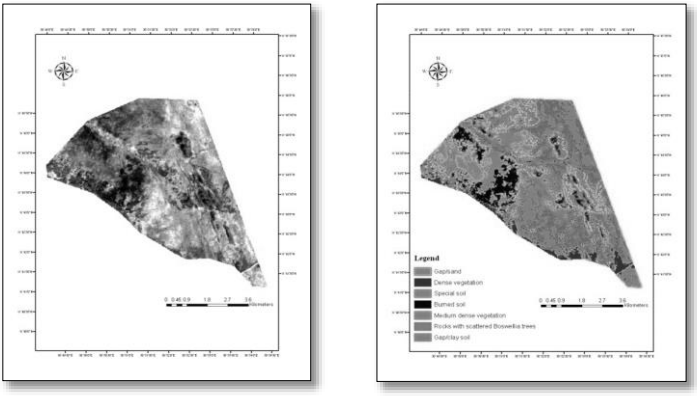


Figure 3: Trend of stocking density of trees per plot in Umabdalla Natural Reserved Forest during the years 1998, 2007 and 2011.

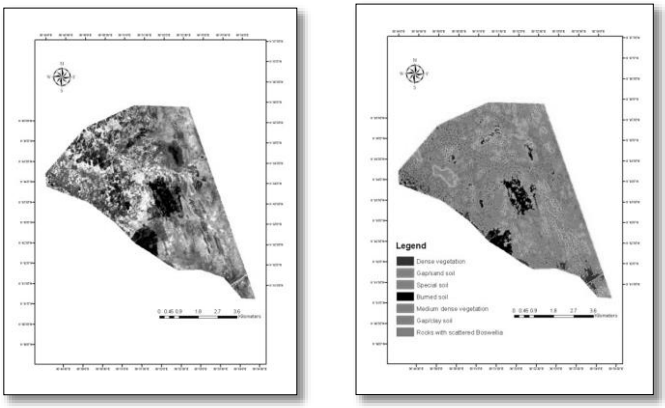
Remotely sensed data classified the land use system into seven classes namely, gap within sandy soil, special soil locally known as (*Tollay*), dense vegetation, burned soil (Fire), medium dense vegetation, rocks with scattered trees, and gap within clay soil. The area of gaps in the clay soil decreased during 1992, 2005 and 2012 gradually by (38%, 25%, 16%) respectively, because After Nuba Mountains' Peace Agreement some parts of the forest reserve were partially controlled by the FNC and as a result improvement of regeneration occurred besides increasing of tree cover. Also, open canopies created a suitable environment for seeds that were

provided from leftover mother trees. As the result the fires which represent the main source of degradation in the forest decreased in the same years by (7%, 5%, and 3%), respectively coupled with an increase in the area of medium dense vegetation at the expense of the dense vegetation (table (2) and figures (4, 5 and 6).



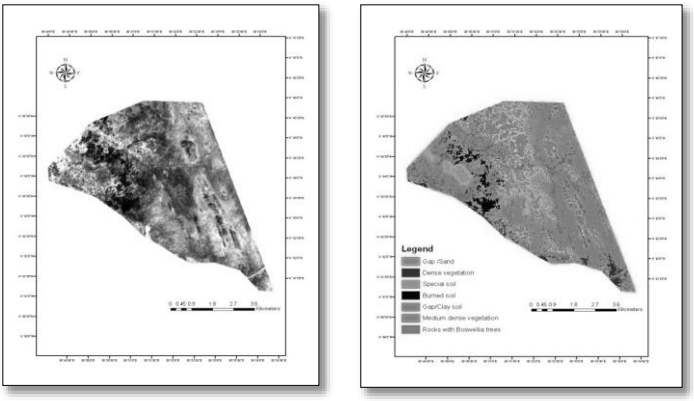
Colour-infared image (B, G, NIR) Classified image

Figure 4: Land use system classes of Umabdalla Natural Forest Reserve based on Landsat TM image classification, 1992.



Colour-infared image (B, G, NIR) Classified image

Figure 5: Land use system classes of Umabdalla Natural Forest Reserve based on ASTER image classification, 2005



Colour-infared image (B, G, NIR) Classified image

Figure 6: Land use system classes of Umabdalla Natural Forest Reserve based on ASTER image classification 2012.

Table 2: Classification of the land use system in Umabdallah natural forest reserved

No	Class name	Area per hectare			Percentage %		
		1992	2005	2012	1992	2005	2012
1	Gap/sand	499.32	668.27	227.90	11.62	15.61	5.32
2	Dense vegetation	144.45	113.73	98.68	3.36	2.65	2.30
3	Special soil (Tollay)	160.92	331.06	272.72	3.74	7.73	6.37
4	Burned soil	300.87	194.64	140.82	7.00	4.54	3.29
5	Medium dense vegetation	737.91	1410.46	1973.2	17.17	32.95	46.10
6	Rocks with scattered Boswellia trees	820.98	478.86	867.12	19.10	11.18	20.26
7	Gap/clay soil	1631.97	1082.77	699.32	37.98	25.29	16.34
	Total	**4296.42**	**4279.82**	**4279.81**	**100**	**100**	**100**

The results of change detection of land use in Umabdalla natural forest reserve showed decrease in some land use classes during (1992- 2005/ 2005-2012/ 1992-2012) by (27%, 13% and 20%), respectively, while some classes remained without change in the same periods by (59%, 59% and 60%) respectively. On the other hand some land use classes revealed an increase during the same periods by (14%, 19% and 20%), respectively (figure 6).

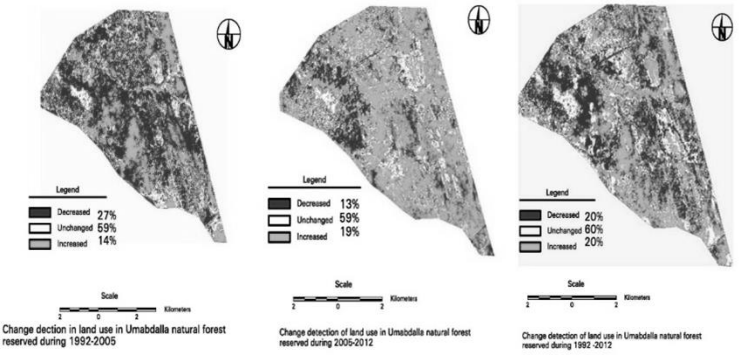
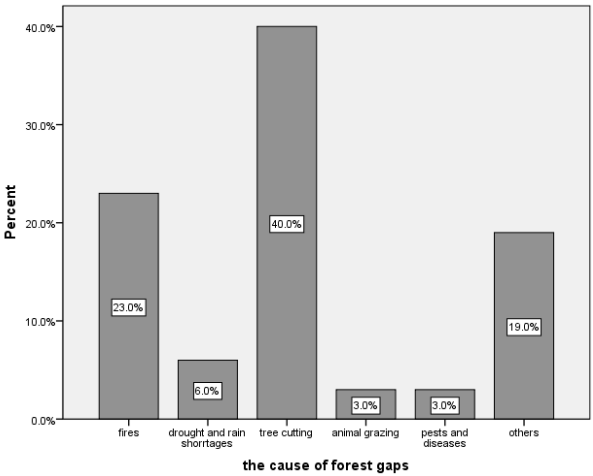


Figure 7: Change detection of land use in Umabdalla natural forest reserved during 1992, 2005 and 2012

The analysis of the social survey data showed different causes of forest gaps among which trees cutting and fires scored 40% and 23%, respectively, because the forest represent the main source of fuel wood for the community around the forest beside animal grazing and lopping of the trees during the dry season because the forest located within the animal routes during their movement south and north between the rainy season and the dry season in summer. Also honey collectors contribute very much in the forest fires. Due to the improper management the forest is characterized by gaps and scatter newly invaded trees the majority of interviewed respondents agreed to replant the gaps in the forest as a suitable land use (figure 7).



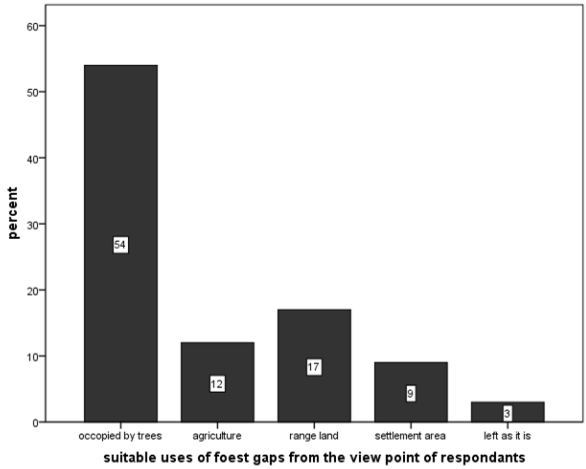


Figure 8: Up the causes of forest gaps, down the suitable uses of forest gaps from the view point of respondents in Umabdalla natural forest reserved

4. Conclusions

The study concluded to the following remarks:

- Illegal felling and tree lopping are highly practiced in the forest.
- Forest fires represent the main cause of degradation in Umabdalla forest reserved.
- The community around the forest of need of extension and chances for participation in the forest management and activities.

5. Recommendations

- Forestry extension should be intensified among different levels of local people.
- Introduction of integrated agroforestry system in forest reserve land under FNC control.
- Attention of FNC must be given for annual early clearance and opening of the forest reserve fire lines.
- Encouragement of local people to participate in natural forest reserve protection, conservation and reforestation.

Acknowledgment

The author acknowledge the Institute of Photogrammetry and Remote Sensing, Technical University of Dresden, Germany for provision of satellite imageries.

References

Ali, H. A. (2005) Yield of gum Oliferia (Boswellia papyrifera Del). Hochst, in relation to method of tapping in South Kordofan Msc. Thesis, University of Kordofan.

Badri, S. (2012) Sudan Environmental Threats and Opportunities Assessment with Special focus on Biological Diversity and Tropical Forest, Washington, DC20024, USA.

El Tahir, B. A. Fadl, K. M and Fadlalmula, A. D. (2010) Forest biodiversity in Kordofan Region, Sudan: Effects of climate change, pests, disease and human activities, Biodiversity, Vol. 11, article (3 &4), p34 - 43.

Elsiddig, E. A. (2007) Jebel Marra the potentials for Resources and Rural Development in Darfur, Khartoun, Sudan.

FAO (2012) The land cover atlas of Sudan, FAO, Rome.

FNC (1995) The Forest Products Consumption Survey in Sudan. Forests National Corporation, Khartoum Sudan.

FNC (1999) Umabdalla Forest Reserve Inventory. Kordofan Technical Sector. Fordland Castañeda, Christel Palmberg-Lerche and Petteri Vuorinen, May 2001. Forest Management Working Papers, Working Paper 5.

Kheiry, M.A. (2007) Spectral mixture analysis on monitoring and mapping the desertification process in semi arid areas, case study North Kordofan, Dresden Germany.

Koli, A.O. (2010) Some factors effecting gum arabic production in Dalanj area, Southern Kordofan – Sudan, PhD thesis University of Khartoum, Sudan.

Mohammed, H.M. (2011) Management of Natural Stands of Acacia seyal Del. variety seyal (Brenan) for Production of Gum Talha, South Kordofan, Sudan TUDpress, Dresden, Germany.

Newton, C.A. (2007) Forest Ecology and Conservation, New York, United States.

Sanjak M.E. (2000) The Contribution of Non Timber Forest Products to Local Livelihood in Southern Kordofan State, Sudan.

WSARP (West Sudan Agricultural Research Project) (1982). Work Plan, Volume 111. Research Plan for Kadogli and other stations, WSARP Publication No. 15, Khartoum, Sudan and Pullman, Washington, USA.

Impacts of Internally Displaced Communities on the Tree Cover at Elgeneina Locality, West Darfur State, Sudan

Mohamed El Nour Taha[a], Elamin Sanjak Mohamed Ali[b], Mohamed Abulgasim Ahamed Hasan[ca]*

[a] Department of Forestry and Range Sciences, University of Kordofan, Sudan

[b] Department of Forest Management, Faculty of Forestry, University of Khartoum, Sudan

[c] Forests National Corporation,, University of Kordofan, Sudan

Abstract

The broad objective of this study was to investigate the negative impacts of internal displacement phenomenon on the vegetation cover and possibility of restoring the natural environment affected by the internally displaced persons at Elgeneina Locality, West Darfur State, Sudan. More specifically, the study aimed to assess the level of the resource base destruction in the area as a consequent result due to reliance on the vegetation cover for providing necessary needs for settlement of such communities. The populations that are historically resident farmers and/or nomadic animal herders have been seriously affected by the climate change and variability in terms of successive drought spells that have hit large areas of the country. Tribal frictions and conflicts over limited resources have come up between different stakeholders and some have been kicked out of the game to move and settle in safe hosting sites around nearby cities as in the case of Elgeneina the subject area.

For achievement of the study objectives, primary and secondary data were collected. Sources of the secondary data included records of the Forests National Corporation, UN agencies, NGOS and local

* Corresponding author: nour.54321@hotmail.com

organizations. The primary data were obtained using social survey through face-to-face interviews with the internally displaced persons and inventory of the vegetation cover in the area. The study findings revealed tremendous changes in the economic activities of the displaced communities in the study area, as the majority lost the main source of their income generation which was basically farming or private business. Trading forest products in form of fuel wood, charcoal and building materials has become the alternative source of income for a considerable proportion of the displaced persons and this was reflected in an alarming deforestation trend. Inventory of the vegetation cover indicated a severe destruction of the resource where highly preferable tree species have been overexploited and replaced by less preferable species. A fictitious circle of about 10km around settlement camps has almost been deprived of the vegetation cover due to illicit felling. Both natural and reserved forests represented the main sites for settlement before establishment of camps for displaced communities. At the same time, forest trees constituted the main source of material necessary for house construction and energy. Limited extension services were dedicated to encourage participation of displaced communities in rehabilitation of areas affected by their residence. The afforestation programs were confined merely to camping sites where only few numbers of displaced persons could take part.

Keywords: internal displacement, climate change, tribal frictions, conflicts over resources, vegetation cover, settlement camps, resource inventory, afforestation

1. Background Information

Around the world, natural disasters and conflicts over resources have displaced millions of people. Displaced population fleeing to settlement camps looking for safety in host villages often put great stress on natural resources leading to environmental degradation and conflicts with local populations. According to the Office of the United Nations High Commissioner for Refugees (UNHCR), there are estimations of 200 million migrants “on the road” today, equal to 3% of the world’s population including 67 million forcibly displaced persons fleeing wars, violence or natural disasters, most of them are extremely vulnerable women and children. Worldwide, a sizeable number of displaced people amounting to 16 millions are officially refugees whose survival depends in many cases on international protection and assistance. There is however a significant difference between a refugee and a person displaced internally in his own country.

In addition to many other problems encountered in Sudan, the problem of internally displaced persons in Greater Darfur is most serious. Thousands of civilians have been displaced and settled in camps and the outskirt towns. The conflict there is complicated; caused and aggravated by a number of political, social and economic interventions, but it has originated mainly as environmental crises due to climate change and consequent conflicts over natural resources. The region witnessed one of the most destructive conflicts between non – Arab groups and Arab groups, due to long drought spells that hit the area nineteen seventies and eighties. A quite significant number of Arab nomads used to migrate from north to west and south Darfur in search of pasture and water for their livestock, where they compete with local inhabitants over the use of natural resources. Such competition led to conflicts which triggered the present ongoing conflict in Darfur. Traditionally frictions between farmers and pastoralists have been common in Darfur, but many different invisible

hands and hidden agendas might be behind the ongoing conflict; result is unfortunately people are nowadays looking for safe places.

2. Study Area

The study area; Elgeneina Locality is part of West Darfur State (Figure 1) that has been founded by the Tenth Presidential Decree in 1994; it lies in far western part of Sudan between longitudes 21°-48° E and latitudes 10°38' N and 14° -58'N. The total area of the state is about 75000 km2 covering fifteen localities (including Elgeneina Locality) subdivided into 28 administrative units.

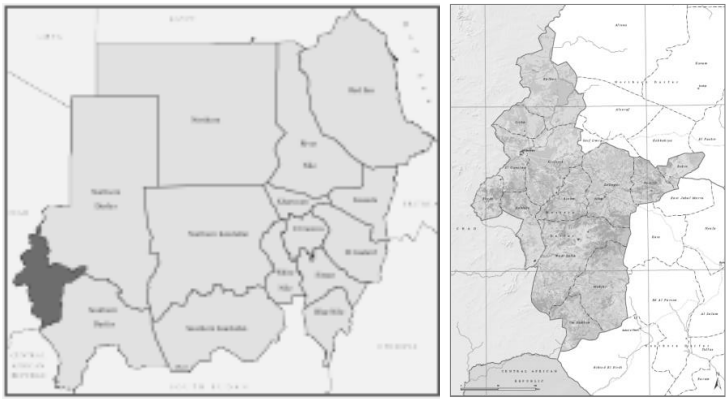


Figure 1: Location map of Elgeneina Locality in West Darfur State (Adapted from FAO 2012, the Land Cover Atlas of Sudan. Rome, Italy, March 2012)

Climatic zones of the state having fluctuating nature of precipitation are ranging from semi-desert with average rainfall 200 mm/annum in the north, poor savannah and rich savannah with average annual rainfall 800 mm in the south (Figure 2). Jebel Marra Massif with Mediterranean climate (1200mm annual rainfall continues for more than three months) is characterizing the state.

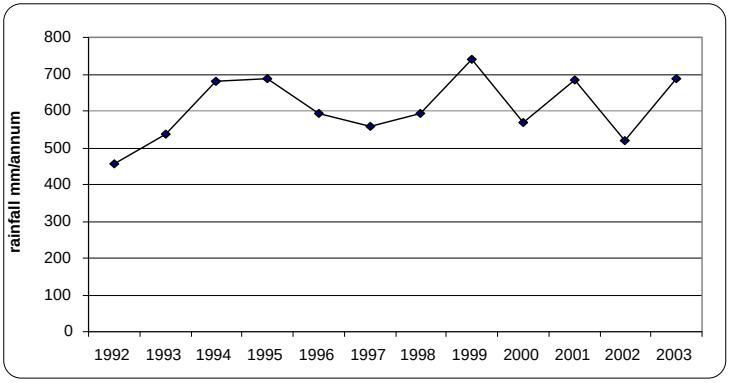


Figure 2: Rainfall rates in West Darfur State (1992 – 2003) (MAARWDS, 2006)

Average temperature is ranging between 30°C in summer and 23°C in winter. Winds, topography and soil classification of the state are profoundly described by Gaballa (2009). The state is generally rich in vegetation cover and the forest cover is estimated to be about 512928 hectare (representing about 7% of state area) distributed all over the state. However, the forest resources consist of both economically valuable plantations and natural forests that have been reserved and protected (MAARWDS, 2006).

Hakura is the habitual dominant land tenure system organized by traditional leaders, *Sheikh* or *Umda.* Hakura is usually well demarcated piece of land divided into small plots allotted to families or persons looking after it. The land tenure system in the area contributed to the misunderstanding and in turn the conflict between farmers and pastoralists (Salah and Gahffao, 1999). Inhabitants of West Darfur State are different ethnically belong to major tribes of non–Arab groups (mainly farmers) and traditional Bedouins of Arab origins (mostly nomads) encompassing more than 46 tribes living in harmony each with its own language or dialect, but Arabic is the common language. The total population is estimated as 1380000 individuals, only 9% live in urban areas and the majority (91%) is found in rural areas, with an average population density of 24 capita per square km

(Ayoub, 2001). A quite big number of populations in West Darfur State migrated to Chad as refugees. The internally displaced inhabitants were estimated as 832,926 individuals in the state (WDSP, 2005). The major tribes settle in the region are: Arab, Fur, Masaleet, Gimir, Tama, Arenga, Asangur, Zagawa, Mima, Asingar, Bargo, Barno and Falatta (Ayoub, 2001). According to OXFAM (2001), the main tribes found in Elgeneina Locality include Massalit, Bargo, Barno, Zagawah, Tama, Aringa, Fellata, Hawsa, Gura'an and Jellabah.

The major economic activities in the state are subsistence agriculture and livestock herding, where 80% of the state population is engaged (DRC and Uni. Zalingia, 2008).

3. Research problem and justification

The study area; West Darfur State is a typical example of fragile marginalized remote area, where people have to rely on natural resources for their living and survival. In the past the rainfall was satisfactorily for crop production and local people used to live in harmony with their surrounding environment. Recently, frequent drought is a rule rather than exception; rains are sporadic and erratic in nature with long periods of episodes (Figure 2). Natural rangelands have become poor due to lack of regeneration of grasses and herbs. As a result, nomads have to rely on tree cover for the provision of fodder or to graze on the agricultural lands of the settlers. This situation led to conflicts between pastoralists themselves on one side due to competition on the scarce fodder, and between pastoralists and farmers on the other side. Conflicts between individuals developed to be between groups and finally between tribes. In many sites in the study area conflicts escalated to disputes. With the intensification of the fights between different stakeholders, many local people flee their home of origin seeking for safe sites. Severe destruction of the vegetation cover has taken place for provision of shelter, energy and source of income. Like many other parts of the country, the study area

is subjected to severe deforestation of devastating areas, preliminary step of desertification process. The situation has been worsening due to the fact that the Forests National Corporation (FNC) in the study area is always underfunded and understaffed, so it is not potentially capable for restoring the environment, this adds to lack of necessary inputs and poor infrastructure.

To highlight such an alarming problem, Elgeneina Locality has been selected to achieve objectives of this research with emphasis on the following:

- The apparent deterioration of the vegetation cover due to irrational use of forest resources by the internally displaced communities implies the importance to quantify damage extent and restoring possibilities.
- It is important to approach the internally displaced persons in an attempt for mobilizing them to participate in the rehabilitation of areas affected.
- Providing the internally displaced communities with necessary assistance to reduce pressure on the natural resources necessitates identification of their urgent needs.
- There are few, if not, scientific studies on the environmental impacts of internal displacement phenomenon.

4. Research objectives

The overall research objective focused on investigating negative impacts of the Internal Displacement Phenomenon on the vegetation cover and possibility of restoring the natural environment affected by internally displaced persons at Elgeneina Locality, West Darfur State, Sudan. More specifically, the study aimed to achieve the following objectives:

- Assessing destruction level of the vegetation cover.
- To examine the potentiality of restoring the vegetation cover through involvement and participation of internally displaced people

- To evaluate the degree of reliance on the vegetation cover for sustainable livelihood.

5. Research Methodology

Primary and secondary data necessary for achievement of research objectives were collected. The secondary information was obtained from records of relevant governmental and non-governmental institutions, mainly Forests National Corporation, UN agencies, international NGOS and local NGOS. The primary data were principally collected through social survey and resource inventory.

5.1 Social survey

Camps (residence villages) of internally displaced people around Elgeneina town were considered as the sites for study. The camps targeted for the study were Ardmata, Durtey, Abuzar, Zalinga and Kerndun. Being the basic unit of production and consumption in rural areas, households were the focal units of the study. The target household members could be identified according to Bentley (1982) based on combination of the following criteria:

- Residence: the household members live in the same house.
- Production or working unit: the household members work together in a common field.
- Consumption: the household members pool their income in one basket for consumption.

From the survey, individual household members fulfilling all the above mentioned criteria were chosen using the simple random sampling technique from food registration lists prepared by the Humanitarian Aids Commission in each camping village. A purposively designed, well constructed and pretested questionnaire was distributed to the selected interviewees. The questionnaire was developed according to directives of FAO (1985) and guidelines of Burchinal (1986) to obtain data on personal information of respondents (gender, age, marital

status, education, main economic activity, source of income), reasons for displacement, arrival time, place of residence, occupation after displacement, assessment of vegetation situation cover before and after displacement, as well as source and uses of forest resources (building materials, fuel, fodder, marketing).

5.2 Resource Inventory

Elgeneina town was considered as a centre of a fictitious circle with 10 km radius. Eight adjacent transects 45^0 apart from each other were made from a central point in the town. With the help of the Geographical Positioning System (GPS), circular sample plots of 1000 m^2 area were located 1 km apart along each transect (Figure 3). Measurements made in each sample plot were pertaining to assessment of natural vegetation, counting tree stumps, in addition to estimating survival and mortality rates of vegetation cover. Moreover, a resource inventory was done in both Kaja Forest and the Elgeneina Belt; both are three kilometers far from town centre.

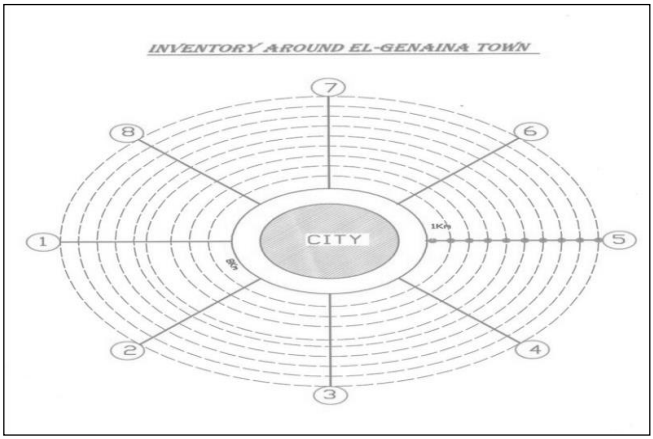


Figure 3: Layout of sample plots for resource inventory, Elgeneina town

6. Results

6.1 Distribution of respondents according to gender, marital status and education level

Gender issue was considered in selection of respondents to achieve objectives of this study. As presented in table 1, male respondents represent the majority (60.6%), while females were 39.4%. Studies on gender assessment can be useful as planning instruments to achieve the desired influence on women, leading to improvement in their position and prospects of life.

