

# Management and restoration practices in degraded landscapes of Eastern Africa and requirements for up-scaling

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## SUMMARY

The paper reviews forest restoration and rehabilitation efforts as well as the contributing factors to up-scaling successful restoration practices in eastern Africa. It discusses the main forms of restoration measures which include both traditional and modern measures (agroforestry, plantation and woodlot establishment). Furthermore, the paper discusses joint forest management (JFM) and/or participatory forest management (PFM) as potential strategy in facilitating restoration and sustainable management of the forest resources in eastern Africa. Lastly, the need for review of forestry and environmental policies in the region to make them more enabling for up-scaling of forest restoration and land rehabilitation practices with opportunity for development of forest enterprise has been discussed.

Keywords: degradation, enclosures, natural regeneration, restoration, policies

## Gestion et pratiques de restauration dans les paysages dégradés de l'Afrique de l'Est et les conditions nécessaires à une amélioration

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Ce papier examine les efforts de restauration et de réhabilitation forestière en Afrique de l'est, ainsi que les facteurs contribuant à l'amélioration de pratiques de restauration réussies. Il compare les principales formes que prennent les mesures de restauration, incluant les mesures traditionnelles et modernes (agro foresterie, plantation et