Table 1: Distribution of respondents according to gender, marital status, education level

		Gender		Marital status		Education level			
Camps	No	Male	Female	Married	Single	University	Second.	Basic	Illiterate or khalwa
Ardamata	293	58.5		78.2		7.8	13.0	22.0	55.0
Durty	22	95.5		86.4		4.5	4.5	22.7	68.0
Abuzar	55	61.8		85.5		164.	16.4	18.0	63.0
Zalinge	21	52.0		81.0		4.8	4.0	42.0	52.3
Kerindun	20	55.0		95.0		15	15.0	25.0	55.0
Total %	411	60.6	39.4	80.5	19.5	6.3	12.7	22.1	57.9

As far as marital status of respondents is concerned, the majority of respondents (80.5%) were found to be married (table 1). The marital status is directly affecting the household family size and in turns the consumption of forest products. The educational level could be used as a monitor to detect the possibility of creating changes in attitudes and raising awareness of target groups for the sake of conserving the environment. About 57.9% of the interviewed people were either illiterate or enrolled to *khalwa* (traditional Quran school) level of education; while 22.1% pursued their education to preliminary level, i.e. about 80% of the respondents have not had the chance to follow their education beyond the preliminary level. About 12.7% have studies up to secondary level. Only a small proportion of respondents

(6.5%) had the chance to pursue their education to university level (Table 1).

The general characteristics (gender, marital status, education level, etc…) of the respondents are of great importance and can be used as efficient tools for forecasting population growth and the success of the extension programs in mobilizing and sensitizing local communities to protect their environment.

6.2 History and causes of displacement and sites for settlement

In addition to inquiries about the history and sites for settlement in the study area, the respondents mentioned some factors responsible for their displacement and residence in sites other than homes of origin (Table 2).

Table 2: History and reasons of displacement and sites of settlement

Camps	No.	Displacement date			Displacement reasons	Settlement site		
		Before 2003	2003	2004	Conflict	Forests	Open yard	Shelter
Ardamata	293	8.1	51.5	43.0	97.3	54.3	16.7	29.0
Durtey	22	0	36.4	63.0	100	27.0	9.1	63.6
Abuzar	55	0	20.0	80.0	100	40.0	32.7	27.0
Zalinge	21	0	66.7	33.3	100	47.0	33.3	19.1
Kerindun	20	0	35.0	65.0	100	35.0	25.0	40.0
Total %	**411**	**3.8**	**46.5**	**49.6**	**98.1**	**49.6**	**19.7**	**30.7**

It seems that the process of displacement has started even before 2003, but the percentage of internally displaced persons was very low (3.8%). The year 2003 witnessed a sharp increase in the number of displaced persons (46.5%). The displacement phenomenon reached its climax in the year 2004 where the camps received almost half of the displaced persons. Irrespective of the year of displacement, the bulk of the respondents (98.1%) attributed their movement to the tribal conflict in the study area. Only few

respondents making 1.9% emphasized the role of frequent drought cycles as a major cause behind their displacement. This finding was coming in line with the conclusions reached by Chen (2006). The relief organizations have estimated people in displacement camps in western Sudan since 2003 to be around two million persons, whereas between two and three hundred thousands were killed. The reasons for such humanitarian crises were very complex and have stemmed from the ethnic and religious differences encountered in the region (Waal, 2004 and Hoile, 2005).

The entire interviewed sample assured that they had even no specific destination when they decided to leave their original home lands; the one and only goal was to escape the clash theatre. A considerable portion (49.6%) of the displaced people settled in or nearby the forests in the study area, where forests usually provide them with both a free shelter and the products necessary for energy and construction. About 19.7% of the respondents settled in open sites or yards (wild land) without any protection at least for the first days of their arrival before joining displacement camps. The rest of the respondents (30.7%) were used to reside in shelter sites constructed using forest products, which practice that was confirmed by the Forests National Corporation (FNC, 2003), clarifying that some people were reported to flee their villages to the forest east of Kaja.

6.3 Sources of income

Having known the income sources of the respondents, it would contribute to improve the quality of development programs designed and provided in time suitable for target stakeholders. Moreover, diversification of income sources of people in the region would add to reducing the competition for natural resources and in turn limiting conflicts. Figure (4) illustrates income generating activities of respondents in the study area before and after displacement.

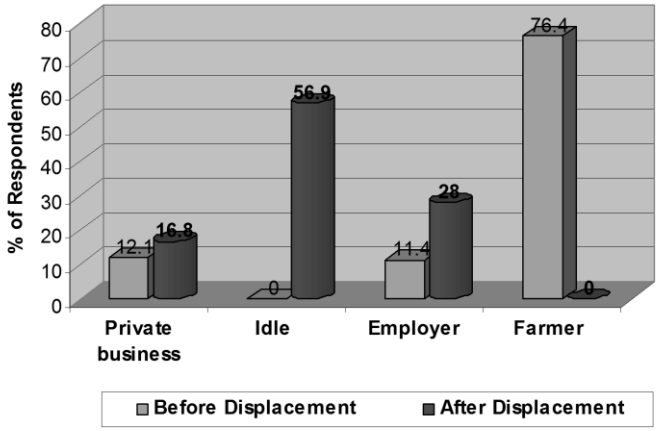


Figure 4: Income sources of respondents in the study area

Before fleeing homes of origin to live in displacement camps, the majority of the3 respondents (76.4%) were relying on farming as the main source of income, and only few people making 12.1% of the sample were reported to rely on private business for income generation. The rest of the respondents (11.4%) were employees either in public governmental institutions or in the private sector, mainly the NGOs. After displacement, more than half of the interviewed displaced persons making about 56.9% have become idle and used to receive aids provided by the relief organizations. The percentage of the community members that were used to depend on the private business for their income has somewhat increased to 16.8% compared to 12.1% before displacement. Moreover, the group of the employees has relatively increased to 28%, almost due to the influx of NGOs at the camps area. Such a situation affected negatively the development process in the study as has been clearly stated by Young *et.al.* (2005).

6.4 Uses of trees as by internally displaced persons in the study area

As has been personally observed and confirmed by the respondent interviewees, forests were heavily felled and used for many purposes (Figure 5). Tree cutting for fuel wood was ranking first as stated by the majority of people (57.2%). It is worth mentioning that fuel wood is the main source of energy in the study area, particularly in the rural parts, where other energy substitutes are not available. Some residents were even reported to dig out tree to be used for fuel. As well, a considerable number of respondents making 36.5% of the sample asserted that they rely on the tree cover for provision of round timber necessary for house construction. This result agreed with the USAID (2008) report emphasizing that internally displaced persons resident in settlement camps used to build their houses using a variety of construction materials, mainly forest products in addition to other supportive materials. Very few respondents making only 5.1% of the sample were reported to rely on trading forest products (in form of charcoal, fire wood and building poles) for income generation. The FNC (2008) has paid attention to such destructive activities near the camps prepared for internally displaced communities, where large forest areas were heavily subjected to continuous illegal felling primarily for wood trading. USAID (2008) stated that before the arrival of the internally displaced persons to the camps prepared for them, the natural resource situation around the camping are, particularly tree cover, was very satisfactorily. Nevertheless, for security concerns, the displaced persons were reluctant to collect firewood far away from camping sites, and they even resorted to cutting green trees and shrubs from reserved and natural forests to be used as material for cooking or trading after having been dried.

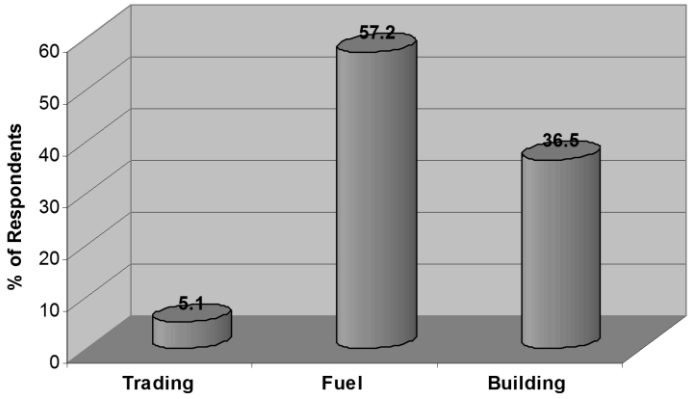


Figure 5: Uses of trees as by internally displaced persons in the study area

The USAID (2008) also noted that internally displaced persons were very much involved in harvesting trees to supply the brick making industry with huge amounts of fuel wood and to providing firewood or making charcoal for commercial purposes. Such income-earning activities could be very hazardous and contribute to depletion of tree vegetation cover and might be dangerous to men who might sometimes leave their resident camps to collect fuel wood from remote insecure areas threatened by armed groups living there (UNEP 2008).

6.5 Sources of energy

Like other rural communities in developing countries, people in the study area depend on fuel wood as a main source of energy (Table 3).

Table 3: Sources of energy and wood collection in the study area

Camps	No.	Energy source			Collectors	
		Conservation forest	Natural forest	Market	Women	Men
Ardamata	293	6.5	70.6	22.9	86.7	11.3
Durtey	22	9.1	81.8	9.1	86.4	13.6
Abuzar	55	0.0	67.3	32.3	85.5	14.5
Zalinga un	21	14.3	52.4	33.3	95.2	4.8
Kerndun2	20	5.0	85.0	10.0	80.0	20.0
Total %	**411**	**6.1**	**70.6**	**23.4**	**86.6**	**11.9**

The bulk of the displaced community members interviewed stated that they collect firewood from the forest areas; 70.6% were used to get their wood needs from natural forests, while 6.1% collect the firewood from reserved forests. The rest of the respondents (23.4%) obtain firewood and charcoal from markets in the area. There is still great pressure on the vegetation cover in the study area, and the situation would be much worse when displaced people sometimes in urgent cases have been pushed to fell even green trees to satisfy their energy needs. Firewood collectors might walk long distances (5 – 9 km) taking often several hours to get fuel wood from surrounding areas, or even they would resort to digging the extremely hard clay soil for pieces of tree roots (WCRWCH, 2006). The females, mainly old women and even girls were found to be the main wood collectors (86.6%) used to leaving the camps in small groups roaming in different directions, which case is very dangerous for them as they are the prime victims for mass rape and sexual assault. Therefore, various UN agencies and non-governmental organizations have tried to implement a variety of strategies aiming at protecting women and girls collecting firewood in notoriously unsafe environment surrounding the displacement camps (WCRWCH, 2006).

6.6 Consumption patterns of energy

An attempt was made to identify the consumption patterns of fuel wood in displacement camps (Figure 6).

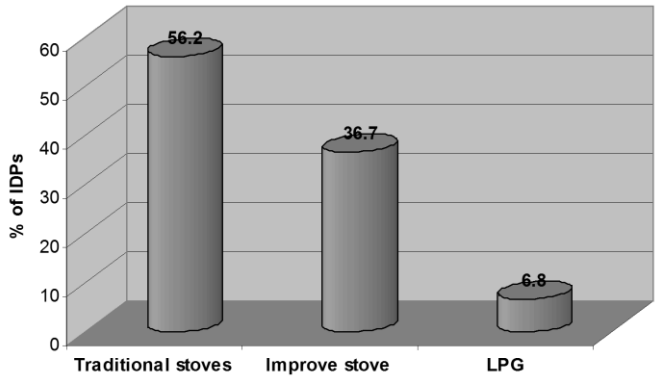


Figure 6: Types of cooking stoves used by internally displaced persons at the study area

Traditional stoves; metal sheet or 3-stone stove have been identified to be the main tools used by the majority (56.2%) of the respondents for cooking and other household purposes. It is an indication of consuming large quantities of fuel wood for provision of energy. However, improved stoves have been used by a considerable number of displaced persons making 36.7% of the sample (Figure 6; Plate 1). Relatively a small segment of interviewees (6.8%) could be able to bring their liquid petroleum gas (LPG) appliances and cylinders with them; hence they depend on the LPG as the main source for energy.

Figure 7: Types of improved stoves used in the study area

The LPG is portable, clean, safe and extremely efficient in generating heat; having explaining such characteristics and demonstrating the value of LPG to households in providing more efficient and hygienic fuel, it would be an appreciable contribution to better quality of life style in rural areas (Jenny 2002; Magzoub 2006).

6.7 Resource inventory: dominant trees and shrubs in the study area

As a summery to the results of the field survey for the resource inventory of the vegetation cover at the areas inhabited by the internally displaced persons around Elgeneina town, Table (4) shows the total number of trees/shrubs along the different transects (survey lines), average number of trees/shrubs per sample plot and the dominant trees and their percentages. The total number of trees and shrubs reported in the eight survey lines was estimated to be about 3645 with an average of 46 trees/sample plot. The two species *Calotropis procera* and *Boscia senegalensis* were the most dominant with an overall number of 1649 representing 35%, and 2856 representing 61.18% of the whole vegetation cover for both species respectively.

From the previous findings, it is clear that the most important trees and shrubs according to their preference for domestic uses by the internally displaced communities have been no longer dominant or even not existing in some places around Elgeneina town; the capital of the state. Instead, less preferable species mainly *Calotropis procera* and *Boscia senegalensis* were reported to have dominance, which is an indication of retrogression in plant succession in the study area. The picture was almost similar in Kaja Forest, where number of trees per survey line was relatively low and in some survey lines there was no even a single tree.

Table 4: Dominant trees and shrubs in the study area

Survey line	No. of trees	*Average trees & shrubs/sample plot*	Dominant trees/shrubs	Total No.	(%)	Overall %
1	773	*77.3*	***Calotropis procera*** ***Boscia senegalensis***	414 359	53.1 45.8	**35%** **61%**
2	707	*70.7*	*Calotropis procera* *Boscia senegalensis*	435 272	60.7 38	
3	661	*66.1*	*Boscia senegalensis* *Calotropis procera*	444 217	65.5 31.8	
4	553	*55.3*	*Boscia senegalensis* *Calotropis procera*	480 73	74.7 11.4	
5	481	*48.1*	*Calotropis procera* *Boscia senegalensis*	239 242	47.7 48.3	
6	878	*87.8*	*Boscia senegalensis* *Calotropis procera*	607 271	62.4 27.9	
7	259	*25.9*	*Boscia senegalensis* Ghibaish	176 83	45 20.7	
8	323	*32.3*	*Boscia senegalensis* Ghibaish	276 47	76.3 12.1	

6.8 Estimation and quantification of forest damage in Elgeneina Locality

It has been observed that forest destruction and consequent loss in forest benefits caused by the internally displaced persons in the different forest circles of the West Darfur State was higher in the natural forests followed by the reserved forests and forests at basins. Elgeneina Locality has been ranking first with regard to such damage of the tree cover among other forest circles of the state (WDSP 2005). Osman (2005) has made an attempt to estimate the total loss of forest benefits in Elgeneina Locality in monetary terms as 177656490 SDG which is equivalent to $ 39479220. As shown in Table (5), the

present study has estimated the annual destruction of forest cover in the study area as 25.2 hectares which is equal to 379,673,390 SDG, equivalent to $ 457,438.

Table 5: Estimated and quantified damage of reserved forests in Elgeneina Locality

Forests	Area (feddan)	% of damage	No. of trees per feddan	Total damage (SDG)
Shargey kaja	15000	50	77	8662500
EL Genina belte	1100	40	51	336600
Morin	17000	90	26	3978000
Umdarrabrero	122	25	105	42840
Azerni	1850	50	77	712250
Rahat elgrad	15000	40	51	3060000
Mangarsa	600	30	64	115200
Jebel koglong	135000	60	26	21060000
Total	**185672**	**48**	**60**	**379673390**
			25.2 Ha	**457438 $**

6.9 Involvement of internally displaced persons in afforestation programs

Form the results presented in Table (6), it is clear that there is a possibility to secure participation of internally displaced people in tree planting activities. A significant proportion (69.8%) of the respondents was appreciating the efforts made to involve displaced communities in afforestation activities in the camps. About 53.3% of the respondents already participated in the afforestation programs. As far as the assessment of the afforestation program is concerned, the interviewed persons had different opinions and assessed the forestation programs quite differently. About 48.8% assessed the program as good or fair, while 19.5% assessed it as poor and only 13.4% assessed the program as excellent.

Table 6: Involvement of internally displaced persons in afforestation programs

Camps	No.	Afforestation programs		Assessment of tree cover		
		Appreciating efforts	Participation	Excellent	Fair	Poor
Ardamata	293	71.3	56	31.1	46.8	21.8
Durtey	22	90.9	72.7	36.4	45.5	18.2
Abuzar	55	67	43	36.4	58.2	5.5
Zalinga un	21	4.8	0	38.1	52.4	9.5
Karendun2	20	100	35	10	55	35
Total %	**411**	**69.8**	**53.3**	**13.4**	**48.8**	**19.5**

7. Recommendations

- Importance of integrated land use planning that addresses needs of different stakeholders as an attempt to escape conflicts that arise due to competition for natural resources.
- Strategic plan for forestry is needed to assess and manage resources in the humanitarian and recovery contexts.
- Encouragement of internally displaced persons to participat in rehabilitation of degraded environment should be tackled through exploiting ample leisure time of such groups.
- Adoption of energy conservation alternatives like LPG and improved stoves would reduce pressure on the vegetation cover in the study area.

Figure 8: Damage of vegetation cover and illicit tree felling around Elgeneina town and inventoried sites

Figure 9: Soil degradation around Elgeneina town and inventoried forests

References

Ayoub, Muna M. (2001) Conflicts between farmers and pastoralists at West Darfur State and challenges for peaceful livelihood in Darfur (Arabic). Peace and Development Studies Centre. Khartoum, Sudan.

Bentley, W.R. (1982) Forestry research education and extension in India. Paper prepared for the Asia society. FAO, Rome.

Burchinal, L.S. (1986) Lecture Notes and steps in conducting a survey. Working paper presented at the annual forestry extension workshop on the methodologies and techniques in conducting forestry extension program in Sudan.

Chen, Allan, (2006) Civil war in the Sudan hasmade the Darfur area into one of the largest refuges zone in the world. a_chen@lbl.gov.

DRC and Uni. Zalingia, Darfur Region Commission and University of Zalingia (2008). Status of woody biomass in selected areas of eastern West Darfur State (unpublished).

FAO (1985) Monitoring and evaluation of participatory forest projects. FAO forestry paper. (60) –Rome, Italy.

FAO (2012) The land cover atlas of Sudan, FAO, Rome. March 2012.

FNC Forests National Corporation (2008) Pamphlets of the National Tree Festival (45) at West Darfur State (Arabic). FNC, West Darfur State, Sudan.

Gaballa, A.G. (2009) Environmental and social impact of conflict in West Darfur State. A thesis submitted to the University of Khartoum, in fulfillment of the requirements for the degree of M.Sc. in environmental studies, Khartoum, Sudan.

Hoile, David (2005) The European Sudanese Public Affairs Council working for peace in Sudan, Darfur in perspective- PA GE(1).

Jenny, Clover (2002) Situation report: refugees and internally displaced people are in Africa.

Magzoub, M. (2006) Personal communication with country director of the Practical Action-Sudan.

MAARWDS (2006) Ministry of Agriculture and Animal Resources, West Darfur State. Report, 2006.

Osman, A. A. (2005) Estimation of forest losses due to civil war in West Darfur State (Arabic). FNC, West Darfur State, Sudan.

OXFAM (2001) Socio- economical study in Elgeneina, Habila, Kulbus Province - West Darfur.

Salah, Shazali and Gahffao, A.M.A. (1999) Pastoral land tenure and agricultural expansion: Sudan and Horn of Afirca.

UNEP United Nations Environment Program (2008) Destitution, distortion and deforestation .The impact of conflict on the timber and wood fuel trade in Darfur.

USAID, (2008) Fuel-efficient stove programs in settings of internally displaced persons, summary evaluation report. Darfur- Sudan.

Waal, Alex de (2004) Tragedy in Darfur: On understanding and ending the Horror", Boston Review, Volume 29, Number 5.

WCRWCH Women's Commission for Refugee Women and Children, (2006) Finding Trees in desert firewood collection and alternatives in Darfur.

WDSP (2005) West Darfur State Performance (2005).

Young, H. Osman, A. Aklilu, Y. and DaleFeinstein, Rebecca (2005) Darfur livelihoods under siege. Executive summary and recommendations draft. Ahfad University &Tufts University, 2005. International Famine Center, Babiker Badri. Omdurman-Sudan- A 95053, USA.

Managing of Gullying by Shelter-Belts

Fritz Haubold[*]

Technische Universität Dresden, Department of Geography, Germany

Abstract

Since ancient times soil erosion has affected the Ethiopian highlands and many attempts were made to slow down or to stop it. Some of it were successful but many were in vain. Out of all kinds of soil erosion gullying is the most serious. In its extended form it not only acts as a guide rail for the surface runoff but it even cuts a particular landscape into pieces.

Adaptation and mitigation are the most common strategies to diminish the denudation. Among the different soil and water conservation measures the construction of shelter-belts alongside the gullies could be a useful approach of mitigation. In case of planting fruit trees it provides the shelter-belts with a certain socioeconomic value as well as it fixes the soil mantle and thus it kills two birds with one stone. The main aim of the project is to provide suggestions for improving soil conservation practices in the field.

Keywords: soil erosion, gully, shelter-belt, fruit tree

[*] Corresponding author: Fritz.Haubold@tu-dresden.de

1. Introduction

According to Field et al. agriculture as an economic sector is most vulnerable and most exposed to climate extremes in Africa (IPCC 2012). It contributes approximately 50 % to Africa's total export value and approximately 21 % of its total GDP. In particular, with an inefficient agriculture industry, sub-Saharan Africa is extremely vulnerable to climate extremes. But then, how much can agriculture and forestry contribute to controlling climate change?

Agricultural soils and crops and forest represent enormous reservoirs of CO_2, in the form of organic matter and wood (absorbing CO_2 in vegetation and soils is called 'sequestration'). Soils represent the largest terrestrial stock of C, holding approximately twice the amount held in the atmosphere and three times the amount held in terrestrial vegetation. Thus a major part of the economic potential for greenhouse gas mitigation in agriculture comes from increasing soil carbon reservoirs. Due to relatively high rates of both primary productivity and decomposition soils in Ethiopia have in general intermediate levels of soil organic carbon (SOC). Soil organic carbon levels are directly related to the amount of organic matter contained in soil and SOC is often how organic matter is measured in soils (Ontl & Schulte 2012).Below forests and plantations, respectively, in Ethiopia according to Freier et al. (2010) it accounts from 18,6 to 23,5 kg m^{-3}.

Soil erosion, probably the oldest environmental problem in Ethiopia, is completely the opposite picture to that for sequestration. The most important present-day geomorphic processes are sheet and rill erosion throughout the country, gullying in the highlands, and wind erosion in the Rift Valley and the peripheral lowlands. Gullying, one of the most serious forms of soil erosion of cropland is characterized by the formation of narrow, steep-sided channels etched by rivulets or small streams of water. The effective soil depth in Ethiopia is estimated anywhere between 20 to 59 cm, depending on the area. The loss of soil depth is estimated around 4 mm per year,

outstripping the rate of soil formation estimated at no more than 0.25 mm per year in Africa (Nyssen et al. 2004).

At present soil erosion in Ethiopia accounts to average rates of soil loss from 11 to 30 t ha^{-1} yr^{-1} (Moges & Holden, 2008) which accumulates to 1.5 billion tons of top soil each year. For comparison: the average rate of soil loss in undisturbed forests accounts to 0,004 to 0,05t ha^{-1} yr^{-1}. Based on the above mentioned average storage of 20 kg SOC m^{-3}it adds up to a total loss of 30 million tons SOCyr^{-1}. In other words a loss of soil produces a loss of soil organic matter and finally results in decline of soil fertility. Thus the soil is not only losing its effect of a carbon sink and of a store for water and nutrients but its ecosystem service. To curb soil erosion is a decisive tool of adaptation and/or controlling climate change. If such a loss of soil continues unabated, Ethiopia could lose nearly all of its top soil in about 100 to 150 years (Nyssen et al. 2004).

2. Sustainable land management (SLM) and gullying

Among the reasons for poor agricultural development, there have been constraints associated with certain strategies. In spite of the many efforts that have been made in Ethiopia to cope with land degradation, the reality is that soil and water conservation (SWC) technologies have not been widely adopted by smallholders in Ethiopia or many other countries. For many years technical soundness and environmental factors have provided the only guiding principles for government and donors…The limited success of soil conservation programmes in Ethiopia in the past was largely a result of the “top down” approach to design and implementation. Many farmers were compelled to participate in the food-for-work conservation programmes implemented in the 1980s and consequently failed to maintain the physical structures adequately (Kassie et al. 2009).

Recent studies (Worku et al. 2012; Yihenew et al. 2009) have shown the emergence of success cases of rain-fed agriculture in Ethiopia, which are transforming the lives of many poor farmers. Innovative and indigenous technologies have been applied to achieve improved yields. These have involved a wide diversity of interventions, ranging from integrated soil fertility management, soil and water conservation, rainwater and runoff harvesting systems, integrated pest management, tillage and soil management systems, improved seeds, and innovative agronomic practices.

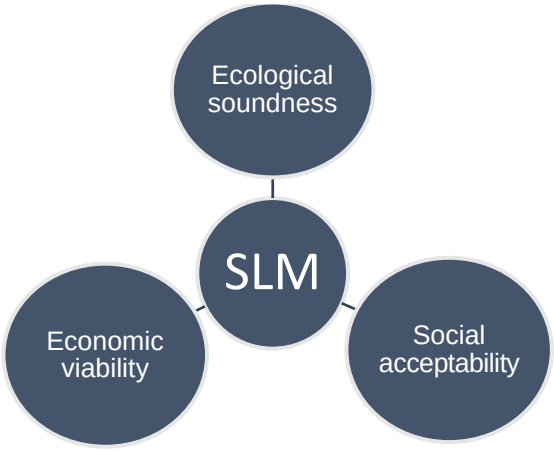
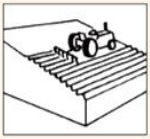
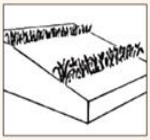


Figure 1: The broader approach of sustainable land management

There are quite a big number of publications on land management and gully control (Desta & Adugna, 2012; Geyik, 1986, Liniger et al., 2011, etc.). A remarkable review in this area is the volume from Mitiku et al. (2006).The main idea of the volume is a so-called broader approach of sustainable land management that aims at ecological soundness, economic viability and social acceptability (ibid.) (Figure 1). Sustainable Land Management is defined as: 'the adoption of land use systems that, through appropriate management practices, enables land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources' (Liniger et al., 2011). The measures for prevention, mitigation and rehabilitation of land degradation and restoration of ecosystems services can be classified into four categories whereas any combinations of the measures are possible (ibid.) (Figure 2).

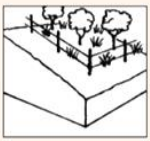


Agronomic measures: measures that improve soil cover (e.g. green cover, mulch); measures that enhance organic matter / soil fertility (e.g. manuring); soil surface treatment (e.g. conservation tillage); subsurface treatment (e.g. deep ripping).



Vegetative measures: plantation / reseeding of tree and shrub species (e.g. live fences; tree crows), grasses and perennial herbaceous plants (e.g. grass strips).

Structural measures: terraces (bench, forward / backward sloping); bunds banks / level, graded); dams, pans; ditches (level, graded); walls, barriers, palisades.



Management measures: change of land use type (e.g. area enclosure); change of management / intensity level (e.g. from grazing to cut-and-carry); major change in timing of activities; control / change of species composition.

Figure 2: Categories of SLM Measures (Liniger et al., 2011)

Due to the general stage of land degradation in Ethiopia SLM interventions mostly aim at mitigation of land degradation or rehabilitation of already degraded land, whereas the latter one is more on focus here. Rehabilitation is particularly addressed to land degradation caused by gullying processes.

3. SLM and social acceptability

A broader approach in general should meet all requirements. That means it should indicate not only new ways in land management but also aspects of changing environments. In case of the scientific cooperation network concerned it suggests adaptation of soil and water conservation to climate change. The point is what is it like with the psychology of changes and adapting to it? The short story on an old farmer from Tanzania in the Special Report of the IPCC (2012) suggests there is no doubt about that life is change (Box 1).

Box 1

Joseph is 80 years old. He and his father and his grandfather have witnessed many changes. Their homes have shifted back and forth from the steep slopes of the South Pare Mountains at 1,500 m to the plains 20 km away, near the Pangani River at 600 m, in Tanzania.

What do 'changes' mean to someone whose father saw the Germans and British fight during the First World War and whose grandfather defended against Maasai cattle raids when Victoria was still Queen?

Joseph outlived the British time. He saw African Socialism come and go after Independence. A road was constructed parallel to the old German rail line. Successions of commercial crops were dominant during his long life, some grown in the lowlands on plantations (sisal, kapok, and sugar), and some in the mountains (coffee, cardamom, ginger). He has seen staple foods change as

maize became more popular than cassava and bananas. Land cover has also changed. Forest retreated, but new trees were grown on farms. Pasture grasses changed as the government banned seasonal burning. The Pangani River was dammed, and the electricity company decides how much water people can take for irrigation. Hospitals and schools have been built. Insecticide-treated bed nets recently arrived for the children and pregnant mothers.

Joseph has nine plots of land at different altitudes spanning the distance from mountain to plain, and he keeps in touch with his children who work them by mobile phone. What is 'climate change' to Joseph? He has suffered and benefited from many changes. He has lived through many droughts with periods of hunger, witnessed floods, and also seen landslides in the mountains.

He is skilled at seizing opportunities from changes – small and large: Change is better than resting.

The crux of the broader approach of SLM is the social acceptability. For example, the World Food Programme noted that the limited success of soil conservation programmes in Ethiopia in the past was largely a result of the "top down" approach (Kassie et al., 2009). There are quite a big number of factors that contribute to the acceptability of SWC (Figure 3).Generally it first of all applies to the households' choice of livelihoods. This requires that experts focus less on searching for standard solutions valid once and for all, and more on engaging in a continuous process of developing and adapting technologies with farmers (Mitiku et al., 2006).

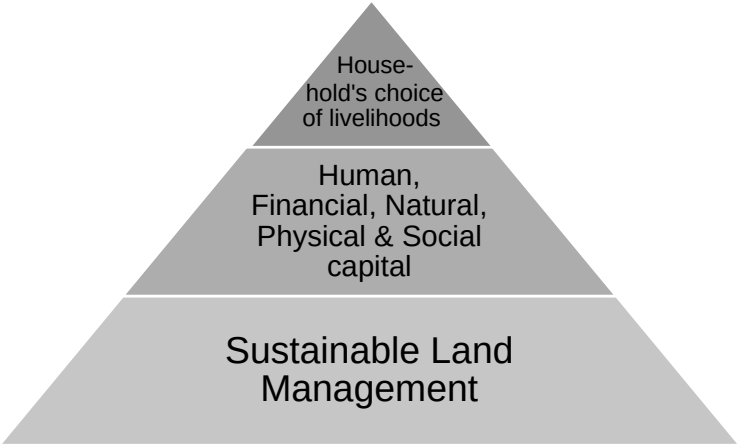


Figure 3: Factors influencing the social acceptability of land management

Other studies show similar constraints associated with the adoption of SWC measures, as there are (i) farmers' perception of soil erosion problem,(ii) family size,(iii) number of economically active family members,(iv) wealth status of the farmer,(v) farm size, and (vi)technology attributes (Genene & Wagayehu, 2010). Hence in overpopulated areas soil conservation technologies, which take some land out of production, like construction of soil conservation structures, have little chance of acceptance by farmers. So, for example, in the Gununo catchment three out of for farmers removed the soil conservation structures, half of them partially and half of them totally, mostly due to technology attributes and shortage of farmland (Tadesse & Belay, 2004). Thus the economic viability is a key to all measures of SLM. There would be little importance attached to SLM - and its uptake - if the livelihoods of millions were not at stake. Despite the constraints and problems land users have, they are willing to adopt SLM practices that provide them with higher net returns, lower risks or a combination of both (Liniger et al., 2011).

In the study area related many attempts of gully control on cropland have been made by farmers with different success. The area is located

near the town of Aje, about 35 km west of the city of Shashamene, East Shewa, Oromiya, Ethiopia. The catchment area of the gully portions is located partly on rolling land and partly in nearly-flat areas.

4. SLM and ecological soundness

In terms of soil erosion gullying seems to be the most serious problem in mountainous areas. Causes of gullying can be manifold but are generally known. Buried soils testify deforestation, which might have started around 5000 14C years BP in the Ethiopian highlands (Figure4). Since the 20th century, vegetation removal, however, concerns also shrubs and small trees, as well as grass strips in between the fields and on steep slopes. This lowers the infiltration capacity of the soil, favours the occurrence of flash floods and is estimated to be the major cause of rapid gullying in many areas (Mitiku et al., 2006).

Figure 4: Gully erosion near Aje, East Shewa, Oromiya, Ethiopia

A broader approach also implies the principle ‘prevention is better than cure'. According to Poesen et al. (2003) it could start with a survey on

What are efficient gully prevention and gully control measures?

What can be learned from failures and successes of gully erosion control programmes?

Depending on the state of degradation there are four basic strategies of SLM, i.e. prevention, mitigation, rehabilitation and no intervention (Figure 5). They determine the economic viability and are a trigger for the gully control measures.

On the other hand the selection of control measures is also depending on the gully type. One way of classifying gullies is based on the duration into ephemeral and permanent gullies (ibid.).Ephemeral gullies are incised channels that are typically wiped out by tillage or ploughing and the gully re-forms in the subsequent year. Though management practices focus on both the ephemeral and the permanent gullies the latter type is the basic treatment unit for gully control here. Permanent gullies, because of their high grade of degradation, demand rehabilitation and thus extensive and comprehensive measures. They should include the following three strategies in order of priority:

a) Improvement of gully catchments to reduce and regulate the run-off volume and peak rates,
b) Diversion of runoff water upstream of the gully area,
c) Stabilization of gullies by structural measures and accompanying revegetation (Desta & Adugna, 2012).

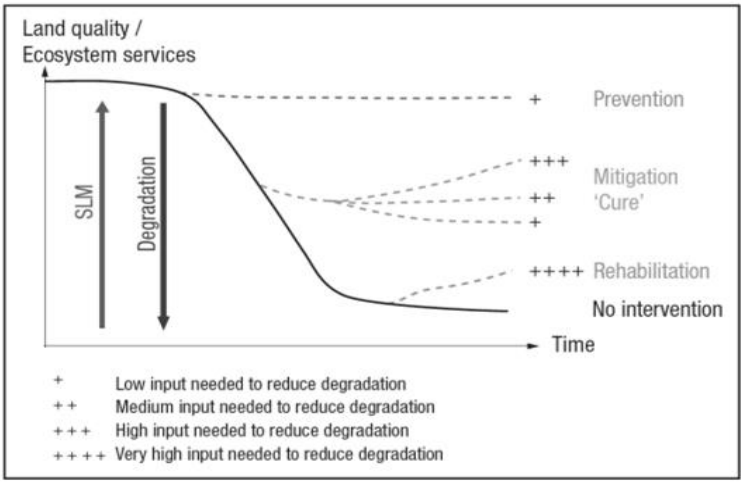


Figure 5: Strategies of SLM depending on the grade of land degradation (Liniger et al., 2011).

Apart from a large variety of structural measures such as brush fills, bunds, check dams, etc. only a few aspects with regard to the latter strategy of the stabilization of gullies and revegetation will be discussed in this paper. In more or less devastated areas with deeply incised gullies, where rehabilitation is a must, the concept of so-called shelter belts or riparian buffers offers an important contribution to the measures of stabilization. The term riparian buffer originally is used to describe lands adjacent to streams where vegetation is strongly influenced by the presence of water (Figure 6). They are often thinlines-of-green containing native grasses, flowers, shrubs and trees that line the stream banks. They are also called vegetated buffer zones, life barriers or life fences. A healthy riparian area is evidence of wise land use management. Riparian forest buffers in the agricultural landscape can take numerous forms, for example as an agroforestry practice (Schultz et al., 2004).

The idea to transfer the concept of riparian buffers to the management of gullies is not completely new. First attempts started

already in the nineteen-eighties (Geyik, 1986). But the present situation in SLM suggests putting it on the agenda continuously. To manage shelter belts in a manner of agroforestry would make it profitable. Agroforestry development is potentially the most promising approach to meet the enormous demands for fuel wood, construction and other basic needs of the rural communities as well as the conservation of land resources. In this effort, it is fundamental to select multi-purpose trees that are fast growing, fit into the mixed farming system and bring micro-climatic benefits in stabilizing soils and the environment (Deena, 2003). Problems that may arise from certain characteristics of the plants of the riparian vegetation could be minimized by managing it in a manner of multi-species buffer, consisting of a mixture of indigenous grasses, shrubs and trees. In other words, to combine the economic viability with the ecological soundness makes it even more profitable. Moreover, combinations of measures that lead to integrated soil and water, crop-livestock, fertility and pest managements are promising as they increase both ecosystem- and livelihood-resilience (Liniger et al., 2011).

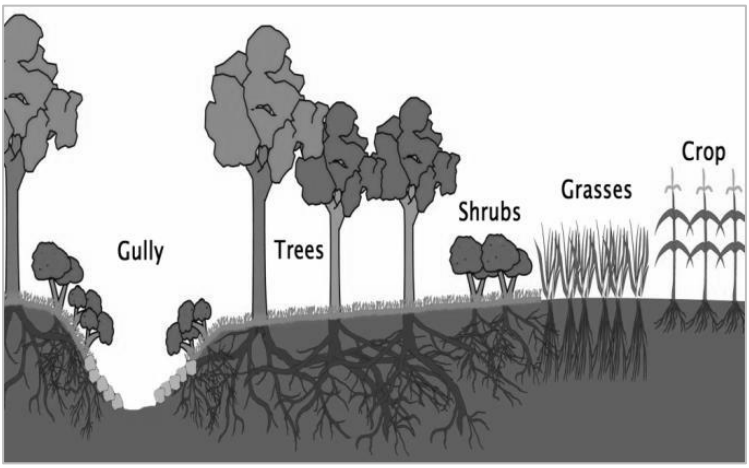


Figure 6: Multispecies riparian buffer
(modified after Schultz, NREM, Iowa State University)

5. SLM and economic viability

Rehabilitation is required when the land is already degraded to such an extent that the original use is no longer possible, and land has become practically unproductive and the ecosystem seriously disturbed. Rehabilitation usually implies high investment costs with medium- to long-term benefits (Figure 7) (Liniger et al., 2011).

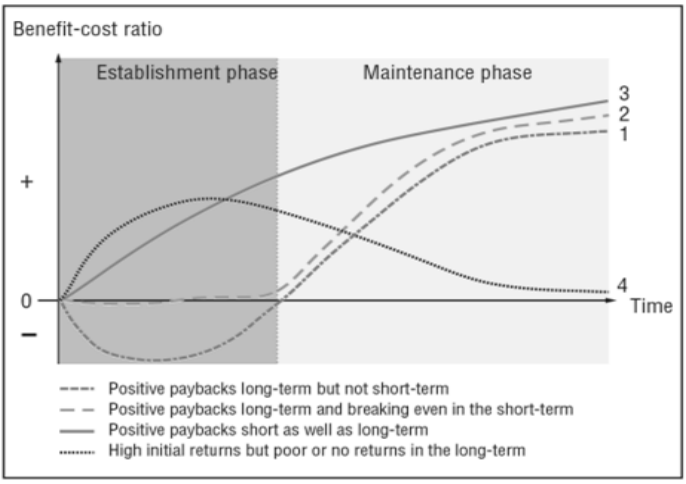


Figure 7: Benefits and costs of SLM over time (Liniger et al., 2011)

1) Long-term but not short-term: many land users might be constrained thus might need a kick-start where the establishment costs are partly funded by aid and external sources.
2) Long-term and breaking even in the short-term: thus increased benefits but also higher inputs.
3) Short as well as long-term: This is the ideal case, where land users receive rewards right from the beginning.
4) High initial returns but poor or no returns in the long-term: These options are tempting for land users but will lose attractiveness in the long-run as the returns are not sustained.

Major efforts and investments have been made in the implementation of structural measures. They are conspicuous in showing efforts made towards SLM. However they are input intensive and often could be substituted by less demanding agronomic, vegetative and management measures. As a rule of thumb priority should be given first to agronomic and/or vegetative measures with as little outside input as possible and only then apply structural measure if the 'cheaper' options are not adequate. In addition, structural measures should be combined as much as possible with vegetative or agronomic measures to protect the structures and make them directly productive (e.g. fodder grass on earth bunds). Frequently, measures can be implemented together, combining different functions and creating synergies (ibid.).It is important in order to minimize the constraints associated with the adoption of SWC measures by the farmers. For example a recent study in the northwest highlands of Ethiopia has shown that fanya juu bunds neither increased yields nor complemented other inputs. It is therefore hard to argue that they represent a "win-win" solution to the problem of soil erosion. Furthermore, farmers have voiced serious objections to bunds. For example, farmers have been concerned about water logging and have also complained about loss of planting area because the bunds reduced cultivable area by 8-20 percent (Kassie et al., 2009).

A study in the Gununo watershed, Southern Ethiopia presents relevant results (Figure8). Among the bund stabilizers, farmers preferred elephant grass for its adaptability and performance on the soil bunds. Elephant grass showed very good establishment (90%) and performance (Mazengia & Mowo, 2012).

Criteria	Banana	Elephant grass
Establishment	Poor (50%)	Very good (90%)
Growth	Grows slow and exposes soil bunds to erosion for long period	Grows fast and protects soil bunds from erosion relatively better
Moisture requirement	Requires high moisture and cannot get enough moisture on the bunds	Perform good with low moisture even during dry season
Space requirement	Requires more space and compete with other crops for land, nutrient and light	Requires less space and it competes less with other crops
Relation to pest	Harbor mole rat	Harbor mole rat
No. of harvest per year	Once	20 times
Other benefits		Lessen women burden to collect fodder
Over all compatibility to the system	Low compatible	More compatible

Figure 8: Comparison of two soil bund stabilizers using farmers' criteria (Mazengia & Mowo, 2012)

The challenge of gully stabilization goes much more behind the problem of bund stabilization. As noted, it demands multispecies riparian buffers consisting of grass, shrub, and tree components that are appropriate to addressing the many processes that contribute to gully network integration (Ohde, 2011). A good framework to select suitable plant species was given by De Baets et al. (2009). For this purpose, four main criteria were determined, i.e. (1) the potential of plants to prevent incision by concentrated flow erosion, (2) the potential of plants to improve slope stability, (3) the resistance of plants to bending by water flow and (4) the ability of plants to trap sediments and organic debris (ibid.).But other than in De Baets' study that was made for the Mediterranean region in countries like Ethiopia the selection of plants depends much more on the benefit-cost-ratio.

However, the combination of measures (biophysical approach) is the best solution for effective gully control and for productive use of the gully area. The construction of gully physical structures will be followed by the establishment of biological measures (Desta &

Adugna, 2012). In detail a number of biological measures are suggested (Figure 9):

a) Reinforced bundling (or wattle) - a technique where fresh stems of plants are bound together, then horizontally planted (across the gully bed or along the sidewall), and covered by soil.
b) Layering of vegetative material - the horizontal planting of fresh stems of plants across the gully floor or sidewall.
c) Gully bed plantation - the planting of water-loving or moist tolerant trees, shrubs and grasses.
d) Retaining wall with bamboo-mat
e) Planting of trees, shrubs and grasses on gully sidewalls
f) Direct sowing (broadcasting) on gully beds and into cracks on sidewalls
g) Off-Set Plantations
h) The gully offset is the area that extends from the top edge of the gully wall up to five meters away. Adequate stabilization is inevitable to prevent the sideway extension of the gully and further encroachment of arable land (ibid.).

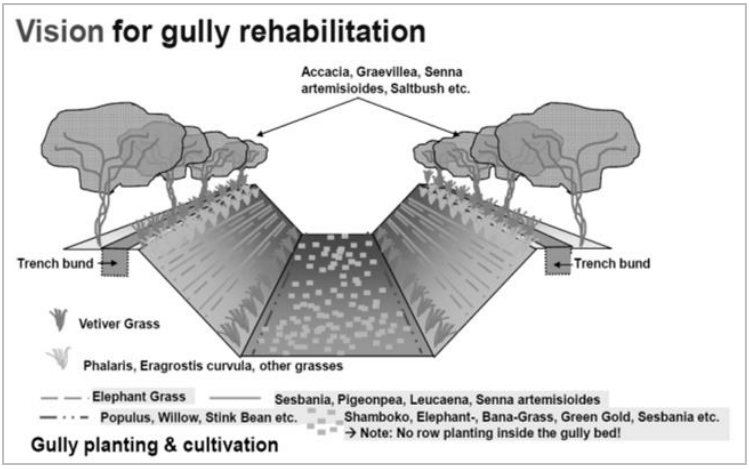


Figure 9: Sustainable gully control (Desta & Adugna, 2012)

There is a lot of studies (Geyik, 1986;Benin et al., 2002; Mitiku et al., 2006; Desta & Adugna, 2012) presenting various species of trees, shrubs, and grasses appropriate for gully revegetation. This list is an abstract and gives only a general idea (Table 1) tcomprises mostly indigenous plants suitable for each zone of the riparian buffer.

Table 1: Tropical and subtropical plants commonly used for gully and erosion control

Trees	Shrubs	Grasses	Legumes
Acacia auriculiformis *Acrocarpus fraxinifolius* *Calliandra calothyrusus* *Cassia spectabilis* *Cordeauxia edulis* *Cordia africana* *Cytisus proliferus* *Dalbergia sissoo* *Eucalyptus robusta* *E. cameldulensis* *E. Saligna* *E. Tereticornis* *Gliricidia sepium* *Gmelina arborea* *Grevillea robusta* *Lagenaria siceraria Leucana leuceceohala Mimusops kummel* *Moringa ruspoliana* *M. stenopetala* *Opuntia* *Passiflora edulis* *Tamarindus indica* *Ziziphus spina-christi*	*Arundinaria intermedia* *Dendrocalamus strictus* *Hibiscus spp.* *Lantana camara* *Moringa longituba* *M. rivae* *Tagasaste* *Tithonia grandis* *T. diversifolia*	*Cynodon dactylon* *Cynodon plectostachyus* *Paspalum spp.* *Pennisetum clandestinum* *P. purpureum* *Vetiveria zizanioides*	*Desmodium intortum* *D. uncinatum* *Stylosanthese guyanensis*

The selection of the plants is based on different criteria, i.e. (i) food/nutritional value, (ii) socioeconomic importance, (iii) availability, (iv) marketability, (v) potential for development through value addition, and (vi) potential for other uses. Whether SWC technologies offer private benefits, social benefits, private and social benefits, or no benefits at all is important for a number of reasons. As noted, bunds therefore actually reduce the area under cultivation by a significant percent. If farmers are to benefit from installing bunds, productivity must not only increase, but must increase by more than is lost by the reductions in cultivation area (Kassie et al., 2009). In our study in the southern highlands of Ethiopia all farmers voted positively towards riparian buffers, but only if they could take advantage of it.Most farmers already implemented different SWC measures. They planted pointier alongside the gullies in order to improve the slope stability (Figure 10). According to Desta & Adugna (2012) the use of vegetative material in gully control offers an inexpensive and permanent protection. Furthermore at present the farmers started with constructional measures such as soil bunds above and check-dams across the gully to stop channel erosion.

Figure 10: Sustainable land management by use of vegetative (left and right) and physical measures (right) in Aje/Southern Ethiopia

Last not least SLM is also a problem of soil fertility. Some indigenous tree leaves are believed to add fertility to the soil. Hence farmers use leaf litter as a mulch to enhance soil fertility. However some species of trees are not welcome on the farm, as it is believed that their roots

suck nutrients from the soil. Therefore leaves of these species are collected from outside and carried to the farm.

6. Conclusion

Sustainable land management is a big challenge. Out of the large variety of factors influencing it the most important are mentioned above. In addition to them there are many others like for instance the problem of land tenure. Without secure tenure rights, farmers and communities have less incentive to manage their lands sustainably because they have no guarantee that they will be able to reap the long term gains of their investments. Furthermore, it is fundamental to select multi-purpose trees that are fast growing, fit into the mixed farming system and bring micro-climatic benefits in stabilizing soils and the environment (Dejene, 2003).It is important to note that sustainable land management will not work at the individual farm level. A „broader approach" is needed in which many different farms cooperate with the surrounding population over a wide area. Experiences have shown that most of the gully rehabilitation efforts are made accidentally without having clear purposes. As a result, it is common to see gullies with a huge biomass but not harvested and after all owners are not known. This has forced the community members into conflict and hence destruction of the whole endeavor. In view of this fact, the identification of gully owners and demarcation of their boundary, development of a management plan and formulating user's agreement (on maintenance and proper utilization of the gully) should come before any treatment effort (Desta & Adugna, 2012). And in the same way sustainable land management will not work without a sound environmental education that should not start at farmer's level but much earlier. If environmental education is based on indigenous as well as on external knowledge it is most promising.

References

Benin, S. Pender, J. and Ehui, S. (ed.) (2002) Policies for sustainable land management in the East African Highlands. Summary of Papers and Proceedings of the Conference held at the United Nations Economic Commission for Africa, Addis Ababa, Ethiopia, April 24-26, 2002, 188 pp.

De Baets, S. Poesen, J. Reubens, B. Muys, B. De Baerdemaeker, J. and Meersmans, J. (2009) Methodological framework to select plant species for controlling rill and gully erosion: application to a Mediterranean ecosystem. Earth Surface Processes and Landforms, Volume 34, Issue 10: 1374–1392.

Dejene, A. (2003) Integrated Natural Resources Management to Enhance Food Security - The Case for Community-Based Approaches in Ethiopia. Environment and Natural Resources Service, Working Paper No. 16, FAO, 48 pp.

Desta, L. Adugna, B. (2012) A field guide on gully prevention and control. In: Nile Basin Initiative, Eastern Nile Subsidiary Action Program (ENSAP). 67 pp.

Freier, K. P. Glaser, B. Zech, W.(2010) Mathematical modeling of soil carbon turnover in natural Podocarpus forest and Eucalyptus plantation in Ethiopia using compound specific δ13C analysis. Global Change Biology (2010) 16: 1487–1502.

Genene, T. & Wagayehu, B. (2010) Farmers' perceptions of land degradation and determinants offood security at Bilate Watershed, Southern Ethiopia. EJAST 1(1): 49-62

Geyik, M. P. (1986) FAO watershed management field manual - Gully control. FAO Conservation Guide 13/2

IPCC (2012) Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)], Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp.

IPCC (2013) Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

Kassie, M. Holden, S. Köhlin, G. Bluffstone, R.(2009) Economics of Soil Conservation Adoption in High-Rainfall Areas of the Ethiopian Highlands. Working Papers in Economics, 400, University of Gothenburg, Sweden, 33 pp.

Liniger, H.P. Mekdaschi Studer, R. Hauert, C. and Gurtner M. (2011) Sustainable Land Management in Practice – Guidelines and Best Practices for Sub-Saharan Africa. TerrAfrica, World Overview of Conservation Approaches and Technologies (WOCAT) and Food and Agriculture Organization of the United Nations (FAO).

Mazengia, W. and Mowo, J. (2012) Role of collective actions in integrated soil and water conservation: The Case of Gununo Watershed, Southern Ethiopia. Journal of Development and Agricultural Economics Vol. 4(1): 23-36.

Mitiku, H. Herweg, K. Stillhardt, B. (2006) Sustainable Land Management – A New Approach to Soil and Water Conservation in Ethiopia. Mekelle, Ethiopia: Land Resources Management and Environmental Protection Department, Mekelle University; Bern, Switzerland: Centre for Development and Environment (CDE), University of Bern, and Swiss National Centre of Competence in Research (NCCR) North-South. 269 pp.

Nyssen, J. Poesen, J. Moeyersons, J. Deckers, J. Haile,M. Lang,A.(2004) Human impact on the environment in the Ethiopian and Eritrean highlands – a state of the art. Earth-Science Reviews 64: 273-320.

Ohde, N.R. (2011) Ephemeral gullies and ecosystems services: Social and biophysical factors. Graduate Theses and Dissertations. Paper 11944.

Ontl, T. A. & Schulte, L. A. (2012) Soil Carbon Storage. Nature Education Knowledge 3(10): 35.

Poesen, J. Nachtergaele, J. Verstraeten, G. Valentin, C. (2003) Gully erosion and environmental change: importance and research needs. Catena 50: 91-133.

Schultz, R.C. Isenhart, T.M. Simpkins, W.W. and Colletti, J.P. (2004) Riparian forest buffers in agroecosystems – lessons learned from the Bear Creek Watershed, central Iowa, USA. Agroforestry Systems 61: 35–50.

Tadesse, M. Belay, K. (2004) Factors Influencing Adoption of Soil Conservation Measures in Southern Ethiopia: The Case of Gununo Area. Journal of Agriculture and Rural Development in the Tropics and Subtropics, Volume 105, No.1: 49–62.

Worku, H. Awdenegest, M. Fantaw, Y. (2012) The Effects of 'Fanya juu' Soil Conservation Structure on Selected Soil Physical & Chemical Properties: the Case of Goromti Watershed, Western Ethiopia. Resources and Environment, 2(4): 132-140.

Yihenew, G. Tadele, A. Mitiku, H. Yamoah, C. (2009) Lessons from Upstream Soil Conservation Measures to Mitigate Soil Erosion and its Impact on Upstream and Downstream Users of the Nile River. In: Improved Water and Land Management in the Ethiopian Highlands: Its Impact on Downstream Stakeholders Dependent on the Blue Nile Intermediate Results, Dissemination Workshop, February 5-6, Addis Ababa, Ethiopia: 170-183.

Value Chains

New Product Development: Learning from Industries for Communal Forest Utilization and Rural development

*Eckhard Auch**

Technische Universität Dresden, Institute of International Forestry and Forest Products

Abstract

Cash earnings from sustainable natural resource utilization serve as essential requirements for both sustainable livelihoods of the dwellers as well as financing of sustainable natural resource management. For the people to complement subsistence income and increase so resilience, for the natural resource to finance sustainable management and provide benefit to share. One way to create income is competitive products based on sustainable forest resource utilization and to merchandize it. A method to develop such new products is transferred from industrial business to the rural context. The process of developing a new product is structured in steps from the idea generation to the launch. An evaluation after each step controls the process and makes sure that the product under development is still viable and competitive. This "stage-gate (®)" called method was modified and transferred to a rural context where community based actors use forest resources to produce products for commercialization. The concept may be used for the development of new forest based products from forest or agroforestry based production systems.

Keywords: stage-gate* method; value chain

* The term "stage-gate" is a registered trade mark and used only for scientific purpose

*Corresponding author: eckhard.auch@tu-dresden.de

1. Aim and problem statement

To put it as a truism: in our globalized world all people need some minimum cash income. This holds also true for forest based and mainly subsistence oriented livelihoods in remote areas. It can be seen as a kind of basic right of every human to have some money to purchase at least matches, candles, books and to be able to pay school fees or for a medicinal treatment. Further, cash reserves strengthen the resilience of people's livelihoods. Therefore, holistic rural development has to consider options for the generation of cash income. To generate cash usually something, a good, a right or a service, is offered for sale. Without such marketable"products", no business, no income. This contribution explore how forest based communities could design products to enter in business activities.

Another truism is the fact that management as activity requires human resources in form of time and skills, in addition infrastructure like office space, communication facilities, transport etc. In common pool resource management like a community forest the transaction cost for management might be considerable higher than in individually hold property. In such settings many property right holders have to be informed, have to negotiate the issues and have to come to jointly supported decisions. These additional activities result in higher decision making and transaction cost. According to Ostrom (1990: 90) there is a principle of congruence, which is meaning that for a sustainable management the benefits realized by sustainable resource management have to cover the costs of the management and resource protection. So, if a forest provides enough benefits it is likely that its management is sustainable. Therefore, holistic rural development has also to consider options for the generation of cash revenues for sustainable natural/forest resources management.

In conclusion, both sustainable forest based livelihoods and sustainable forest management require a minimum of cash earnings.

One way to create income is to design competitive products, based on sustainable forest utilization, and to merchandize it. Success of such forest based value chains depends on various factors, external ones but also internal ones like proper production and continued supply or financial management, and especially on an attractive, well-designed product. Since business and industry share the very same problem in designing these attractive products it is worth to look on the method designed by these sectors. The method is transferred to the situation where rural communities are interested in creating jointly a forest based value chain.

The understanding of forest based rural development refers here to people living in communities in the tropics using forests and trees as means to make their livelihoods. Assumed are common pool resources and/or cooperation of community members. It is of importance that the community becomes the leading force in this process, by taken over ownership of the process and by working together. Observing the current situation of rural NTFP commercialization, in many cases either powerful individuals organize their own business, e.g. coffee production, or buyers (markets) come from outside into the villages and set the terms of trade, e.g. for NTFPs collected from the wild like natural gums. Similar, NGO initiatives from outside transfer production and marketing ideas to a community by establishing projects for medicinal plant collection, craft production, tourism etc. To become sustainable value chains of these products, the community has to develop entrepreneurial spirit and negotiation skills. More, local people have to organize themselves to counterweight the strong and competitive players in the value chain and to negotiate on eye level.

Leading questions for the development of forest based products are:

1) What can a forest based community offer to a market? -> This question leads to methods of how to generate new product ideas. The topic is elaborated under Chap. 3.1 Idea generation

2) How are such new forest based products to develop? -> This question leads to the topic of the new product development method; the identified method was adapted to rural community situation and is presented under Chap. 3 The stage-gate method.

2. Theories/methods related to new product development

2.1 Concepts for marketing

Marketing Strategies can be distinguised by their starting points. Kotler (2011: 10) distinguish two generic concepts. (1) The selling concept which is based on internal assets and builds on existing products and aims to maximize profits by increasing sales and reducing production cost. Marketing strategies within this generic concept can be distinguised by their underlying philosophy for profit generation. Starting point is the assumed rational and preference of the buyer or consumer:

Consumers will favor highly affordable (cheap) products -> focus on improving production and distribution efficiency -> Production focused concept

Consumers will favor the most quality/performance/special feature products -> focus on continuous product improvements -> Product focused concept

Consumers will not buy enough (of unsought goods) -> undertake large-scale selling and promotion campaigns -> Selling focused concept

The second concept (2) put external factors, esp. the customer's needs as starting point and seeks to offer products convincing buyers to be the mean to satisfy their needs. Marketing (business) tries to give customers what they want. Here profit is maximized by selling more competitive, usefull products.

Consumers will favor the most quality/performance/special feature products -> focus on continuous product improvements -> Product focused concept

Concepts which consider not only the consumer's short-run wants but also its long-run welfare, which is equal to society's well-being, are labeled as societal, sustainable and/or socially and environmentally responsible. Such concepts follow the sustainability principles, they "meet the present needs of consumers and businesses while also preserving or enhancing the ability of future generations to meet their needs knowing the needs and wants of target markets" (Kotler 2011: 11)

2.2 Components of marketing

Elements of a marketing strategy refer to the 4P (E. Jerome McCarthy) or from a consumer's perspective 4C (Robert F. Lauterborn): product or customer solution (variety, quality, design, features, brand name, packaging, services), its price or customer cost (list price, discounts, allowances, payment period, credit terms), place or convenience (advertising, personal selling, sales promotion, public relations) and promotion or communication (channels, coverage, locations, inventory, transportation, logistics) (Kotler 2011: 52ff, Qing et all. 2014: 206). Long-term strategies consider also environmental quality (place) and social capital (people). A marketing strategy is composed by features of these elements. The development of new products is largely interrelated with the design of the marketing strategy.

2.3 Markets and business environment

Knowledge about the company's (or community's) larger environment is required to be able to identify what consumer or buyers really want (pay) for. Fig. 1 gives aspects of the environment which may be studied.

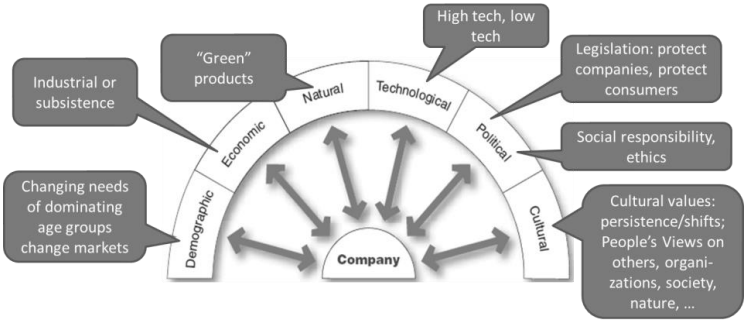


Figure 1: Macro-environment of a community enterprise. Source: Kotler (2011: 71), modified

Complementary to the macro-environment the micro-environment and markets have to be understood. To look is on the customers, also actors on partners for supply and retail, competitors, the public and the own organization (Fig. 2).

Markets are essential for selling the product. According to Cooper (2010: 67) various markets can be considered, apart from the conventional consumer markets (individuals, households, personal consumption) also business markets (further processing), reseller markets (resell at a profit), government markets (gov. agencies buy to produce public services / transfer to others) and international markets (these buyers in other countries).

Figure 2: Microenvironment of a community enterprise. Source: Kotler (2011: 67), modified

2.4 Product definition and life cycle

A Product is defined in a quite wide understanding. According to Kotler (2011: 224, 7) it refers to "anything that can be offered to a market for attention, acquisition, use, or consumption that might satisfy a want or need". This comprises all tangible objects, not only food, charcoal or cell phones but also services like a guided tour, a hike or a leaned room, further events, ideas, or combinations. The philosophy behind this approach sees products merely as means to solve a consumer problem.

In theory marketed products have a life cycle. This concept may not fit to each and every product (charcoal may be traded since hundreds of years), but the more products are specified (species used, size of pieces, packing unit, brand and wrapping design, quality) and the more the product is manufactured or processed, the theory fits. Fig. 3 shows the stages in a product's life span. The first stage is the development of the product; there are costs but no returns, so the profit made is negative. In the introduction stage the product is produced and sold, so first returns come in, but not enough to cover the cost of the production (often connect to high initial investments in production facilities). With increasing number of units sold the product enters the growth stage: returns are bigger than the cost, profits are positive. The product's sales numbers decline when it becomes less competitive, old fashioned or not being bought by other reasons. Usually a company stops production before the returns are smaller than the cost. If the product is improved or redesigned, it is seen as a new product and starts a new cycle. (Kotler 2011: 275). Product life cycles have become much shorter compared to some decades ago (Cooper 2010: 9), the implication is that products has to be newly developed or adjusted by redesign more often.

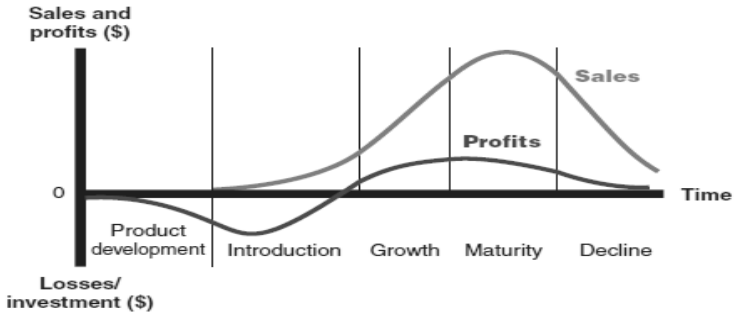


Figure 3: Sales and profits over the (industrial) product's life (Kotler (2011: 275)

2.5 Product portfolio concept

The products of a company can be evaluated by using a portfolio approach from the Boston Consulting Group. All products are ranked in a coordinate system according to their relative market growth potential a measure of market attractiveness (vertical axis) over their relative market share as a measure of the strength in the market (horizontal axis). Products with high growth and good market share are the "stars", they build the base for future performance; well established products with high market share but slow growth are the "cash cows", financing the company currently; Low potential products with low growth rate and low market share are uninteresting "dogs". "Question marks" are products with low market share, it is not clear yet if they grow to a star or decline to a dog (Kotler 2011: 42-43). Best products are one of the success factors for a company, as well as the continuing development of new products with potential to become stars.

3. New product development (NPD) process

3.1 Structure of the process

Product development is "the transformation of a market opportunity and a set of assumptions about product technology into a product available for sale" Krishnan and Ulrich (2001: 1). Under consideration

of the facts presented above “New product development” (NPD) is essential to sustain companies. Therefore it is not surprising that profit and growth oriented companies have established standard procedures for the NPD. These procedures are adjusted for the individual company and sector. From the various procedures described in the literature a simplified model was synthesized (Fig. 4). Details of the stages are elaborated in Chapter 3. The process starts with a product idea and is finalized with the launch of the product. The development process is not linear, in the course of development stages may overlap and iterate.

Figure 4: New product development process in six stages

3.2 Failure of NPD

Not all product ideas are successfully transferred in products. On each stage products under development are dropped. The selection in the course of the relative allocation of time resources is displayed in Fig. 5.

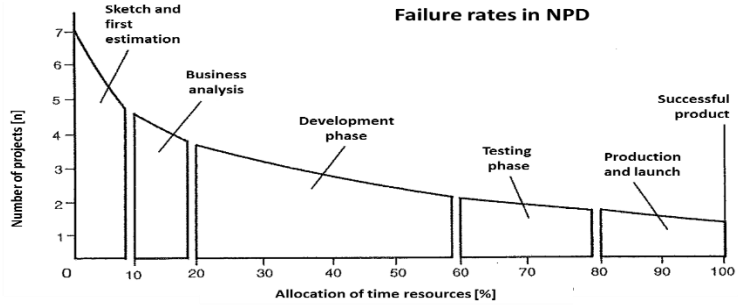


Figure 5: Failure of NPD projects, Source: Page (1991), cited from Cooper (2010: 12), modified

The development of a new product is a considerable investment, a failure results in the loss of the investment. Since failures are not to prevent the strategy is to minimize the investments in later dropped projects. This is realized by the establishment of strong evaluations in the early stages of the projects, when investments made are relative small. Fig. 5 indicates the cost of the different stages by the allocated share of time resources. The later stages, starting with the development, are the expensive ones. Product ideas have to be checked seriously and evaluated if they will be dropped or continued before they enter the expensive development phase (Cooper 2008: 214, 2010: 141). Cooper transformed this insight into a concept for NPD, called "stage-gate" method (®). An adaptation of this concept to a NPD by a forest based community requires that in the beginning various product ideas have to be brainstormed and in the early stages the viable and most promising one is identified and further developed. The selection has to consider the available assets of the community enterprise as well as the markets and business environment.

3.3 Control of failures with the "stage-gate method"

Basic principle is that the each stage of the whole development process is evaluated systematically after each stage and requires a positive evaluation to be allowed to enter into the next stage (or to receive further investments). Cooper used the term "gate" for these evaluations. Fig. 6 shows the placement of the "gates".

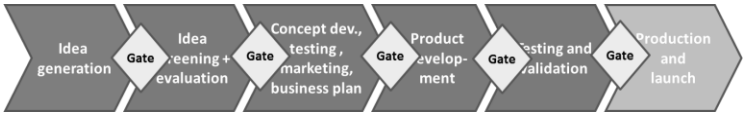


Figure 6: New product development process with phases/stages and gates/evaluation

3.4 Features of the gates

The evaluations on the gates have to be done by a committee with members who are accountable for wise resource investments. Investors/owners of the different resources contributed have to be involved and aware on the potential, the changes and risks of their investment. Recommended is an interdisciplinary team, including investors (in a communal context provision of labor, land use rights, capital etc., experts for marketing, production etc., decision maker, and in the context of a community based enterprise the participation of representatives of the people as well as experts with local/traditional knowledge. The evaluation committee is guiding the NPD process by setting the terms of reference (ToR) and thresholds for the evaluations Cooper. It will be a good and important base for both a successful development of a new product and for the subsequent steering of its successful commercial production. Together with a "go" decision the ToR for the next gate, has to be set up. These specifications are the reference for the developers, so the gates marking the corner points of the process. Since product development has an explorative character the process is done in an adaptive approach, from one gate to the other.

Base for evaluation are the results from an integrated analysis of the new product. The ToR for the analysis are to set up by the evaluation team when the activities of the particular stage start. These ToR are targets for the activities of the stage. The product development team has also to do the analysis of the achievements of the stage by assessing how far the product developed has met the given targets (Fig. 7). The analysis is to document and serves as base for the evaluation of the evaluation committee. The formal procedure support communication between development team and evaluation committee, and creates ownership amongst the participants.

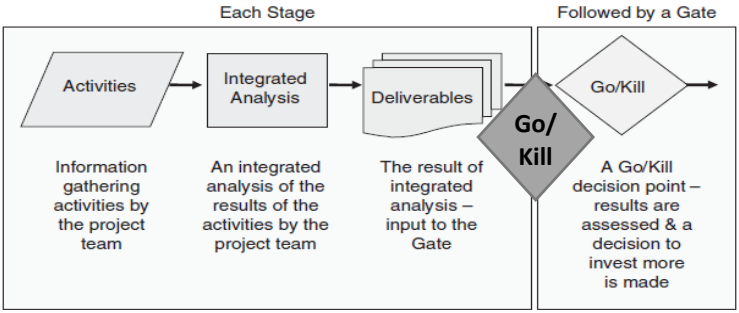


Figure 7: Evaluation of phases/stages, Source: Cooper (2008: 214), modified

The evaluation committee has to give clear decisions. Apart from "go" or "drop" the result of an evaluation can also be a "send back for improvement" or a "conditional go on" with intermediate examination. The evaluation team is in charge to minimize the risk of failures, it has to make sure that the investment will be successful!

4. Phases/stages of NPD in the context of a forest based rural development

4.1 Idea generation

4.1.1 Phase/stage

Each product starts with an idea. The idea can origin from internal or external, it can be a further development of existing products, the transfer of solutions observed in other sectors or in nature, or a generic invention. But for searching a solution one has to know the problem very well! So the first step is to understand the customer's needs. Only "knowing the needs and wants of target markets enables to delivering the desired satisfactions better than competitors do" (Kotler 2011: 10). This highlights the different philosophy: not a product-centered "make and sell" but a customer-centered "sense and respond" should be the attitude. The job is not to find the right customers for your product but to find the right products for your customers (ibid.). Kotlers statements are directed towards industries of mass consumption products, a forest based community usually has less options in selecting resources.

Nevertheless it is also for a forest community worth to think first in their customers' needs. So the first task is twice: (1) to understand the markets and environment of the business. Depending on location and situation of the communal organization market studies have to be done. Aspects to survey are given in Chap. 2.3. (2) Based on the knowledge brought together a marketing concept, at least some principles for marketing has to be agreed. In the context of forest utilization social and sustainability aspects have to be considered.

Creating of new product ideas is a special kind of innovation. Innovations consist to a big part of known knowledge, often a recombination of known ideas and solutions (Kalogerakis 2010: 1). This is used to create innovations systematically with analogies (see Fig. 8). Creation of innovations can be facilitated by (Cooper 2008: 215, 2010; Sumberg and Reece 2004: 303; Kalogerakis 2010: 14ff.):

- Customer feedback
- Cooperate with innovative customers
- Screen competitors
- Visit trade fairs
- Study market and trade reports
- Spend time to rummage and browse
- Do research activities, read scientific publications
- Consult and motivate your own staff (production, marketing)
- Workshops with experts and customers

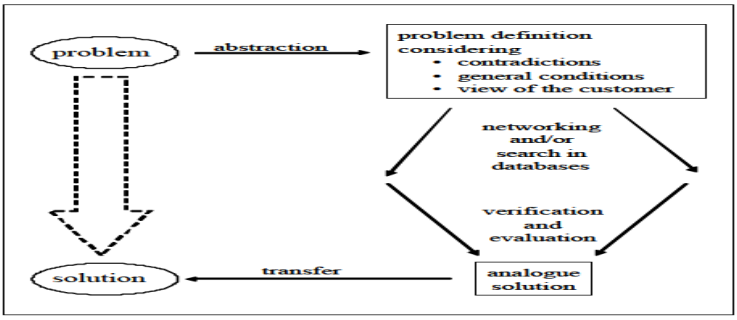


Figure 8: Systematic search for analogies Schild (2004: 8)

For the search of new products it is recommended that many ideas, including fantastic and crazy ones, are brainstormed and collected, to increase the change to identify highly promising product ideas. Since the evaluation of the ideas in the first gate is quite easy and simplified a large list of ideas will not really increase the cost for the assessment.

4.1.2 Gate

Since the generated ideas are not operational and hardly in detail accessible, their evaluation can be done with a simplified yes/no point-list (Cooper 2010). Evaluation criteria might be:

- Strategic orientation – fit the product idea to the organization?
- Magnitude of the chance big enough?
- Is the market attractive?
- Has the product competitive advantage?
- Is the idea technological feasible?
- Situation specific KO-criteria have to be identified, the ideas have to be checked if any of the KO-criteria applies.

Ideas not eliminated by KO-criteria have to be ranked accordingly to their "yes-scores". Another method to identify the brightest idea is pairwise comparison. Only realistic and attractive ideas shall pass. Minimum evaluation criteria, which have to be met by the preselected product ideas, have to be set up.

4.2. Idea screening and evaluation

4.2.1 Phase/stage

In this phase the preselected ideas are to screen and to evaluate. A frame for the required features and properties of the new product is to determine. Result of the phase is a clear definition of the product, its production, market potential and an economic assessment. Methods to employ for the evaluation:

- Rough assessment of market potential, e.g. by expert interviews, an internet review and a survey with core users;

- Utility analysis methods like a checklist with Lickert scales and scores;
- Portfolio analysis; and a
- Financial/economic analysis, based on estimations. In general the net present value (NPV) with sensitivity analysis, the cost/benefit ratio and the payback period is estimated.

4.2.2 Gate

The evaluators have to compare the assessment results with the minimum criteria set in advance. It is a responsible task because the following step involves a certain investment. There is a clear decision to make, either a “drop” or “pas”, it could also be a “go back for improvement”.

4.3. Concept development

4.3.1 Phase/stage

In this phase the product idea is to conceptualize and, based on this concept, the feasibility is to determine. First assessment of the market and of the resource has to be done. Based on this information various planning has to be done, comprising a marketing plan, production plan, testing plan, business plan and a risk analysis. The planning has to be done with realistic data, so the subsequent financial/economic analysis will be much stronger than the one from the previous step. To do is a NPV, a sensitivity analysis considering risk factors and a cost/benefit ratio. Also an impact analysis (environment, social) should be done. Result of the activities is clear definition of the product, its justification with a financial analysis, and a project plan (Cooper 2010).

4.3.2 Gate

As in previous phase, the evaluators have to compare the now much more precise results with the minimum criteria set in advance. Since

the following phase involves the probably largest investments a “go” decision has to be walked through thoroughly.

4.4. Product development

4.4.1 Phase/stage

The phase is dedicated to do a detailed feasibility study. A prototype of the new product is to develop and to test. Also plans for production, marketing etc. are to design. To consider are (Cooper 2010):

- Prototype development
- Prototype testing
- Production planning (harvesting, processing, training, tools and machines)
- Market analysis, including a study with customer feedback on prototypes
- Market launch planning
- Detailed financial planning
- Assessment of legal aspects

As results a tested prototype of the product as well clear plans for production and marketing have to be in place.

4.4.2 Gate

The evaluation focus on the prototype, the evaluation committee has to make sure that it fulfills the determined minimum standards on quality and the other aspects.

4.5. Testing and validation

4.5.1 Phase/stage

In this phase the product could be produced, but has to be tested and validated before it is offered on the market. A first lot of products have to be produced, or to be offered in case of services. Testing has to be done according to the standards which has been set-up in the

"Concept development" stage. It should be done internal as well as by users. The product is to validate according to its acceptance by customers. With the leanings from test serials the plans for marketing, business, and economics has to be reviewed and updated. The economic/financial analysis has to be adapted accordingly.

4.5.2 Gate

Evaluation committee has to scrutinize the test results and feedbacks generated in this phase. It has to review product quality, market responses and the updated economic/financial results. Finally, the ultimate decision to launch or not to launch the product is to take. In the latter case it has to make very clear what features of the product have to be improved. A decision to drop the product may also be possible, even when the process was designed to enable this decision in an earlier stage.

4.6 Production and launch

In this phase the designed and refined plans have to be implemented, the product is to launch and to offer on the market. For the purpose of learning an evaluation of whole product development project is recommended (Cooper 2010).

5 Discussion and Conclusion

The stage-gate method was designed for larger industrial companies. On the method level it is well transferable to a forest based community. But on the operational level the method has to be designed and filled with what is locally available. An industrial enterprise can contract experts or assign staff to do the many studies required for a sound assessment. A rural community usually lacks of such experts. The evaluators as well may not be able to assess the suggested studies. The challenge is to simplify planning and studies

so that the local actors understand it, without losing the information required for a sound decision making. The method has to be adapted to the individual situation of the forest based community. In this context it is to highlight, that the NPD procedure has to be implement in a highly flexible, result-oriented way.

Within the context of forest based products the buyers are seldom the final consumers. Often the buyer is an intermediary and controls the value chain between producer and processor, the producer itself has no contact to processors or final consumers. Intermediaries usually use this information gap to strengthen their position and market power. So an initiative from village may be perceived as competition by the Intermediaries. New product developers have to understand the actors, their interest, relations and power first before they start an intervention. This can be a first step towards understanding the customers' needs and desires for designing successfully new products.

The evaluation committee of the gates are steering the process. So both competent persons and the important, responsible ones have to be part of this committee. The team should be interdisciplinary to represent the investors, leaders, production, marketing and management experts. It should be made sure that all share somehow the risk of the investment.

References

Cooper R.G. (2008) Perspective: The Stage-Gate® Idea-to-Launch Process—Update, What's New, and NexGen Systems. Journal of Product Innovation Management 25(3):213–232. doi: 10.1111/j.1540-5885.2008.00296.x

Cooper R.G. (2010) Top oder Flop in der Produktentwicklung / Erfolgsstrategien: Von der Idee zum Launch, 2. Aufl. Wiley-VCH, Weinheim

Schild, K. Herstatt, C. Lüthje, C. (2004) How to use analogies for breakthrough innovations. http://doku.b.tu-harburg.de/volltexte/2005/133/. Accessed 14 Jan 2014

Sumberg, J. Reece, D. (2004) Agricultural research through a 'new product development' lens. Experimental Agriculture 40(03):295–314. doi: 10.1017/S0014479704002030

Kalogerakis K. (2010) Innovative Analogien in Der Praxis Der Produktentwicklung. Mit einem Geleitwort Von Prof. Dr. Cornelius Herstatt. Forschungs-/Entwcklungs-/Innovations-management. Gabeler Verlag, Wiesbaden

Kotler, P. Armstrong, G. (2011) Principles of marketing, 14th edn. Prentice-Hall, Englewood Cliffs, N.J

Krishnan, V. Ulrich, K.T. (2001) Product development decisions: A review of the literature. Management science 47(1):1–21

Langbehn, A. (2010) Praxishandbuch Produktentwicklung. Grundlagen, Instrumente und Beispiele, Campus, Frankfurt am Main

Qing, F. Wei, S. Huilan, C. (2014) Micro-blog Marketing of University Library Based on 4C Marketing Mix. In: Li S, Jin Q, Jiang X, Park, James J. (Jong Hyuk) (eds) Frontier and Future Development of Information Technology in Medicine and Education, vol 269. Springer Science+Media, Dordrecht, pp 205-212

Availability of Medicinal Plants in Uganda's Natural Forests: Local Peoples' Perspective

Daniel Waiswa[*]

Department of Geography, Geo-informatics & Climatic Sciences, Makerere University, Uganda

Abstract

Forests provide a wide range of products and services. In Uganda, a huge proportion of the population lives below the poverty line and is heavily dependent on natural resources such as forests for livelihood support. One of the products obtained from forests is medicine that is gotten from medicinal plants. Despite the acknowledgement of the important role played by medicinal plants in Uganda, especially amongst forest-dependent communities, there is little if any documentation about the availability of medicinal plants in the forests. This study therefore aimed at exploring the availability of medicinal plants among other plant species in Uganda's natural forests. The specific objectives were to: (i) Assess the availability of medicinal plant species in Uganda's forests, (ii) Determine the level of utilization of medicinal plants obtained from Uganda's forests, and (iii) Assess the abundance of identified medicinal plants in Uganda's forests. This involved utilization of forest inventory and socio-economic data collected using the International Forestry Resources and Institutions methodology. Data analysis focused on extracting data on medicinal plant species in the database and summarizing it using descriptive statistics. The results show that, based on the local peoples' perspective, a number of plant species of medicinal value are available in Uganda's natural forests despite their being less

[*] Corresponding author: daniel.waiswa@fulbrightmail.com

abundant. This calls for mechanisms for their conservation which among others could require a value chains analysis of these medicinal plants in Uganda.

Keywords: Uganda, value chains, medicinal plants, local people, conservation

---

1. Introduction

Uganda is a developing country located in East Africa. It covers an area of about 24.1 million hectares with a current population of about 33 million people (UBOS, 2011). A huge proportion of Uganda's population lives below the poverty line and survives on about $1 per day. The people are thus heavily dependent on natural resources (UBOS, 2011; NEMA, 2010) for basic livelihood needs like health care. In Uganda, traditional medicine usage among the rural population for day-to-day health care needs is estimated to be about 90% (Kamatenesi-Mugisha and Oryem-Origa, 2006). Medicinal plants are reported to be used in the treatment of several diseases including HIV/AIDS (Lamorde et al., 2010), measles (Olila et al., 2001), Malaria (Namukobe et al., 2011; Tabuti, 2008), sexual impotency and erectile dysfunction (Kamatenesi-Mugisha and Oryem-Origa, 2006; Agea et al., 2008), and tuberculosis (Bunamulemaet al., 2013). Despite the recognition of the forests as one of the main sources of traditional medicines in Uganda (Namukobe et al., 2011), there is still inadequate information about the availability of medicinal plants in the forests.The overall goal of this study was therefore to explore the availability of medicinal plants among other plant species in Uganda's natural forests. The specific objectives of the study were to: (i) Assess the availability of medicinal plant species in Uganda's forests, (ii) Determine the level of utilization of medicinal plants obtained from

Uganda's forests, and (iii) Assess the abundance of identified medicinal plants in Uganda's forests. Information obtained from this study was hoped to play a vital role in shaping the agenda for the utilization and conservation of medicinal plants in Uganda.

2. Methods

This involved utilization of existing forest inventory and socio-economic data collected by Uganda Forestry Resources and Institutions Center using the International Forestry Resources and Institutions (IFRI) methodology (Nagendra, 2007). This methodology utilizes a set of instruments that aid collection of both forest inventory and socio-economic data about a forest and its users. The forest inventory is implemented using three concentric circular plots of radii 1, 3 and 10 m. The circle of 1 meter radius is used for assessment of ground cover (seedlings and herbs) while the 3 meter radius circle is for assessing saplings and shrubs and the 10 meter radius circle is for assessing trees. A total of 30 sample plots is established during each visit to the forest. During the forest inventory, each plant species in the sample plots is identified followed by asking the local people about its importance and abundance. Although this dataset is not specifically focused on medicinal plants, it was deemed appropriate for this study as it is readily available and covers a wide geographical area in addition to the forests having been visited more than once thus giving it the potential to provide a good baseline on availability of medicinal plants in Uganda' s forests.

The dataset used consists of 18 forests that have been visited more than once since 1993. Table 1 gives the characteristics of the selected forests while Figure 1 shows the districts where the selected forests used in this study are located.

Table 1: Characteristics of selected forests

Forest Name	District	Property Regime	Vegetation Type	Forest Area (ha.)
Bufuma	Bududa	National Park	Montane Forest	80
Bukaleba	Mayuge	Central Forest Reserve	Lakeshore Moist Savanna Forest	4500
Busowe	Kalangala	Central Forest Reserve	Lakeshore Moist Tropical Forest	450
Butto/buvuma	Mpigi	Central Forest Reserve	Tropical Rain Forest	1906
Echuya	Kabale	Central Forest Reserve	Montane Forest	1200
Jubiya	Masaka	Central Forest Reserve	Tropical Rain Forest	4571
Kabunja	Kalangala	Central Forest Reserve	Lakeshore Moist Tropical Forest	150
Kajjonde	Mityana	Central Forest Reserve	Riverine Tropical High Forest	342
Kapkwai	Kapchorwa	National Park	Montane Forest	300
Kizzikibi	Mpigi	Central Forest Reserve	Tropical Rain Forest	520
Mabira	Mukono	Central Forest Reserve	Tropical Rain Forest	30,000
Malabigambo	Rakai	Central Forest Reserve	Swampy Forest	1137
Mbale	Luwero	Central Forest Reserve	Wooded Savanna	1207
Mugomba	Wakiso	Central Forest Reserve	Tropical Rain Forest	725
Najjakulya	Mpigi	Private Forest	Tropical Rain Forest	50
Namungo	Mpigi	Private Forest	Lowland Tropical Forest	40
Rwensama	Masindi	Central Forest Reserve	Riverine Tropical High Forest	121
Rwoho	Mbarara	Central Forest Reserve	Montane Forest	9073

Source: Namaalwa, 2008.

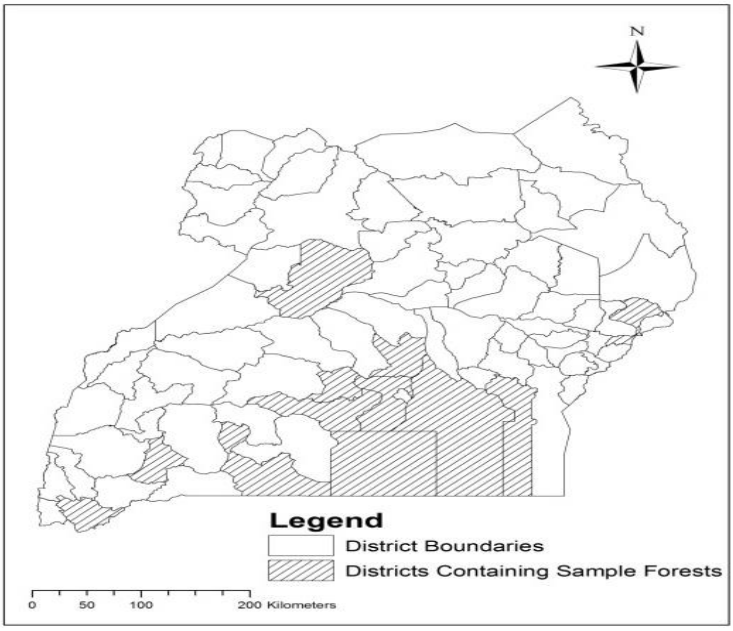


Figure 1: Districts where study forests are located

Data analysis focused on mining data on plant species especially their scientific and local names together with their reported uses and abundance according to the local people and then summarizing the data using descriptive statistics.

3. Results and Discussion

3.1 Availability of medicinal plants in Uganda's forests

Table 2 shows the total number of plant species and the number of medicinal plants identified in the sample plots established in the study forests.

Table 2: Total number of plant species and number of medicinal plant species in study forests

Forest Name	Number of Plant Species	Number of Medicinal Plant Species
Bufuma	78	10
Bukaleba	95	6
Busowe	63	4
Butto/buvuma	162	17
Echuya	54	10
Jubiya	95	8
Kabunja	77	8
Kajjonde	110	16
Kapkwai	83	12
Kizzikibi	108	7
Mabira	94	23
Malabigambo	101	18
Mbale	71	17
Mugomba	164	11
Najjakulya	121	11
Namungo	133	7
Rwensama	84	4
Rwoho	75	16
Average	***98***	***11***

Each of the 18 sampled forests contained a number of plant species, of which some were identified as being of medicinal value by the local people. The number of plant species in each of the sampled forests ranged from 54 to 164 with a mean of 98. On the other hand, the number of medicinal plant species in each of the sampled forests ranged from 4 to 23 with a mean of 11 medicinal plant species. Generally, the number of medicinal plant species available in Uganda is high. These study findings are in line with the findings of Tabuti et al. (2003) who recorded 229 plant species belonging to 168 genera in 68 families with medicinal properties. Bunalema et al. (2013) also documented a total of 90 plant species, distributed within 44 families in her study of the knowledge of plants traditionally used for treatment of tuberculosis in Uganda where priority plants identified included Zanthoxylum leprieurii, Piptadeniastrum africanum, Albizia coriaria and Rubia cordifolia among others. In a similar development,

a study of the traditional plants used for medicinal purposes by local communities around the Northern sector of Kibale National Park in Uganda by Namukobe et al. (2011) reported 131 plant species in 55 families treating 43 physical illnesses and disease with malaria and cough treated using Vernonia amygdalina Del and Albizia coriaria Welw. Respectively being the most treated diseases. Similarly, Ssegawa and Kasenene (2007) in their study of the medicinal plants diversity and uses in Sango bay area of southern Uganda documented 186 medicinal plant species in 163 genera and 58 families. It is worth noting this study had a relatively fewer number of medicinal plant species documented probably because of the size of the study area where other studies focus on larger areas like counties while each of the study forests used in this study could only be as large as a village.

3.2 Level of utilization of medicinal plants from Uganda's forests

The results revealed that over 80% of the plant species used as medicinal plants are for home use. Commercial utilization is indeed on a very small scale as only few species are reported about in that category.Some of the medicinal plant species used for commercial purposes include *Prunus Africana,Mondia whytei*, *Citropsis articulata and Galinsonga parviflora* among others. The low level of utilization of medicinal plants on a commercial basis could be attributed to the inadequate validation of the purported therapeutic properties of medicinal plants. Additionally, the processing, packaging and storage of herbal medicines are substandard and require improvement. Some of the medicinal plant species are also threatened (Tabuti *et al.*, 2003).

3.3 Abundance of medicinal plants from Uganda's forests

Table 3 and 4 show the abundant and non-abundant medicinal plant species respectively in Uganda's forests.

Table 3: Abundant medicinal plant species

No	Botanical Name	Plant Type*	Use(s)
1.	*Acalypha volkensii*	H	Home use
2.	*Ageratum conyzoides*	H	Home use
3.	*Aspilia mossambicensis*	H	Home use
4.	*Bidens kikimandscharica*	H	Local use
5.	*Bidens pilosa*	H	Wounds
6.	*Citropsis articulata*	H	Commercial, home use
7.	*Commelina africana*	H	Home use
8.	*Conyza floribunda*	H	Home use
9.	*Crassocephalum crepidioides*	H	Home use
10.	*Digitaria scalarum*	H	Home use
11.	*Dracaena fragrans*	H	Boundary marker
12.	*Drymaria cordata*	H	Home use
13.	*Ensete ventricosum*	H	Home use
14.	*Erlagea tomentosa*	H	Local use
15.	*Galinsoga parviflora*	H	Commercial, Home use
16.	*Trimeria bakeri*	S	Home use
17.	*Vernonia amygadylina*	S	Home use
18	*Garcinia huillensis*	S	Home use
19	*Hewittia sublobata*	H	Herbal use
20	*Microglossa angolensis*	H	Home use
21	*Momordic feotida*	H	Home use
22	*Myritica kanditiana*	S	Treating headache
23	*Paullinia pinnata*	H	Home use
24	*Phytolacca dodecandra*	H	Deworming
25.	*Piper guineense*	H	Local use
26	*Piper umbellatum*	H	Home use
27	*Rubia cordifolia*	H	Fruits
28	*Rubus kaniensis*	H	Home use
29	*Sapium ellipticum*	T	Home use, firewood
30	*Senecio discifolius*	H	home use
31	*Sesamum angustifolium*	H	Home use
32	*Tragia benthamii*	H	Home use
33.	*Tragia insuavis*	H	Home use

* H- Herb and S-Seedling.

Table 4: Non-abundant medicinal plant species

No.	Botanical Name	Plant Type*	Use(s)
1.	*Abrus precatorius*	H	Home use
2.	*Acalypha ciliata*	H	Home use
3.	*Achyranthes aspera*	S	Home use
4.	*Aerva sp*	H	Home use
5.	*Aeschynomene cristata*	H	Home use
6.	*Aeschynomene schimperi*	H	Home use
7.	*Ageratum conyzoides*	H	For treating wounds
8.	*Aloe volkensii*	H	Home use
9.	*Asparagus africana*	H	Home use
10.	*Aspilia africana*	H	Home use
11.	*Aspilia mossambicensis*	H	Local use
12.	*Bersama abyssinica*	S	Home use
13.	*Bidens pilosa*	H	Treatment of wounds.
14.	*Biophytum petersianum*	H	Home use
15.	*Blighia unijugata*	S	Herbal use
16.	*Cannabis sativa*	H	Animal treatment
17.	*Cardiospermum grandiflora*	H	Home use
18.	*Centella asiatica*	H	Herbal use
19.	*Cida acuta*	H	Home use
20.	*Cissampelosa mucronata*	H	Home use
21.	*Chaetacme aristata*	S	Home use
22.	*Citropsis articulata*	S	Local use
23.	*Commelina africana*	H	Home use
24.	*Conyza floribunda*	H	Unknown
25.	*Crassocephalum crepidioides*	H	Home use
26.	*Crassocephalum vitellinum*	H	Home use
27.	*Desmodium ramosissimum*	H	Home use
28.	*Digitaria scalarum*	H	Treatment of fever
29.	*Dracaena steudneri*	S	Baby skin cure
30.	*Drymaria cordata*	H	For headache
31.	*Ensete ventricosum*	H	Home use
32.	*Erlangea tomentonsa*	H	Home use
33.	*Erythrina abyssinica*	S	Home use
34.	*Erythrophleum guineense*	S	Poisoning
35.	*Euphorbia hirta*	H	Treatment of Asthma, Home use
36.	*Guizotia scabra*	H	Herbal use
37.	*Hoslundia opposita*	H	Home use
38.	*Kalanchoe spp*	H	Home use
39.	*Kigelia africana*	T	Home use
40.	*Leonotis nepetifolia*	H	Home use
41.	*Leptacelium spp*	H	Home use

42.	*Maerua duchesnei*	T	Home use
43.	*Maesa lanceolata*	S	Home use
44.	*Marattia fraxinea*	H	Local se
45.	*Microglossa angolensis*	H	Home use
46.	*Momordica foetida*	H	Home use
47.	*Mondia whytei*	H	Appetizer.
48.	*Ocimum suava*	H	Home use
49.	*Oxalis corniculata*	H	Home use
50.	*Paullinia pinnata*	H	Home use
51.	*Paullinia pinnata*	H	Home use
52.	*Phyllanthus capillaris*	S	Home use
53.	*Physalis peruviana*	H	Fruit
54.	*Phytolacca dodecandra*	H	Local use
55.	*Piper guineense*	H	Home use
56.	*Piper umbellatum*	H	Home use
57.	*Pittosporum manii*	S	Home use
58.	*Prunus africana*	S	Prostate cancer
59.	*Pseudarthria confertiflora*	S	Home use
60.	*Pseudarthria hookeri*	H	Home use
61.	*Rubia cordifolia*	H	Eye treatment
62.	*Rubus keniensis*	H	Fruits/ Medicinal
63.	*Sapium ellipticum*	T	Medicinal
64.	*Senecio discifolius*	H	Home use
65.	*Senecio hadiensis*	H	Local use
66.	*Senna obtusifolia*	S	Home use
67.	*Sida acuta*	S	Home use
68.	*Sigesbekia orientaris*	S	Wounds
69.	*Sonchus oleraceus*	H	Home use
70.	*Spondianthus preusii*	P	Locally
71.	*Steganotaenia araliacea*	P	Local use
72.	*Treculia africana*	S	Home use
73.	*Trigia spp*	H	Home use
74.	*Triumfetta macrophylla*	H	Home use
75.	*Tylosema fassoglensis*	H	Home use

* H- Herb, S-Seedling and T-Tree.

Most medicinal plant species were not abundant. Only 33 species out of 108 medicinal plant species were abundant. This is in line with the findings of Agea *et al*. (2008) in his market survey of *Mondia whytei* roots in Kampala city Uganda that its supply is dependent on seasons thus getting unusually low at times despite its high demand as a sexual stimulant among other uses. The supply, according to Agea

etal. (2008) could still be associated with the unorganized market structures in place for *Mondia whytei* and other medicinal plants. According to Tabuti *et al.* (2003), some of these medicinal plants that are mainly collected from the wild are believed by the community to be threatened by unsustainable intensities of use and patterns of harvesting. However, just as Agea *et al.*(2008) states, the availability of many gathers of Mondia whytei, who could promote its cultivation, is a big opportunity that can be harnesses to increase abundance of the currently non-abundant medicinal plant species. And also in agreement with Tabuti *et al.* (2003), most medicinal plants, whether abundant or not, in Uganda's forests are herbaceous.

Although there are reports of the medicinal properties of these plants, their efficacy remains unknown. Several studies including Agea *et al.* (2008) and Kamatenesi-Mugisha and Oryem-Origa (2006) recommend further research on efficacy and safety of herbal remedies in addition to investigating the possibility of value addition to the roots sold. Similarly, Tabuti *et al.* (2003) in their study also argue for validation of purported therapeutic claims of medicinal plants that can help promote confidence among users of traditional medicine, and also create opportunities for the marketing of herbal medicines in addition to generating incomes for the community. A case in point about validation of therapeutic claims was accomplished by Olila*et al.* (2001) in their study on the treatment of measles in Uganda using medicinal plants where the efficacy of *Warburgia ugandensis* was attributed to the antibacterial and antifungal activity of its components while *Zanthoxylum chalybeum* seeds extracts had neither antifungal nor antibacterial activities thus making its mode of action in measles treatment unclear.

4. Conclusion and recommendations

Based on the local peoples' perspective, a number of plant species of medicinal value are available in Uganda's natural forests. Most of the

medicinal plants are for home use. However, these medicinal plants are not abundant. Studies focused on medicinal plants are needed to understand the availability and utilization, especially of the non-abundant, medicinal plant species as this has implications on their conservation and commercialization. This may entail implementing a value and or market chains analysis so as to among others not only validate the local people's therapeutic claims but also contribute to further development of these plant species for commercial /industrial purposes and ultimately their conservation.

References

Agea, J.G.Katongole, B.Waiswa, D. and Nabanoga, G.N. (2008) Market survey of *Mondia whytei* (Mulondo) roots in Kampala City, Uganda. *Afr.J .Trad. CAM* 5(4):399-408.

Bunalemaa, L., Obakiro, S., Tabuti, J.R.S., and Waako, P. (2013). Knowledge on plants used traditionally in the treatment of tuberculosis in Uganda. *Journal of Ethnopharmacology*, 151:999-1004.

Kamatenesi-Mugisha, M. and Oryem-Origa, H. (2006) Traditional herbal remedies used in the management of sexual impotence and erectile dysfunction in western Uganda. *African Health Sciences* 5(1):40-49.

Lamorde, M., Tabuti, J.R.S., Obua, C., Kukunda-Byobona, C., Lanyero, H., Byakika-Kibwika, P.,Bbosa, G.S., Lubega, S., Ogwal-Okeng, J., Ryan, M., Waako, P.J., and Merry, C. (2010) Medicinal plants used by traditional medicine practitioners for the treatment of HIV/AIDS and related conditions in Uganda. *Journal of Ethno-pharmacology*, 130:43-53.

Nagendra, H. (2007) Drivers of reforestation in human-dominated forests.*Proceedings of the National Academy of Sciences,* 104(39), 15218-15223.

Namaalwa, J. (2008) When do Property Rights Matter for Sustainable Forest Management? A Case of the UFRIC Sites in Uganda.IFRI

Working Paper # W08I-2, International Forestry Resources and Institutions Program.

Namukobe, J., Kasenene J.M., Kiremire, B.T., Byamukama, R., Kamatenesi-Mugisha, M., Krief, S.,Dumotent, V. and Kabasa, J.D. (2011) Traditional plants used for medicinal purposes by local communities around the Northern sector of Kibale National Park, Uganda .*Journal of Ethnopharmacology,* 136:236-245.

NEMA [National Environment Management Authority](2010)*State of the Environment Report for Uganda 2010*. Kampala: NEMA.

Olila, D., Olwa-Odyek, and Opuda-Asibo,J. (2001)Antibacterial and antifungal activities of extracts of *Zanthoxylum chalybeum* and *Warburgia ugandensis* Ugandan medicinal plants. *African Health Sciences* 1(2):66-72.

Ssegawa, P. and Kasenene, J.M. (2007) Medicinal plants diversity and uses in the Sango bay area, Southern Uganda. *Journal of Ethnopharmacology*, 113:521-540.

Tabuti, J.R.S. (2008). Traditional medicines used in the treatment of malaria in Budiope County, Uganda. *Journal of Ethnopharmacology*, 116: 33-42.

Tabuti, J.R.S., Kukunda, C.B. and Waako, P.J. (2010) Medicinal plants used by traditional medicine practitioners for the treatment of tuberculosis and related ailments in Uganda. *Journal of Ethnopharmacology*, 127:130-136.

Tabuti, J.R.S., Lyea, K.A. and Dhillion, S.S. (2003) Traditional herbal drugs of Bulamogi, Uganda: plants, use and administration. *Journal of Ethnopharmacology*, 88: 19–44

UBOS [Uganda Bureau of Statistics]. 2011. *Statistical Abstract 2011*. Kampala: UBOS.

Challenges and opportunities for developing the use of baobab (*Adansonia digitata L.*) in the African and European food industry value chains

Dietrich Darr[*] and Rabea North

Hochschule Rhein-Waal, Kleve/Germany

Abstract

Baobab (*Adansonia digitata L.*) is a tree that is endemic to the hot, drier parts of sub-Saharan Africa. Its fruits are highly nutritious and can be sold as novel food in the EU and the US since 2008. Great potential as being the next 'super fruit' has been forecasted, which this paper is attempting to review. Through expert interviews the baobab value chain was analyzed and conclusions were drawn concerning the current and future success of trading baobab products on an international scale. The main findings were a number of issues along the value chain that greatly influence the quality and timely delivery of baobab. Most experts advised against a focus on moving more baobab products into the European market, as European consumers are generally not aware of this tree. Instead, the African market should be concentrated on, as baobab poses a great addition to family nutrition, especially in famine-ridden areas.

Keywords: Global Supply and Demand; Baobab Value Chain; Commercialization of Underutilized Fruits

[*] corresponding author: dietrich.darr@hochschule-rhein-waal.de

1. Introduction

Baobab (*Adansonia digitata L*.) is a majestic deciduous tree that can grow up to 25 m high and may live for several hundreds of years (Gebauer et al. 2002). The species is native to and widely distributed in the drier parts of sub-Saharan Africa and southern Arabia (Wickens& Lowe 2008).Further endemic species of *Adansonia* can be found in Madagascar and north-western Australia (ibid). Figure 1 shows the estimated appearance of *Adansonia digitata L*. in Africa based on notes, reports, photography, maps and travel literature.

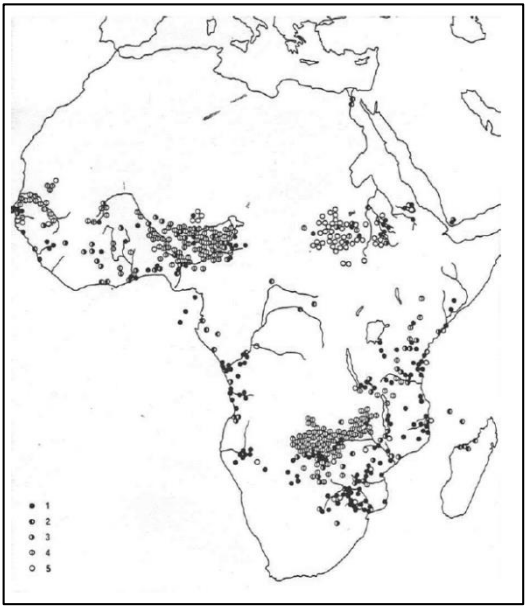


Figure1: Distribution of Baobab in sub-Saharan Africa (Wickens, 1982)

The tree is typically characterized by a short and stout trunk of conical, cylindrical or bottle-shaped form, attaining up to 14 m in girth with thick, angular and wide spreading branches (Gebauer et al. 2002). Baobab morphology is influenced by genetics and environmental factors (Cuni Sanchez 2010). For example, fruit size and shape vary

widely with edaphic and climatic conditions, as also chemical composition and nutrient contents of the fruits do. Phyto Trade, a trade association of the natural products industry in Southern Africa, estimated the baobab coverage of the southern African countries in 2008. Malawi in particular seems to have a high occurrence of baobabs with an estimated coverage of 10 % of the country.

Table 1: Estimated occurrence of wild baobab in Southern Africa (Phyto Trade Africa, 2008)

Country	Total land area of country (km^2)	Areas of baobab occurrence	Estimated baobab coverage as % of country's total land area	Estimated land area with baobab population (km^2)
Botswana	582,000	Hard country in north-east, and north-west	1	5,820
Malawi	118,484	Shire Valley, Nsanje	10	11,848
Mozambique	801,590	By Lake Malawi, Chupanga and Magude, Cabo Delgado and Nampula provinces	5	40,080
Namibia	825,000	Northern Namibia	0.5	4,125
South Africa	1,233,404	Limpopo basin, northern Zoutpansberg Mountains, Transvaal	1	12,334
Zambia	752,615	Luangwa, Gwembe Valley, Zambesi Valley	1	7,526
Zimbabwe	390,580	Zambesi Valley, Save Valley, Limpopo basin	3	11,717
Total	**4,703,673**			**93,450**

Source: Phyto Trade Africa (2008)

The tree, of which many parts can be used as food (e.g., Gebauer et al. 2002; Sidibe & Williams 2002), has an important role in contributing to family nutrition and food security as well as to cash income generation especially for marginalized rural communities (Jamnadass et al. 2011; Adam et al. 2012). The fruit pulp is of high nutritional value, particularly for calcium and vitamin C (Stadlmayr et al. 2013), has pre-biotic and antioxidant functions and high dietary fiber contents (Gebauer et al. 2002). Other parts of the baobab such as leaves, young roots and oil from the seeds also provide valuable nutrients and are eaten either regularly or in times of food scarcity (Sidibe & Williams 2002). Wood as such has no value as timber but the bark is used to make ropes (Gebauer et al. 2002). In times of drought the bark and wood, which store some water, are used by animals to chew on (Wickens & Lowe 2008). Baobab parts are being processed by local communities into varied products such as juice, sweets and snacks (Buchmann et al. 2010). The naturally low water content of the fruit pulp allows for its long-term storage and later consumption in times of need and makes its transport to domestic and international markets easy (Gruenwald & Galizia 2005).To many people in Africa baobab is therefore of high significance, not only for food supply but also as medicine and on a spiritual level (Wickens and Lowe 2008). For example, it has been reported that spirits of the ancestors live in a baobab, traditional believes of fertility are attached to particular trees and even witchcraft ceremonies can involve a baobab (ibid.)

However, despite its current significance for rural communities throughout large parts of sub-Saharan Africa, baobab is considered being an underutilized crop as its potential for improving local diets and livelihoods is not yet fully used. Value chains and marketing pathways are poorly developed, and the species is largely neglected by research, development and extension institutions, which is why practical local knowledge exceeds scientific knowledge (Gruere et al. 2006).

2. New opportunities

Since 2008, dried baobab fruit pulp has been accepted as a novel food ingredient in the European Union as well as for the US market (CEC 2008; Wilkinson 2006; Jones 2007; FDA 2009). The fruit properties meet health claims such as pre-biotic and antioxidant functions, high calcium, vitamin C and high pectin and fiber contents, which make it a suitable candidate for a new generation of functional foods and drinks (Gruenwald & Galizia 2005). It has been estimated that baobab has the potential to be a billion dollar industry for Africa and could employ over 2.5 million households (cf. Cuni Sanchez et al. 2010). Commercialization of such resources can be a potential strategy for 'conservation through use' (Belcher and Schreckenberg 2007). Companies and organizations throughout sub-Saharan Africa are increasingly aware of the opportunity arising. However, there are many challenges in developing a sustainable baobab value chain which individual stakeholders cannot address, such as limited availability of planting material, lack of knowledge on sustainable resource management techniques, poor fruit processing technologies and organized market chains (Wickens & Lowe 2008). As fruit production can vary greatly from tree to tree (Cuni Sanchez 2010), an additional challenge is the need to domesticate baobab trees by selecting the one with highest nutrient and lowest anti-nutrient contents.

The international demand for baobab products is slowly growing. The first baobab product which was available on the European market was sold in 1997 (Späth, pers. comm.). Gebauer et al. (2014) found more than 300 products that contain baobab as an ingredient. The proportion of baobab is sometimes very small as seen in products such as baobab herbal salts, chocolate or gin with baobab. However, the variety of products that contain baobab nowadays is remarkable.

The Baobab Social Business in Munich is one of the pioneers in trading baobab products in Europe. With 15 products they remain the biggest provider on the German market. The fruit powder is organic and fair

trade and one of their products, a soft drink called BAOLA, is on the menu of a number of restaurants, bars and cafés in Germany's major cities such as Munich and Berlin (Gebauer et al. 2014). Leafs and seeds are not accepted as food in the EC and are largely used for cosmetics and body care products instead. The product range consists of aftershave, perfume, shampoo and shower gel as well as leg lotion and foot spray. According to the findings of Gebauer et al. (2014) the German drugstore chain "dm" currently offers a product range of their home brand "Balea" that consists of 14 different baobab products such as anti-aging cream. The company advertises baobab as being anti-inflammatory and retaining high moisture.

3. Methodology

Despite the remarkable number of baobab products available on international markets, baobab remains a niche product on small markets such as the ones for fair trade or vegan products. To explore the reasons for a low demand and to subsequently assess the potential for increasing baobab use in Europe expert interviews were conducted. These included producers, wholesalers and processors of baobab and took place between October 2013 and February 2014. Such experts had a commercial background that sometimes had a not-for-profit character. Some sold baobab products directly to the consumer and some acted as middlemen. Most of the experts had close contact to the small-scale farmers in Africa and supported them in their decisions regarding production and sales of raw baobab products.

Through the interviews a better understanding of the supply and demand situation as well as current changes along the value chain were gained.

4. Findings

Table 2 presents an overview over the current supply of baobab fruit powder as estimated by a number of baobab experts. Most of the powder currently comes from Senegal where even large quantities of organic and fair trade powder can be provided. Other important producing countries are, though on a much smaller scale, Malawi, South Africa, Zimbabwe, Burkina Faso and recently Mozambique. Sudan and Kenya produce powder, too, though they cannot guarantee it to be organic. The amount that such countries produce is unknown as they are not one of the major suppliers to international markets. One expert estimates the worldwide total supply of baobab produce to be between 500 and 700 tons per year. The global export of baobab fruit powder to international markets is estimated to be around 100 tons per year. The majority of buyers currently come from Europe, Japan and the US. Markets in China and India are increasing steadily. Due to the modest international demand for baobab powder, most of the harvesting and processing initiatives throughout Africa only produce to demand and could expand their production significantly even on short notice if demand would increase suddenly. The potential sustainable baobab fruit yield in southern Africa alone has been estimated to exceed 100,000 tons annually (Phyto Trade Africa 2008). Due to the intensive subsistence use of baobab in West Africa, the potential supply for commercial uses is limited in this region (cf. Buchmann et al. 2010).

Table 2: Current and potential supply of baobab fruit powder from selected countries in sub-Saharan Africa

Country	Current supply	Potential supply	Source
Senegal	~50 t/a		Späth, pers. comm.
Malawi	600 t/a (incl. domestic)		Dohse, pers. comm.
Zimbabwe	~10 tons/a	700-4 Mill. t/a	Collenberg, pers. comm.
Burkina Faso	?		
South Africa	3-5 tons/a certified organic powder	300-500 t/a	Venter, pers. comm.
Mozambique	Just started		Micaia, pers. comm.
Sudan	?	?	
Kenya	?	?	
Global	~100 t/a (export), ~500-700 t/a (total)	?	Micaia, Späth, Triebel pers. comm.

Source: Expert interviews, Oct. 2013 - Feb. 2014

The current overall international demand for baobab powder is far below the initial expectations. Originally, estimates regarding the potential demand for baobab in Western countries have been very euphoric (cf. Cuni Sanchez et al. 2010). Now, six years after allowing baobab products to be sold in the EU, expectations are much lower. No major food producing company to date has ventured into baobab food products for the mass market. In fact, a number of baobab food products, both from small and large-scale producers, have already been discontinued. In the course of the interviews a number of reasons were identified that explain the limited penetration of the mass market:

- Baobab is still unknown to most consumers in Europe. Large-scale marketing campaigns would be required to make them aware of the products and their benefits. The establishment of such new products and brands, however, takes time and is risky (Siro et al. 2008).
- Baobab products are currently sold at premium prices. In markets such as Germany consumers are used to buying food at very low prices, which instantly narrows the potential market. A more promising alternative seems to be the use of baobab for cosmetics products, as this market is less price-sensitive and growing at attractive rates (GfK 2010).
- Despite the dedicated efforts to upgrade local production processes, quality standards and specifications defined by European processors as pertaining to, for example, moisture content, absence of impurities, consistent quality and timely delivery remain a challenge for many African suppliers. Unreliable quality and supply of raw material discourage European food processors from using the resource at larger scale.

As these challenges will likely remain in the mid-term most of the experts suggest that a stronger focus should be set on developing the use of baobab for domestic African markets instead. Despite the various uses of baobab documented throughout entire sub-Saharan Africa, baobab is not necessarily an inherent part of the daily diet. For example, in Zimbabwe Baobab is fed to animals and ignored by humans (Collenberg, pers. comm.). Considering that baobab primarily grows in famine-ridden areas, the tree offers significant potential for contributing to food security and a more balanced diet. Moreover, domestic markets provide the advantages of less strict quality standards and regulations, a larger customer base, reduced logistics and transportation cost and reduced marketing efforts since customers are already familiar with the product.

5. The baobab value chain: From Africa to Europe

A number of baobab harvesting, wholesale and processing initiatives have been established in various African countries, sometimes with a not-for-profit character, in order to exploit the commercial opportunities arising from the novel food acceptance of baobab powder. Because the international baobab market is in its early stage of development, production is still small-scale and collection of baobab focuses on a small area only.

Fruits are in ample supply in many parts of sub-Saharan Africa. The fruits are picked from the tree with a long stick that has a hook attached to its end. To reach the fruits hanging further up, collectors frequently climb up the tree. While some baobab trees, in particular the ones growing on individual farmers' plots, are typically exclusively harvested by these farmers, baobab trees outside the villages frequently constitute common pool resource that is open to the entire village community. Due to the non-exclusive character of resource access fruits from these trees often tend to be harvested too early, which leads to high moisture content and overall lower fruit pulp quality. In countries like Malawi, South Africa, Zimbabwe or Mozambique, the baobab harvesting and processing initiatives, therefore, typically organize farmers and fruit harvesters in village-level organizations in order to facilitate fruit collection and processing. The headman of the organization then communicates and negotiates with the middlemen. In Mozambique, the village organizations sometimes partially also own the baobab processing plants.

Once the fruit has been collected, pre-processing comprises the steps of cleaning the fruits, breaking them and separating the pulp and seeds from the fibers. In its most basic way of processing, the pulp is then placed in a mortar in which it is separated from seeds and fiber in a long and slow process. Grinding usually takes place when a minimum required quantity of fruit pulp is available. Eventually, the pulp is sieved

several times until the baobab fruit powder is fine and clear of any residues. Most of these stages involve manual work. More advanced equipment for mechanized sieving has been developed in Malawi.

Cleaning the fruits before they are opened, i.e. carefully removing the fine hairs and other impurities from the shell has proved to be essential for obtaining high quality fruit powder. Currently various operational models for pre-processing and processing exist: Either the pulp is extracted and grinded into powder directly by the harvesters, or fruits are cracked locally and the pulp is shipped on to a processing unit. A third option is the collection of the whole fruits and the delivery thereof to a centralized site where processing takes place. Decentralized pre-processing has the advantage that the quality of the fruit pulp can already be assessed at the harvesting site when the fruits are opened. It also reduces transportation cost, as only the processed fruit powder is transported that does not contain the seeds and fibers anymore. Centralized cleaning, grinding and sieving, on the other hand, seems to result in higher qualities of fruit powder containing less impurities. More advanced technical equipment can be used and better hygienic conditions during the processing stages can be achieved. .

The fruit powder is then collected and transported to wholesalers, where the final quality control takes place, special assortments (e.g., ultra-fine powder) are produced to custom order, and more sophisticated packaging technologies (e.g., vacuum packaging) are available. Wholesalers also deal with international bulk buyers' requests. Meeting the hygiene regulations for international markets still poses an enormous challenge to many baobab harvesting, wholesale and processing initiatives, which makes developing the baobab trade with European customers a risky and expensive business. When cleared for export, the powder is shipped to Europe where it is then either sold directly to retail customers mainly through online stores, or further processed by a European food manufacturer into products that meet the taste of European consumers.

Despite dedicated efforts made by Phyto Trade Africa and others to proactively build consumer awareness for baobab products in Europe and other developed markets, reaching the end consumer outside the health/ organic/ fair trade niche market still represents a major challenge. In the past, a number of mass market producers have tested the market with limited editions of baobab products (e.g., Bauer, PepsiCo); yet, these products have been discontinued after some time.

The analysis of the value chain with Europe being the target market supports the point that the paper already made. At this point in time, a focus on the domestic African markets seems to offer much greater potential for baobab utilization.

Figure 2: The baobab value chain

6. Conclusion

The expert interviews delivered a good insight into a number of issues along the baobab value chain. The reliability of timely delivery and a consistent quality of the powder have proved to be the major current challenges for international baobab trade. The availability of fruits does generally not seem to be a challenge at the current levels of demand. With demand further increasing, the impact of commercial baobab collection on subsistence consumption of baobab need to be carefully evaluated particularly in regions, where baobab currently already constitutes an important component of the diet. Furthermore, a need for sustainable management techniques is evident, especially when additional demand can be expected. More research is needed to explore domestication technologies, including germplasm selection and development of planting material. This also will assist in a better understanding of the impact of environmental factors and management on the quantity and quality of baobab pulp. In addition to that, there seems to be ample scope to further develop available processing technologies in order to improve the quality of the baobab products and increase the efficiency of the production process.

References

Adam Y.O., Eisa M.A., Ahmed D.M. (2012). Role of Adansonia digitata L. fruits in development and forest conservation in Rashad locality, Nuba mountains, Sudan. University of Khartoum Journal of Agricultural Sciences 20(3), 314-328

Belcher, B., Schreckenberg, K. (2007). Commercialisation of Non-Timber Forest Products: A Reality Check. Development Policy Review 25: 355-377.

Buchmann C., Prehsler S., Hartl A., Vogl C.R. (2010). The importance of Baobab (Adansonia digitata L.) in rural west African subsistence – Suggestion of a cautionary approach to international market export of Baobab fruits. Ecology of Food and Nutrition, 49: 145–172

CEC (2008). Commission Decision of 27 June 2008 authorising the placing on the market of Baobab dried fruit pulp as a novel food ingredient under Regulation (EC) No 258/97 of the European Parliament and of the Council (notified under document number C(2008) 3046) (2008/575/EC). Official Journal of the European Union. 11/7/2008, http://www.food.gov.uk/mul/t/imedia/pdfs/commdec2008575ec.pdf [last accessed on 08/06/2012]

Cuni Sanchez A., Osborne P., Haq N. (2010). Identifying the global potential for baobab tree cultivation using ecological niche modeling. Agroforestry Systems 80:191–201

FDA (2009). Agency response letter GRAS notice no. GRN000273, 25/July/2009. US Food and Drug Administration.http://www.fda.gov/Food/FoodIngredientsPackaging/GenerallyRecognizedasSafeGRAS/GRASListings/ucm174945.htm [last accessed on 08/06/2012]

Gebauer J., Assem A., Busch E., Hardtmann S., Möckel D., Krebs F., Ziegler T., Wichern F., Wiehle M., Kehlenbeck K. (2014). Der Baobab (Adansonia digitata L.): Wildobst aus Afrika für Deutschland und Europa?! Erwerbs-Obstbau 56 (1), pp 9-24

Gebauer J., El-Siddig K., & Ebert G. (2002). Baobab (Adansonia digitata L.): a review on a multipurpose tree with promising future in the Sudan. Gartenbauwissenschaft 67(4), 155-160.

GfK (2010): Wachstumsmarkt Naturkosmetik. Nürnberg: Gesellschaft für Konsumgüterforschung

Gruenwald J., Galizia M. (2005): Market brief in the European Union for selected natural ingredients derived from native species: Adansonia digitata L. Geneva: The United Nations Conference on Trade and Development (UNCTAD)

Gruere P.G., Giuliani A., Smale M. (2006). Marketing underutilized plant species for the benefit of the poor: A conceptual framework. IFPRI Discussion Paper no. 154, Washington, USA.

Jamnadass R.H., Dawson I.K., Franzel S., Leakey R.R.B., Mithöfer D., Akinnifesi F.K., Tchoundjeu Z. (2011). Improving livelihoods and nutrition in sub-Saharan Africa through the promotion of indigenous and exotic fruit production in smallholders' agroforestry systems. A review. International Forestry Review Vol.13: 1-17.

Jones, C. (2007). Initial Opinion: Baobab Dried Fruit Pulp. Food Standards Agency. http://www.food.gov.uk/multimedia/pdfs/baobabinitialopinion.pdf [last accessed on 30/05/2012]

Phyto Trade Africa. (2008). Baobab (Adansonia digitata L.) - Fruit pulp powder production capacity and sustainability in southern Africa. London: Phyto Trade Africa.

Sidibe M., Williams J.T. (2002). Fruits of the future - Baobab (Adansonia digitata L.). Chichester: International Centre for Underutilised Crops.

Siro I., Kapolna E., Kapolna B., Lugasi A. (2008). Functional food: Product development, marketing and consumer acceptance – A review. Appetite 51: 456–467

Stadlmayr B., Charrondiere U.R., Eisenwagen S., Jamnadass R., Kehlenbeck K. (2013). Nutrient composition of selected indigenous fruits from sub-Saharan Africa. Journal of the Science of Food and Agriculture 93: 2627–2636

Wickens G.E. (1982). The baobab – Africa's upside-down tree. Kew: Royal Botanic Gardens.

Wickens G.E., Lowe P. (2008). The baobabs: Pachycauls of Africa, Madagascar and Australia. New York: Springer.

Wilkinson, J. (2006). Baobab Dried Fruit Pulp – An application for Novel Foods Approval in the EU as a food ingredient. The Seed Bed Centre, Langston Road, Loughton, UK. http://www.food.gov.uk/multimedia/pdfs/baobabapplicationfinal.pdf [last accessed on 30/05/2012]

Market Chain Analysis of Agro-forestry Products The Case of Avocado Fruit at Tembaro Woreda, South Ethiopia

Nega Mateows [a], Teshale WoldeAmanue l[b], Zebene Asfaw [b]*

[a] Dilla University, College of Agriculture and Natural Resources, Dilla, Ethiopia

[b] Hawassa University, Wondo Genet College of Forestry and Natural Resources, Shashemene, Ethiopia

Abstract

In densely populated areas of central and south Ethiopia, fruit trees based agroforestry is an important land use system with its economic and environmental benefits to smallholder farmers. However, the smallholders are not getting enough benefit from the practice. Rather, food aid is common practice. The nature of the product on the one hand and the lack of efficient marketing system on the other hand have resulted in low producers' price and low benefit to the producers. This study was carried out to analyse the market chain of the avocado fruit. Data was collected from 140 avocado producing households, 7 local collectors and 13 retailers through structured interview, focus group discussion, key informant interviews, and field observation. The result shows the presence of four marketing channels with producers, local collectors, retailers, and consumers being the actors. Among the channels the producer-retailer-consumer channel was identified as the first channel in terms of the volume of fruits transacted while the producer-local collector-consumer channel is the least channel.

[*] Corresponding author: thabebo@gmail.com

The results of the econometric analysis show that price, access to extension services and market information, distance, and quantity produced positively and significantly affected the supply of avocado fruits, whereas distance from the market has a negative and significant effect on the quantity supplied. Thus, both physical and institutional infrastructures should be improved to promote buyers to come to the production area than producers to export the fruits to long distances. This will increase the efficiency of the marketing system by reducing the information asymmetry between the buyers and sellers and reducing the market inefficiency due to the perishability of the products. As the tradition in the area considers trading fruits a low profile activity mainly handled by female traders, we recommend concerned stockholders to create awareness that fruits are important cash crops in the study area.

Keywords: agroforestry; market chain; structure, conduct and performance; concentration ratio; marketing margin

---

1. Introduction

Ethiopia is one of the developing countries with high population growth and chronic food insecurity. The majority of the population live in rural areas where agriculture is the main occupation and source of livelihood. In Ethiopia agriculture contributes for about 47.3% of GDP and 90% of export earnings (NBE, 2006). The country also suffers from environmental problems. To achieve the food security and conserve the natural environment goals simultaneously, the country has been implementing different strategies. Diversification of crops, intensification of agricultural production, and encouraging the production of early maturing and high yielding crops in different agro-ecologies of the country are some strategies (CSA, 2009). As Ethiopia is characterized by having different agro-

ecological zones with a total area of about 1.13 million km^2 (Kahsay *et al.,* 2008), it favours the production of crops, animals and trees either in mono-cultural or poly-cultural farming systems. Notably, the southern and south western part of the country is known for the latter system of production. Such production systems are even indigenous designs by the local community for diversifying the products obtained from the system and hence increasing food security as well as contributing for environmental improvement and regulation.

The fruit based agro-forestry system is known in Ethiopia notably in southern and south west Ethiopia as components of such land use systems which balance livelihood improvement and environmental conservation. A number of fruit crops have been growing in different agro ecological zones by small farmers, for subsistence and income generation accounting for about 61,972.60 hectares of land under fruit crops. Bananas (*Musa paradisiaca*) comprises about 58.11% of the fruit crop area followed by avocados (*Persea americana*) and mangoes (*Mangifera indica*) that contributed 14.42% and 14.21% of the area respectively. More than 4,793,360.64 quintals of fruits were produced in the country. Bananas (*Musa paradisiaca*), Mangoes (*Mangifera indica*), Papayas (*Carica papaya*), Oranges (*Citrus sinensis*) and Avocados (*Persea americana*) respectively comprise about 63.11%, 14.55%, 8.07%, 7.46% and 5.35% of the fruit production (CSA, 2012).

The integration of fruit trees and crops is one of the agro-forestry practices that improve the livelihoods of the local community as well as the environment. Notably, the importance of this land use system in densely populated areas such as Tembaro Woreda is crucial. Tembaro Woreda is endowed with diverse natural resources and has the capacity to grow different fruits types. However, the local people in the area are not getting enough benefit from the resources. Rather, food aid is a common practice in the area (WoAD, 2012). The nature of the product on the one hand and the lack of market system

on the other hand have resulted in low producers' price and hence low benefit by the producers.

As Bosena Tegegne (2008) indicates increasing the production of products to the extent of increasing the value of exports is not an end by itself. Rather it is only a means of accelerating the rate of economic growth. If market performance is inefficient, the sustainability of the production becomes questionable and as a result continuous supply of the commodity for the market becomes difficult. Increased production needs to be accompanied by efficient marketing system. Therefore, one means of investigating the efficiency of any product marketing system is through studying the market chain of the products. Therefore, it is essential to know and understand how this system is functioning under certain conditions.

In the study area the estimated volume of production of avocado (*Persea americana*) was about 15850 quintals from which about 12800 was sold (WoAD, 2012). Though avocado fruits are economically important commodity in the area, the marketing and market chain aspects have not yet been studied to the extent that will allow making specific recommendations for further development of the resource and proper management of the market chain in Tembaro Woreda. The fact that Avocado is a non-traditional fruit in the area makes studying the value chain of avocado more timely and crucial. Therefore, the focus of this study is to provide relevant information for proper use and development of Avocado fruits market by (i) identifying the actors and their functions in the Avocado market chain, (ii) analyzing the marketing channels for agro forestry products mainly for Avocado, and (iii) examining the determinants of supply for Avocado fruit.

2. Material and Methods

Tembaro Woreda is located in Kembata Tembaro Zone, SNNPR. It is located at about 400km and 180km south of Addis Ababa and south west of the principal city of the region Hawassa, respectively. Geographically, it is located between $32^{0}98'$ E to $34^{0}29'$E and $8^{0}08'$N to $8^{0}9'$N. The total area of the district is about 27,917 hectares. The altitude of the Woreda ranges from 800 to 2600 m.a.s.l and the slope ranges from intermediate (3-30%) to very steep slope (above30%) according to BoARD (2007). The study encompassed two kebeles namely Bachira and Debub Ambukuna.

Both primary and secondary sources of data were employed to address the objectives of this study. Primary data were collected through a structured questionnaire, focused group discussions, key informant interviews and field observations. The primary data were collected using two types of interview schedule (one for farmers and the other for traders). The primary data collected from fruit producing farmers was on factors affecting the supply of avocado fruit, socioeconomic characteristics of the households, price setting strategies and terms of payment. The interview schedule for traders include: types of traders (retailers, local collectors, wholesalers etc.), buying and selling strategies, experience of traders on fruit trading, access to market information and socioeconomic characteristics of the traders. Secondary data was collected from different sources, such as: government institutions, the Woreda`s Agricultural Development Office, bulletins and websites.

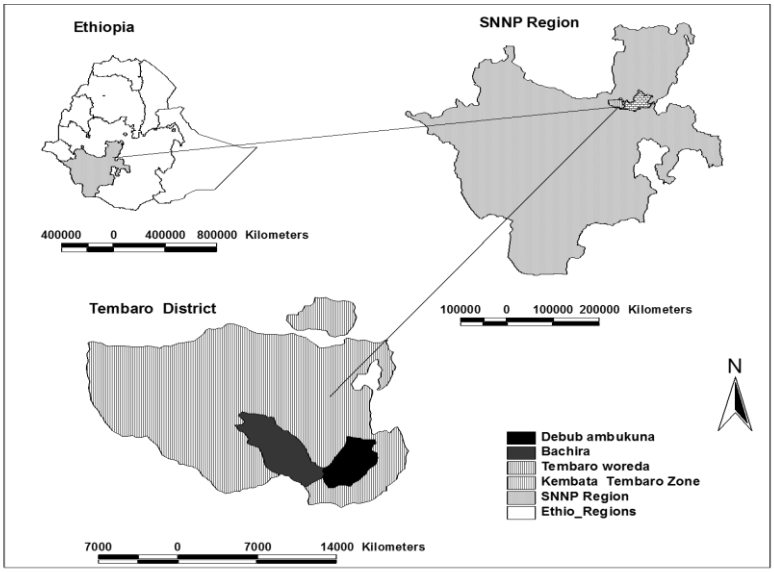


Figure 3: Map of the study area

A two-stage sampling technique was used to draw sample fruit producer farmers. First, two kebeles from the District were selected through purposive sampling approaches based on the potential for avocado fruit production. In the second stage, using the population list of fruit producer farmers from sampled kebeles, the intended sample size was determined proportionally to population size of fruit producer farmers using random sampling method. Accordingly, in this study sample size selection was based on the rule of thumb N≥50+8m, where, N, is sample size and `m` is the number of explanatory variables (Xi) where i=1, 2…11. Based on this rule the researcher had taken a total sample of 140 respondents from the selected kebeles of Tembaro district. A total of 13 sample retailers and 7 local collectors were selected randomly. For the household survey, structured questionnaires were prepared based on the information elicited through key informant interviews and focused group discussions.

3. *Method of Data Analysis*

For data analysis, both descriptive statistics and econometric analyses were employed. The descriptive statistics like mean, min, max, standard deviation, percentages and frequencies were used to examine and understand the socioeconomic characteristics of the respondents as well as the structure, conduct and performance of fruit market. The data was analyzed by using Statistical Package for Social Science (SPSS) version 20 and Excel 2007.

The econometric analysis was used to estimate the factors that affect the supply of avocado fruits. Multiple linear regression models were used since there are more than one independent variables. Here the estimated coefficients indicate the effect of a change in the independent variables on the dependent variable (Green, 2003).

Since the dependent variable, the supply of fruit is a continuous variable, OLS model was used and the OLS regression is specified as:

$Y_i = \alpha_i + ß_1X_1 + ß_2X_2 + ß_3X_3 + \ldots\ldots\ldots\ldots\ldots\ldots + ß_iX_i + U_i$

Where: Y_i = quantity of avocado supplied to market

α_i = Intercept

$ß_i$=Coefficient of the i^{th} explanatory/independent variable

X_i = Vector of explanatory variables

U_i = disturbance term

Hence, the equation for the quantity of avocado supplied is:

Quantity of Avocado Supplied = $\alpha_i + ß_1$Sex + $ß_2$Age + $ß_3$Family size + $ß_4$Edu + $ß_5$Distance + $ß_6$ Experience + $ß_7$Quantity produced + $ß_8$Price + $ß_9$Extension + $ß_{10}$Market Information + ß11 credit + U_i

Before estimating the parameters multicolliniarity and heteroscedasticity detection tests were performed using appropriate test statistics. Variance Inflation Factor (VIF) and Contingency coefficient (CC) were employed to test the existence of

multicolliniarity problem among continuous explanatory variables and dummy variables respectively.

4. Results and Discussion

4.1 Socio-Economic Characteristics of fruit Producers and Traders

Avocado producing households have diverse socioeconomic profiles in the study area. The family size profile of the respondents shows that they have large family size with an average size of 8. There are households that have as low as two family members to those households having as large as fourteen members in the family. The age of the respondents varies between 25 to 60 years with an average age of 41.82. With respect to educational status 40% of fruit producing household heads did not attend formal education, but 60% of the sampled household heads attended formal education though the level of education is less than grade 4. Nevertheless, the same households have ample experience with respect to fruit production especially the traditional fruits such as banana. With respect to the non-traditional ones such as avocado and mango the households have relatively less experience. Notably, they have an average of 9.54 years of experience in producing avocado with minimum of 5 years and maximum of 13 years of experience. The majority of the avocado producers (85.72%) were married and among them 78.57% of them were males while the rest (21.43%) were females. Regarding religion, almost three fourth of the respondents (74.29%) were Protestant and the remaining 24.28%, and 1.43% were followers of Orthodox, and Catholic respectively.

The socioeconomic profile of the traders shows that 95% of avocado traders were females while the remaining 5% were males. In contrast to the age of avocado producers, the avocado traders are relatively younger than the producers that the age of the traders range between 16 years to 34 years with an average age of 21.7 years.

Furthermore, they have few experiences with an average age of 3.45 years in avocado trading minimum of 3 and maximum of 4 years of experience. The avocado traders have relatively better level in their educational status than the producers. Thus 90 percent of the traders attended formal education (40 percent attended elementary school, 35% attended secondary school, and the remaining 15% attended grade 9-10). However, only 10% of sampled traders did not attend formal education.

4.2 Structure, Conduct, and Performance of Avocado Marketing

4.2.1 Market structure

The nature of market structure of avocado was presented and discussed with respect to the types of actors and their functions in the chain, marketing channel, the degree of market transparency, the degree of market concentration and entry and exit barriers.

a. Actors and their functions in fruit markets

In the avocado market chain, varieties of actors (producers, local collectors, retailers and consumers with different function) were identified.

The producers are the first actors in the marketing chain of avocado fruit and all of them are smallholder farmers who produce avocado fruit and supply to the next agents. With respect to marketing, avocado products that producers/smallholder farmers sell the fruit they produced to different buyers/traders in the village market or in the capital market of the district. The second actors in the avocado market chain are the local collectors. They are important actors in the market chain and they collect avocado fruits direct from fruit producers or farmers sell it to retailers and consumers. The retailers are also important actors in the fruit marketing channel that deliver avocado fruit to consumers. That is, they purchase avocado fruit

either directly from producers or local collectors and deliver to consumers. The consumers are the last actors in avocado fruit marketing chain and they are individuals or households who buy avocado fruit from fruit producers, local collectors and retailers for their own consumption only.

b. Avocado market channel

The survey result indicated that there were four major marketing channels for avocado fruit (see figure 2). The estimated volume of production of avocado was about 15850 quintals. From the total production of avocado about 12800 and quintals was sold. Comparison was made among the channels based on the volume of avocado fruits that were transacted through the channel. Accordingly, the producer-retailer-consumer market channel shared the largest volume (i.e. 5248qt) of avocado fruit which is 41% of the total volume of avocado fruits transacted followed by producer-consumer channel which shared 31% (3968qt) of the total volume of avocado fruits transacted. The share of the remaining two channels constituted about 28% of the total volume of avocado transacted. From this 28% about 15% of the total volume of avocado fruits transacted is handled by the producer-local collector-retailer-consumer channel whereas the remaining 13% of the total volume of avocado fruits transacted is handled by the producer-local collector-consumer channel.

In the producer-consumer channel, producers sell avocado fruit directly to the consumers and the channel accounts for about 31% (i.e. 3968qt) of avocado which was transacted during the survey period and it stands second in terms of the volume of avocado transacted in the market.

The producer-retailer-consumer channel, however, stand first in terms of the volume of avocado transacted. In this channel producers sell avocado fruit to the retailers and the retailers in turn sell the fruit

to consumers. The channel accounts for 41% (5248qt) of the total avocado transacted during the survey period

The share of remaining two channels, producer-local collector-retailer-consumer and producer-local collector-consumer is relatively lower than the other channels mentioned. In the producer-local collector-retailer-consumer, consumers purchase the avocado fruit from retailers via local collectors. The channel accounts for about 15% (1920qt) of avocado fruit which was marketed during the survey period. The producer-local collector-consumer is channel the consumers buy the avocado fruit from producers via local collectors and it accounts for 13% (1664qt) of total avocado marketed in the study area during the survey period. The channel stands last in terms of the volume of avocado fruit marketed.

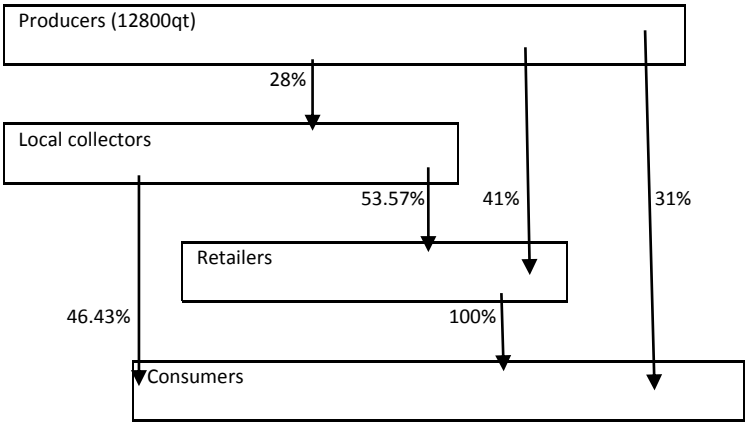


Figure 2: Marketing channel of avocado

c. Degree of market transparency

The survey result indicates that only 35 percent of producers have adequate, timely and reliable market information in the study area but the remaining 65% of the fruit producers mentioned they lack adequate, timely and reliable market information. This might be because of poor infrastructural facilities and institutional problems including lack of access to extension and credit service that favour fruits production and marketing. In this respect, it is known that traders have relatively in better position with respect to information access. That is, 55% of the traders mentioned that they have adequate, timely and reliable market information but the remaining 45% of the traders have no adequate, timely and reliable market information. The result found out that traders have better exposure to information than the producers. This may be because the traders have better access to mobile phones and other means of getting market information. This is in line with the study of Ayelech (2011) who reported that the traders have more privileged in information access than producers.

d. Degree of market concentration for avocado

Concentration ratio is expressed in terms of CRx which stands for the percentage of the market sector controlled by the biggest X firms. Concentration ratio for avocado market was calculated by taking the annually purchased volume of avocado by market participants in quintal. The degree of market concentration was measured using the common measures of market concentration that is Concentration Ratio (CR_4).

The result in table 1 shows that the concentration ratio for avocado is 24.4%. This indicates that avocado fruit markets in the districts were characterized by unconcentrated suppliers/traders/sellers. Four firms (CR_4) concentration ratio is the most typical concentration ratio for judging the market structure. A CR_4 of over 50% is generally considered

a tight oligopoly; CR_4 between 25% and 50% is generally considered a lose oligopoly, and a CR_4 of fewer than 25% is competitive (Kohls and Uhl, 2002). Following the market structure criteria by Kohls and Uhl (2002), avocado market showed competitive nature that was CR_4 of 24.4%. The result coincides with the study of Adugna (2009) who found out the competitive nature of fruits and vegetable market.

Table 3: Concentration ratio for avocado market in Tembaro Woreda

No.of Traders (A)	Cumul. frequency of traders (B)	% of traders ($C=\frac{A}{20}$)	Cumul. % of traders (D)	Quantity purchased in kg (E)	Total quantity purchased in kg F=A*E	% share of purchase ($Si=\frac{F}{8195}$)	% cumul. purchase ($C=\sum_{i=1}^{r} Si$)
1	1	5	5	600	600	7.32	7.32
1	2	5	10	500	500	6.10	13.42
2	4	10	20	450	900	10.98	24.4
1	5	5	25	425	425	5.19	29.59
3	8	15	40	420	1260	14.64	44.23
1	9	5	45	410	410	5.00	49.23
1	10	5	50	400	400	4.88	54.11
6	16	30	80	380	2280	27.82	81.93
2	18	10	90	360	720	8.79	90.72
2	20	10	100	350	700	8.54	99.26
		100			8195	100	

Source: own computation (2012)

e. Entry and exit barriers

Regarding entry and exit, the data shows that there are no technical, financial, and institutional barriers in the avocado market chain. All the avocado fruit producers and traders can enter in to the market without any limitations. The same is true when they want to leave the market. This means that anyone who wants to engage in avocado fruit marketing can enter into the market without any problem. This is also ascertained by the concentration ratio results. Since the concentration ratio of avocado fruit shows the competitive nature of avocado fruit market in the area, the traders can enter into and exit

from the market easily. So, there are no entry and exit barriers in avocado fruit marketing in the study area.

4.2.2 Market conduct

a. Price setting

94.3% of the respondents indicated that the price for avocado is set by the traders influence making use of the pershiable nature of the fruits. But it is only in rare cases (5.7%) that the price for avocado is set by the negotiation made between the avocado producers and price. The selling strategy of the respondent farmers is open to any buyer. This is not in line with Ayelech (2011) who stated that the greater proportion of price for avocado and mango was set by demand and supply interaction and the selling strategy of the respondent farmers was open to any buyer.

b. Terms of payment

Almost all producers in the study area practiced cash in hand system. Out of the total respondents 95% of the respondents receive the price for their product as soon as they sold and the remaining 5% receive the price other day. In rare cases due to the perishable nature of the fruit, the farmers are enforced to sell the fruits for traders or consumers, deferring the recipe of the money/cash the other day. But in most of the cases the producers in the study area practiced cash in hand system. This may be due to the lack of institutional arrangements that facilitate future market as well as the socioeconomic conditions of the fruit producers that may force them use the money for their daily and other related problems. This is in line with the findings of Adugna (2009) who explained that large proportion of the fruit producers practiced cash in hand system and take the price as soon as they sell the fruits.

4.2.3. Market performance of avocado

Table 2 presents the results of the marketing margin among different actors in different channels. The result shows that the share of the actors varies based on the type of the channel. It shows that farmer's share of the total consumer price was 100% in channel I, 85.7%, 82.6% and 86.4% in channel II, III and IV respectively. This implies that 14.3% of the total consumer price in channel II, 17.4% of the total consumer price in channel III and 13.6% of the total consumer price in channel IV results from marketing activities by traders. Without considering channel I (producers sell directly to consumers) the total gross marketing margin (TGMM) is the highest in channel III which is about 17.4% and lowest in channel IV which is about 13.6 %. Producer's share (GMMp) is highest (86.4%) from the total consumers' price in channel IV and lowest in channel III (82.6%). The relatively lowest share of producers in channel III is because of the involvement of local collectors in this channel. Retailers have got relatively higher marketing margin which is 8.7% whereas local collectors have got lower marketing margin which is 8.6%. The result does not coincide with the study of Ayelech (2011) who found out that of all avocado traders, processors get the highest gross marketing margin.

Table 2: Market performance of Avocado in terms of marketing margin with respect to the share of actors in each channel

Actors	Price in birr	Ch. 1	Ch. 2	Ch. 3	Ch. 4
Producer	Selling price	200	180	190	190
	Farmers share%	100	85.7	82.6	86.4
	TGMM%		14.3	17.4	13.6
Local collector	Selling price			210	220
	Margin			20	30
	Marketing margin%			8.6	13.6
	TCMMa%			49.4	100
Retailer	Selling price		210	230	
	Margin		30	20	
	Marketing margin%		14.3	8.7	
	TCMMr%		100	50.6	
Final consumer price		200	210	230	220

Source, Survey result (2012)

4.3. Determinants of the supply of Avocado fruit

Eleven variables were expected to influence the volume of marketed supply of avocado fruit including age of households, sex of households, active labour force, distance from the market, access to market information, access to extension service, quantity of fruits produced, price of fruits, experience, access to credit service and education level of household head. Among the hypothesized variable, five variables were found significant with respect to supply of avocado fruit to the market (Table 3). These are distance from the market, quantity of avocado produced, price of avocado, access to extension service and access to market information. Generally, the significant variables were consistence with priority expected sign. This relation between the dependent variable (supply of mango) and the explanatory variable was explained by the model (with R^2 value of 0.878 and adjusted R^2 value of 0.862). This means that 87.8% of the variation in the dependent variable is explained by the explanatory variables included in the model. Furthermore, the adjusted R^2 of 86.2% which is significant has further consolidated the goodness of the model, hence, its econometrics significance and reliability.

Table 3: Determinants of quantity of avocado supplied to the market

Variables	Coefficients	Std. Err.	t	P-value
(Constant)	0.819	1.307	0.626	0.533
Sex of HHH	0 .025	0.212	0.120	0.904
Age of HHH (in years)	0 .001	0.012	0.098	0.922
Active family size of HHH	0.034	0.076	0.451	0.653
Education level of HHH	0.004	0.097	0.038	0.970
Distance from the market	-0.116*	0.058	-1.991	0.050
Years of experience	0.012	0.028	0.445	0.658
Quantity produced in quintal	0.740***	0.035	21.372	000
Price of avocado	0.528***	0.198	2.669	0.009

Access to extension service	0.0550**	0.225	2.444	0.016
Access to market information	0.239**	0.106	2.26	0.026
Access to credit service	0.044	0.238	0.183	0.855
R^2 0.878				
Adjusted-R^2 0.862				

*, **and *** represents the level of significance at 10%, 5% and 1% respectively.

Distance from the market as hypothesized is negatively related to marketable supply of avocado. The result shows that access to the market is significantly and negatively related to the marketed supply of avocado at 10% significance level. This means that an increase in distance by one kilometre indicates makes the quantity supplied to the market to be reduced by 0.116 quintals, *other things remaining constant*. As the distance from the production area to market place become further and further, farmers supply lesser quantity of avocado to the market. This may be due to the nature of the product (i.e. perishablility) and the costs which are related with transportation. This is in line with the findings of Ayelech (2011) who explained that as the distance increased from the production area to market, quantity of fruits supplied to the market decreased.

The result in table 9 shows that the quantity of avocado is significantly and positively related to marketed supply of avocado at 1% significance level. The value of the coefficient for production of avocado implies that an increase in production of avocado by one unit per hectare resulted in an increase in farm level marketable supply of avocado by 0.740qt, *ceteris paribus*. This could be because as the production of avocado increases, the farmers are going to supply more amounts to the market. The result coincides with Adugna (2009) who explained an increase of fruit production by farming households has increased market supply of the fruits significantly.

As hypothesised the price of avocado shows positive and significant relationship between the variables and significant at 1% significance

level. The coefficient of the variable also confirms that a unit increase in price of avocado market make the households to increase the supply of avocado to the market by 0.528qt, *other things remaining constant*. This might be because as the price for avocado increase in the market, farmers will supply more amount of avocado to the market to get better price for the product. The result coincides with the findings of Wolelaw (2005) who stated that as the price for products in the market increases, the supply will also increase.

Access to extension service as hypothesised is related to the marketed supply of avocado positively and significantly at 5% significance level. On average, if an avocado producer got more extension contact, the amount of avocado supplied to the market increase by 0.0550qt, *other things remaining constant*. This might be because extension service enables the farmers to have better knowledge about how to get better production and creates farmers` awareness about new technologies. This is in line with the result of Yishak (2005), Rehima (2006), and Ayelech (2011) who found that if fruit producer get more extension service access, the marketable supply of each of the commodities will increase and it is related significantly and positively with the supply of products to the market.

Regarding access to market information, the result (positive at 5% significant level) indicates that as access to market information increased, the amount of avocado supplied to the market increased on average by 0.239qt, *other things remaining constant*. This might be because as the farmers have better access to market information, the probability of getting better price for the product will increase, which in turn increase the supply of the fruit to the market. This is in line with Mohammed (2011) who found that access to market information related with the marketable supply of agricultural commodities significantly and positively.

5. Conclusion

Tembaro Woreda is endowed with diverse natural resources and has a capacity to grow different fruits types. However, the local people in the area are not getting enough benefit from the resources. Rather, food aid is a common practice in the Woreda. This study was conducted at Tembaro Woreda to analyze the avocado market chain and investigate the factors that influence the supply of avocado fruit to the market. The actors who are participating in production and marketing services of avocado fruit in the study area include producer, local collectors, retailers and consumers. Four marketing channels were identified for transaction of avocado fruit and among the channels producer-retailer-consumer marketing channel shared the largest volume of transaction while producer-local collector-consumer marketing channel shared the least volume of each fruits in terms of transaction. Avocado fruit trading in the study area is considered as a low profile activity and mainly handled by female traders. The result shows that the market for Avocado fruit at Tembaro district is characterized by unconcentrated suppliers and traders, free entry and exit and the majority of avocado fruit. However, the price is set by the influence of the traders owing to the perishable nature of the fruits that affect the bargaining power of the producers. Moreover the OLS result shows that infrastructural (distance to market, lack of facilities to reduce perishability) and institutional (access to information and extension service) and household factors influenced the supply of avocado fruit in the area. We recommend that government agencies and other concerned bodies should work hard on improving rural infrastructures (road network,) and institutional services (credit service, information network) to produce more avocados and supply more to get more benefit.

Acknowledgements

We are deeply indebted to DeLPHE-BC Project for its generous financial support to carry out this research. Also our gratitude goes to the Tembaro Woreda Marketing and Cooperative office for its provision of the necessary support for this study.

Lists of annexes

Annex 1: Multi-co linearity test with VIF

Variables	Tolerance	VIF
Age	0.855	1.629
Active family labour	0.553	1.808
Education status	0.674	1.484
Distance from market	0.543	1.843
Experience	0.864	1.158
Quantity produced	0.643	1.556
Price	0.472	2.117

Annex 2: Contingency Coefficient

	Sex	Extension contact	Access to market information	Credit
Sex	1			
Extension contact	0.069	1		
market information	0.178	0.114	1	
Credit	0.094	0.069	0.292	1

References

Adugna, G. (2009) Analysis of Fruit and Vegetable Market Chains in Alamata: The Case of Onion, Tomato and Papaya, Southern Zone of Tigray. 114p.

Ayelech, T. (2011) Market Chain Analysis of Fruits in Gomma Woreda, Jimma Zone, Oromia National Regional State. 127p.

BoARD (2007) Agricultural and Rural Development Planning Section Report. People and Housing Survey Report, Central Statistics Authority, Addis Ababa, Ethiopia.

Bosena, T. (2008) Analysis of Cotton Marketing Chains: The case of Metema woreda, North Gondar Zone, Amhara National Regional State. 125p.

CSA (2009) Area and Production of Major Crops. Sample Enumeration Survey. Addis Ababa, Ethiopia.

CSA (2012) Area and Production of Major Crops. Sample Enumeration Survey. Addis Ababa, Ethiopia.

Green, H.W. (2003) Econometric Analysis: Fourth Edition. New York University Macmillan Publishing Company. Implications for development interventions Master thesis.

Kahsay, B. Yigzaw, D. Yisehak, B. Worku, T. and Azage, T. (2007) Smallholder-based fruit seedling supply system for sustainable fruit production in Ethiopia: Improving Productivity and Market Success (IPMS) of Ethiopia Farmers Project, Addis Ababa, Ethiopia.

Kohl, R.L. and Uhl, J.N. (2002) Marketing of Agricultural Product, 9th Edition, Prentice-Hall of India PLC, New Delhi

Urgessa, M. 2011) Market chain analysis of teff and wheat production in Halaba special Woreda, Southern Ethiopia. 120p.

National Bank of Ethiopia (NBE), (2006) Annual Report. Addis Ababa, Ethiopia.

Tembaro Woreda Agriculture Development office (WoAD), 2012. Annual report

Wolelaw, S. (2005) Factors Determining Supply of Rice: A Study in Fogera District of Ethiopia.

M.Sc. Thesis Presented to the School of Graduate Studies of Haramaya University. 90p.

Yishak Gecho, (2005) Determinants of Adoption of improved Maize Technology in Damote Gale Woreda, Wolaita, Ethiopia

An Overview on Associations of Gum Arabic Producers in Sudan: Problems and Challenges

Asma Elyas Mohammed Elzubair[*a], *Yahia Omar Adam*[a] *and Taha Mohamed El Nour*[b]

[a] *Faculty of Forestry, Deptartment of Forest Management, University of Khartoum*
[b] *Deptartment of Forestry and Range Sciences, Universit of Kordofan*

Abstract

The objective of this paper is to give an overview on the Gum Arabic Producers' Associations in Sudan with special focus on their problems and challenges. The paper relied on reviewing literature from different secondary sources. The gum arabic associations established during phase III of the Restocking of Gum Belt Project (RGBP) in North Kordofan State in 1992 with a main objective of promoting financial returns from gum arabic production and marketing for the project participants. This was well connected with the consolidate idea of self-reliance among rural community members to work for the development of both Gum Belt and gum arabic production, besides the overall objective of rural development. However, there were many problems confronted the gum Arabic producers associations in Sudan such as funds, administrated issues, the relation between the members, fluctuation of the gum prices, macroeconomic trends and challenge of technological innovations for developing synthesized gum substitutes. Over and above, the global phenomena climate change has a remarkable effect on the reduction of the gum productivity due to rainfall fluctuation in terms of intensities and distribution, which has consequently resulted in shifting gum belt and gum production activities toward south. This is considered as a real challenge to community development in the northern part of the belt to find other ways to improve gum productivity and marketing.

[*] Corresponding author: asmaelyas@ymail.com

Being so it is also a good opportunity to introduce new soft technologies (e.g. associations, community development, etc...) in areas to the south where farmers have no experience with the gum production and the related activities.

Keywords: gum arabic, community development, Gum Arabic Producers' Associations, Hashab farms, North Kordofan, Sudan

---

1. Introduction

Indigenous cooperation forms are found in both rural and urban areas of Sudan such as Nafeer (social custom of communal help in the rural areas during cultivation seasons, building a house or similar practices) and Fazaa (largely practiced during catastrophic events and emergencies to provide help and assistance), which are practiced in certain occasions. Activities in gum gardens stand also as a good example of communal participation, where whole families are engaged in establishment (planting and/or sowing), tending, and tapping of gum trees.

The International Cooperative Alliance (ICA, 2005) defines a cooperative as “an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise”. Agricultural cooperatives are created by farmers to pool their means and increase their negotiating power on the market (Fulton and Hueth 2009). This paper will provide basic information on the gum arabic producers associations in Sudan and the problems and challenges faced associations will also investigate.

Following the introductory section, the paper is organized to include section two on background of cooperatives in Sudan, section three on the establish of gum arabic producers associations in Sudan and

its objectives and sources of fund, section four highlight the problems facing gum Arabic associations in Sudan and section five concludes and recommends.

2. Historical Background of Cooperatives in Sudan

The first attempts to start modern and structured cooperatives were initiated during the colonial period in 1921 in Delta Tokhar Cotton Estates, to the eastern part of the country, by a British District Commissioner but the experiment did not succeed. However, some economic factors played their role to support success of the first popular attempts to establish some form of cooperatives that known as quasi-cooperatives (Information Service, 1957).

However, in 1948 after the Second World War (WWII) the British Administration, within the plan of the British Colonial Office to promote cooperatives in the colonies, enacted the first Cooperative Legislation in Sudan; it was titled the Cooperative Ordinance.Following the 1948 Act, eighty four cooperatives were registered as consumption, agricultural and service associations, mostly concentrated in Northern, Gezira and Kassala districts. In 1950 and 1951, the British Colonial Authority encouraged the cotton producers in the private farms to export their products through cooperatives. And they formed cooperatives with limited member of 12- 17 individuals (Information Service, 1957).

In the 1973, under Numeri's Regime, the Cooperative Legislation of 1948 was changed for the first time. In 1977, the National Cooperative Union was established, besides the National Cooperative Center for Development and Training as the first educational institution in the councils of cooperation training. In the era of Numeri Regime, the number of associations increased from 900 to 4000 cooperatives, the membership was opened with a minimum limit of 50 persons, and the cooperatives were allowed for

enjoying some privileges including tax exemption (Ministry of Cooperation, 1978).

The idea of forestry cooperative is to involve and become member of a cooperative to get various services and goods through the cooperative (Gray and Lang, 1995). Forestry cooperatives can pool the resources of forest landowners to improve the condition of the landscape, add value to local forest products, and promote the region's economic development. Forest cooperative activities in Sudan are mainly through the Gum Arabic Associations because marketing of the gum is confronted with many constraints and measures of risks.

3. Gum Arabic Producers' Associations in Sudan

The first agricultural cooperative association of gum arabic producers called Zaky Din Cooperative Association was registered in Elobied (the capital of Kordofan Region at that time) in 1983. It was established according to the Law of Cooperation in Om Simaima Village with membership that reached 90 people. The performance of the Zaky Din Cooperative Association recorded failure mainly due to funding problems. It did not succeed to avail guarantees necessary for providing finance from formal sources, namely the Agricultural Bank of Sudan in Elobied, which in turn apologized for financing gum arabic production activities (Adam, 1990). The second association was the Rhode Alnabag Cooperative, concerned mainly with marketing of gum arabic; formed in Om Rowaba in 1989 with a membership of 151 paricipants. The cooperative has achieved successfully its objective specified to marketing of gum arabic (Adam, 1990).

Gum Arabic Producers' Associations (GAPAs) were established in North Kordofan State by the end of the last century in 1992 in Om Rowaba Locality in the third phase of the Restocking of Gum Belt Project (RGBP) with a main objective of promoting financial returns from gum arabic production for both the past and future project participants through the formation of farmer's associations. The

GAPAs were intended to reduce dependency on the traditional finance system locally known as the "Sheil" system. The RGBP project started with a plan to establish 20 associations with 75 persons as a minimum number for the membership (UNSO, 1989). The gum belt project promoted the formal structuring of farmer groups into registered Farmer's Associations. The initial associations comprised farmers whose income derived predominantly from the production and sale of gum arabic. The project assisted the establishment and effective implementation of twenty farmers' associations by the end of 1994. Moreover, the Forests National Corporation (FNC) established additional twelve associations after termination of the project until 2001(UNSO, 1989).

In 2002, the FNC evaluated the activities of the associations in North Kordofan State in one-day workshop and field observation. The workshop recommended the replication of the model of the associations all over the gum belt in Sudan. Associations have been consequently established in the Blue Nile, Western and Southern Kordofan, Gadarif, Sennar and the White Nile States (Cooperation and Forests, 2005).

In 2010, Elgaleem conducted a study in Sheikan and Om Rowaba Localities in North Kordofan State. It focused on the role of Cooperative Societies of Gum Arabic Producers in gum arabic production and marketing, in addition to investigating general services provided by these societies. Elgaleem (2010) concluded that Cooperative Societies of Gum Arabic Producers in the study area were not efficient and services provided did not result in significant differences between members of societies compared to others with respect to production and marketing of gum arabic as well as increase of returns from sales of gum. The conclusive results reached by Mugdam (2014) are opposing those conclusions made by Elgaleem (2010). The role of Cooperative Societies of Gum Arabic Producers in both Bara Locality (North Kordofan State) and Ennuhud Locilty (West Kordofan Stae) was proved to be positive with respect

to gum arabic production and marketing as well as general services provided (Mugadam, 2014).

4. Objectives of the Gum Arabic Producers' Associations in Sudan

The main target of Gum Arabic Producers Associations (GAPAs) in Sudan was to consolidate the idea of self-reliance among rural groups to work for the development of the Gum Belt, insure sustainable gum arabic production and work towards the overall rural development. This besides a wide spectrum of other objectives such as reduction the dependence on the informal credit system known as the “Sheil” system, gradually ridding gum producers of middlemen, achieving rural capacity building though training executive committees of GAPAs on relevant administrative, managerial and financial aspects, providing health and education services in the villages within the gum belt, keep the rural groups intact to their villages and attach them to their holdings to maintain sustainable gum production, retain cooperation among the groups of the rural areas through social organization, raise the awareness of rural population about the environmental aspects and the special role of gum producing stands, and coordinate with companies and organizations working in the field of rural development to provide basic needs and solve the problem of water(UNSO, 1989).

5. Funding Sources available to the GAPAs

There are many formal and informal sources that can provide the GAPAs with credits necessary to finance gum arabic production activities; they represent both governmental and non-governmental institutions (NGOs) exemplified in:

- Banks
- NGOs and INGOs such as FAO and IFAD
- Social funds such as revolving fund “Sanduk” system

- Forests National Cooperation (FNC); an example of governmental institution
- Khartoum Gum Processing Company (KGPC)
- Khartoum Enterprises for Gum Processing (KEGP)

The Traditional Islamic Financial Arrangements, which are widely used by different banking systems and playing an important role in the country. They include the so called the Murabaha(a buy and resell contract, under which the bank purchases the goods ordered from the client and resells it to the customer at a higher price (mark-up), usually on a deferred payment basis), the Salam(a buy and resell contract, but the opposite of murabaha, in the sense that the bank purchases the goods from its client, but the client delivers the goods at a later point in time), the Musharaka(a partnership contract whereby the bank and its client share a project and its profit) and the Mudaraba(a partnership contract whereby the bank and the client share a project, but the bank provides the capital and the client provides labour). The credit is usually guaranteed by the Forests National Cooperation and/or the village sheikh, as well as by the potential crop to be harvested.

6. Problems and challenges facing the GAPAs in Sudan

There are many constraints and problems facing Gum Arabic Producers Associations in Sudan and challenging their efficiency, they can be summarized to include:

- The procedures to registries of an association are complicated and the criteria for being a potential member of an association are difficult for a membership require having a gum garden with trees in the age of production and under the age of production.
- Lack of credit for gum production activities as has been indicated by Abdelraheam (2003), the GAPAs have a small contribution towards provision of finance and improvement of production and marketing of gum arabic. In some cases late

availability of funding affects negatively the smooth implementation of the planned programs and/or activities.

- Lack of professional administration staff which clear indicated by Gareek (2005) who mentioned that the negative role of the CSGAPs due to organizational and administrative weaknesses, besides exclusion from the general assembly's of decision making. AlsoTaha et.al, 2013 concluded that the misunderstanding of producers and administrators on the role and organization of CSGAPs has negatively affected the efficiency of such associations and deterred efforts to provide basic services and improve infrastructure.
- Fluctuation of both the gum prices and the world market demands, this impacts the producer price of gum over the years. However, the situation has been worsening since the 90's, with the upcoming of Chad and Nigeria as main producers of gum talha. The gum Talha from Acacia seyal is substantially cheaper than gum arabic from Acacia senegal (hashab trees) because it has inferior technical properties for some important uses of gum arabic such as in the industry of soft drinks, although it has the same chemical composition.
- Macroeconomic trends and technological innovations for developing manufactured and/or synthesized gum substitutes as a result of the 70s and 80's drought spells which reduced drastically the supply of the gum arabic from Sudan, and consequently the end-users started to integrate substitutes (principally starches). Gum talha has become the main competitor for gum hashab.
- Central and regional policies Eljubaeil (2002) had put much attention on the lack of a clear vision of credit policy, besides the strict conditions and reluctance of financing institutions to lending money both for highly risky traditional agriculture and gum production. Political unrest and inadequate marketing arrangements have resulted in the emergence of new gum producing countries, chiefly Chad and Nigeria, which produce mostly gum talha.

- Lack of infrastructure such as of Gum storage equipment, roads which impact some villages in remote area negatively to deliver their gums to potential markets with higher prices. Additionally, scarcity of the drinkable water plays negative role in the development of the associations.
- Lack of trading information as mentioned by Ibrahim, (2002) gum production communities suffer from the lack of trading information which is due to the inferior economic, social and demographic characteristics of these communities
- Climate change and its consequences on the reduction of the gum productivity. Climate change has a negative impact on the annual rainfall especially in the semiarid areas where the negative change has been exemplified in terms of the vegetation cover as emphasized by the IFAD (2004). The low annual rainfall reported in Bara Locality in the 1970s and 1980s as 129 mm and 74 mm, respectively, might have resulted in changes of species composition and density by encouragement of drought tolerant tree species and inhibited the growth of others, including Acacia sengal. As well, Jamal (1987) reported the deterioration of the gum gardens in very important producing areas in Bara, E1 Mazroub, and E1 Khuwei, up to E1obeid. Moreover, Ahmed and Warrag (2004) indicated that the area between latitude 12° N and latitude 16° N in Sudan (where gum belt lies) was reported to be seriously affected by desertification and desert movement from north to south. The same authors indicated that the northern parts had already changed into desert, while southern parts had changed into semi-desert resulting in clear change of vegetation. So the climate change has its direct effect and consequent impact on the reduction of the gum productivity and in southwards shift of the gum belt due to rainfall fluctuation. Such a phenomenon is a real challenge to the community development in the northern part of the gum belt to find other ways to improve the productivity and marketing; at the same time it is a good opportunity to establish and introduce new soft technologies (e.g. associations, community development, etc..) in gum belt

areas to the south where people have no experience with the gum production and other related/or consequent activities.

7. Conclusions

- The cooperation system in Sudan has been started early since the first attempts that were launched in 1921.
- The cooperative associations contributed significantly to the development in the rural areas in terms of providing credits, loans, water, etc.
- Establishment of the gum arabic associations has led to increasing areas under Acacia senegal stands and improvement of household income of gum producers.
- Climate change is considered as the most important factor challenging production of the gum arabic.

8. Recommendations

- Educational institutions should adopt some information on the cooperatives in their programs and curricula.
- Improvement of infrastructure and provision of adequate financial support for gum farmers and societies in production areas.
- Provision of public services, particularly drinking water, health and educational services.
- Introduction of incentives, motivations and extension services would highly encourage farmers to manage gum gardens for gum production and other environmental aspects in new areas.
- Raising awareness and training on administration of GACS that need to be linked with related institutions.
- Associations in the northern part of the belt should work to find other ways to improve gum productivity; e.g. use of improved seeds, changing the production system and others.

References

Abdelazim, M.I. (2002) Gum Production in Africa with Especial Reference to Sudan and Emphasis on Potential for Poverty Alleviation. Workshop on Gum Arabic Production, processing and Trade in Africa, Khartoum – Sudan, 22 – 25 April 2002.

Abdelraheam, S.A.(2003) Impact of Domestic Support on Provisions at World Trade Export of Gum Arabic. M.Sc. Thesis, University of Khartoum, pp 87.

Adam, M.H.(1990) Production and marketing of gum arabic. Working paper - the first conference of gum arabic. Elobied - North Kordofan.

Ahmed, K.H. and Warrag, E.I. (2005) Sudan vegetation cover assessment, using NOAA-AVHRR data, for the period between "1982-1999". Sudan Silva 11 (1): 20-33.

Cooperation and Forestry(2005) Configured of the General Union of qualitative gums Producers Cooperative. The Second Conference of gum arabic, the National Forest cooperation and Cooperative Union. Al Sahel Center for Training Khartoum.

Elgaleem, I.(2010) The Role of Cooperative Societies of Gum Arabic Producers in Promoting Gum Arabic Production and Marketing: Case of Sheikan and Om Rowaba Localities - North Kordofan State, Sudan. M.Sc. Thesis, University of Kordofan.

Ministry of Cooperation (1978) Leaders of cooperation in Sudan. The Ministry of Cooperation. Khartoum.

Eljubaeil, A.M.A.(2002)Improving Efficiency of Banking Credit for Developmental Services in North Kordofan State, Sudan. M.Sc. Thesis, University of Kordofan, pp 114.

Fulton, M.E. and Brent, H. (2009) Cooperative conversions, failures and restructurings: an overview. Journal of Cooperatives 23: i-xi.

Gareek, M.H.(2005) Annual Reports and Archive Unit. Notes of Performance of Cooperatives in North Kordofan State. Note No. 16 – 2005, Ministry of Finance, North Kordfan State, Sudan, pp 6.

Gray, D. and Lang, M.G. (1995) Starting a Co-operative for Hardwoods and Special Forest Products. California Department of Forestry and Fire Production and U.S. Department of Commerce,Economic Development Administration.

International Cooperative Alliance (ICA) (2005) Cooperating out poverty: the Global Cooperative Campaign Against Poverty; Geneva, Switzerland. Online. Available http://www.coop.org/outofpoverty/campagin.pdf. (accessed 23 August 2006).

IFAD (2004) Environmental assessment study. Main report of Republic of Sudan, western Sudan resource management program. Part 1: great Kordofan. Near east and north Africa division project management department. (annual report).

Information Service of the Republic of Sudan (1957) “News Bulletin”, No. 12.

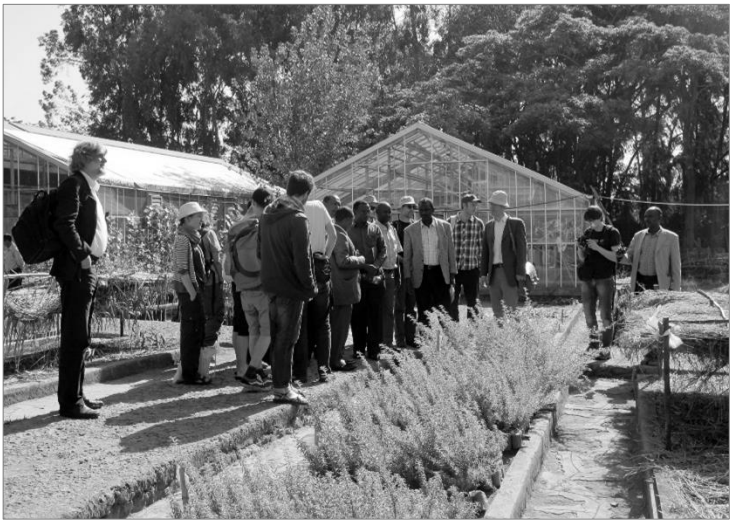
Jamal, A. (1987) Survey on major pests and diseases attacking Acacia senegal and Acacia seyal in sandy and clay soils of Kordofan Province. Gum Arabic Company and National Council for Research Khartoum, Sudan, 33 pp.

Mugadam, I. F. (2014) The Role of Cooperative Societies of Gum Arabic Producers in Promoting Gum Arabic Production and Marketing: Case of Bara and Ennuhud Localities, Sudan. M.Sc. Thesis, University of Kordofan.

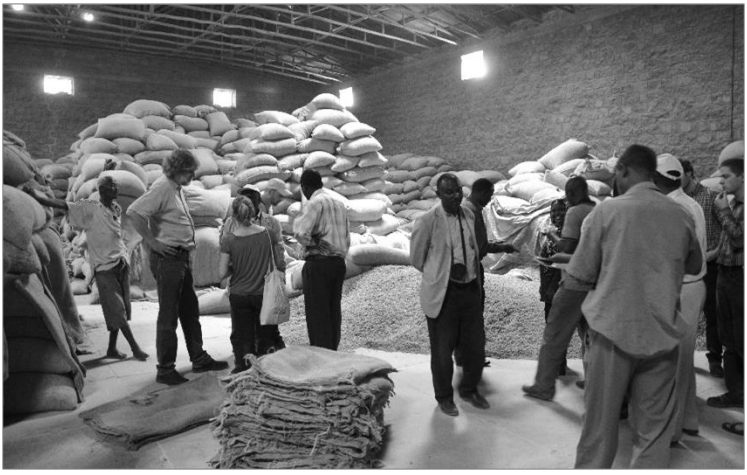
UNSO (1989) Project Document of the Restocking of Gum Belt for Desertification Control, Phase III.

Uphoff, N. (1993) Grassroots Organizations and NGOs in Rural Development: Opportunities with Diminishing States and Expanding Markets. World Development, 21 (4): 607–22.

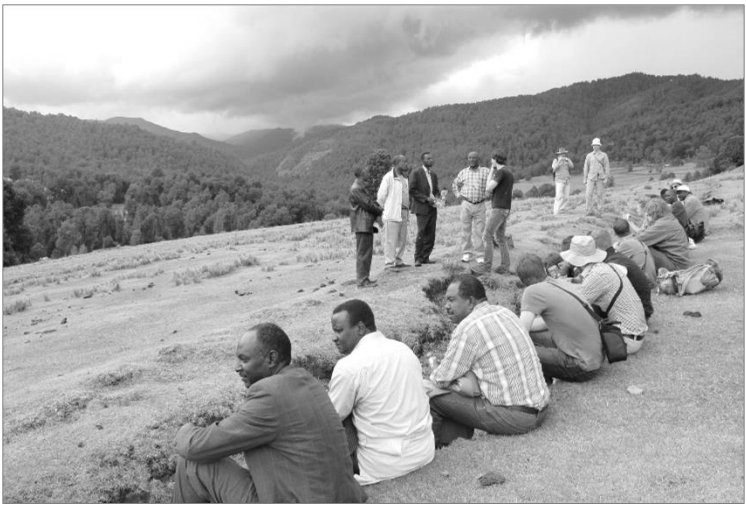
Impressions from the Workshop



Guided tour through the facilities of the Forestry Research Center, Addis Ababa



Visiting a natural gum processing enterprise in Nazareth/Adama



Visiting a participatory forest management area in the Bale Mountain region

Learning about the agroforestry systems in the Sidama region, Southern Ethiopia

German students visiting and studying the gardens and agricultural activities at the campus of the Wondo Genet College of Forestry and Natural Resources (WGC)

Student field trips in the surrounding area of the WGC to determine soil profiles and investigate erosion processes

The asthonishing Ethiopan nature – a salt lake in the Yabello Area.

Tracking back the value chain of gum to its origin and production in the South of Ethiopia at the border to Kenya .

Visiting a NGO to discuss the situation and implementation of environmental protection projects in the Central Rift Valley in Ethiopia.

Ending the successful excursion with a traditional Ethiopian dish.

25. Jahrgang Dresdner Universitätsjournal 8/2014

»Welcome to Africa« für neue Horizonte

Dresdner Studenten in Äthiopien auf den Spuren des Klimawandels

Die Reiseteilnehmer an einem Salzseekrater in Südäthiopien. Foto: Domke

Aus dem afrikanischen Großstadtdschungel Addis Abebas durch das äthiopische Rift Valley bis in die Trockenwälder nahe der kenianischen Grenze – das alles erlebten zehn Studenten der TU Dresden in nur zwei Wochen. Vom 8. bis zum 22. März reisten die Studenten aus den Fachrichtungen Forstwissenschaften und Geografie zusammen mit Prof. Jürgen Pretzsch, Inhaber der Professur für Tropische Forstwirtschaft, nach Äthiopien, um an der »Welcome to Africa«-Summer School zum Thema Klimawandel teilzunehmen.

Das vom DAAD und BMBF geförderte Projekt »Welcome to Africa« dient der Anbahnung wissenschaftlicher Kooperationen im Bereich der Klimawandelanpassung. Partnerländer sind neben Äthiopien und Deutschland auch der Sudan, Tansania und Uganda. Teilnehmer aus all diesen Ländern diskutierten in Äthiopien neueste Forschungsergebnisse und zukünftige Kooperationen. Einige von uns Studenten hatten die Möglichkeit, ihre eigenen Ideen für Abschlussarbeiten zu Themen der ländlichen Entwicklung vorzustellen und direkt mit den afrikanischen Wissenschaftlern zu besprechen. Während des zweiwöchigen Aufenthalts besichtigten wir Orte, die durch den Klimawandel bedroht sind, besuchten aber auch aktuelle Projekte, die dem entgegenwirken sollen, wie beispielsweise partizipatives Waldmanagement und Ökotourismus. Darüber hinaus diskutierten wir mit Forschungseinrichtungen und Nichtregierungsorganisationen staatliche Initiativen im Umgang mit ökologischen Problemen. Neben dem wissenschaftlichen Programm vermittelte die Reise allen Teilnehmern ebenso ein Gefühl für das Leben der Menschen in Äthiopien.

Oft können europäische Konzepte nicht direkt auf andere Länder übertragen werden, ohne lokale Bedürfnissen und kulturelle Unterschiede zu berücksichtigen. Daher war es für uns besonders wichtig, eigene Ideen direkt mit afrikanischen Wissenschaftlern zu erörtern. Aktuell erlebt Äthiopien einen enormen wirtschaftlichen Aufschwung, der jedoch vor allem die städtischen Räume erreicht, dessen negative Auswirkungen aber durchaus die ländlichen Gebiete betreffen. Diese ländlichen Gebiete stehen im Fokus der forstwissenschaftlichen Betrachtung. Die Verknüpfung von Ökologie und Ökonomie ist dabei für die Lebensverhältnisse der äthiopischen Landbevölkerung ebenso wichtig wie für die internationale Gemeinschaft, denn Landnutzungsänderungen verursachen oft erhebliche Emissionen von Treibhausgasen. Traditionelle Methoden und Organisationsstrukturen, wie Erosionskontrolle oder Agroforstsysteme müssen weiter erforscht werden, um die Vereinbarkeit von Ökologie und Ökonomie trotz großer Herausforderungen auch in Zukunft zu ermöglichen.

Programme wie »Welcome to Africa« bieten eine hervorragende Möglichkeit für Studenten, mit einer Abschlussarbeit einen Beitrag zur Beantwortung dieser aktuellen Forschungsfragen im internationalen Kontext zu leisten.

Alexander Pinkwart
Erik Aschenbrand

Article published in the campus journal of the Technische Universität Dresden about the Summer School, written by students that participated in the project excursion.

Network Contact Persons

Ethiopia

Ethiopian Environment and Forest Research Institute

Dr. Wubalem Tadesse
Institute Coordinator
Email: wubalem16@gmail.com
Phone: (+251) 116-476674

Forestry Research Center

Dr. Abeje Eshete Wassie
Center Director
Email: abejeeshete@yahoo.com
Phone: (+251) 116-460444

Wondo Genet College of Forestry and Natural Resources / Hawassa University

Dr. Tsegaye Bekele
Associate Professor
Email: bekele57@yahoo.com
Phone: (+251) 911-72044

Uganda

Makerere University

Dean
School of Forestry, Environment and Geographical Sciences
Email: tweheyo@caes.mak.ac.ug
Phone: (+256) 414-543647/8

Dr. Daniel Waiswa
Lecturer
Department of Geography, Geo-Informatics & Climatic Sciences
Email: daniel.waiswa@fulbrightmail.org
Phone: (+256) 704-937-556

Sudan

University of Kordofan

Dr. Tarig E. Mahmoud
Associate Professor
Email: tarigcom@gmail.com
Phone: (+249) 611-824080

University of Khartoum

Dr. Yahia Omar Adam Gumaa
Associate Professor
Department of Forest Management / Faculty of Forestry
Email: gumaa1973@hotmail.com
Phone: (+249) 185-310104

Dr. Elamin Sanjak Mohamed
Associate Professor/ Forestry Extensionist
Department of Forest Management / Faculty of Forestry
Email: ssanjak2000@yahool.com
Phone: (+249) 155-661599

Tanzania

Sokoine University of Agriculture

Prof. Dr. Yonika M. Ngaga
Dean
Faculty of Forestry and Nature Conservation
Email: ngaga@suanet.ac.tz
Phone: (+255) 23- 2603459

Dr. Ezekiel Edward Mwakaluka
Senior Lecture, Researcher
Department of Forest Biology /
Faculty of Forestry & Nature Conservation
Email: ezedwa@yahoo.com
Phone: (+255) 782-232381

Germany

Technische Universität Dresden

Faculty of Environmental Sciences

Institute of International Forestry and Forest Products

Professorship of Tropical Forestry

Prof. Dr. Jürgen Pretzsch

Socio-Economics & Forestry

Email: *pretzsch@forst.tu-dresden.de*

Phone: *(+49) 35203-38-31824*

Maxi Domke, M.A.

Project Coordination, Socio-Economics

Email: *maxi.domke@tu-dresden.de*

Phone: *(+49) 35203 38-31213*

Dr. Eckhard Auch

Forestry & Socio-Economics

Email: *eckhard.auch@tu-dresden.de*

Phone: *(+49) 35203 38-31822*

Scientific Cooperation Network on Climate Change Adaptation in Eastern Africa

የኢትዮጵያ የአካባቢና የደን ምርምር ኢንስቲትዩት
Ethiopian Environment and Forest Research Institute

TECHNISCHE UNIVERSITÄT DRESDEN

Cover and chapter photos: Naomi Daur, Alexander Pinkwart, Manuel Göbel, Maxi Domke / TU Dresden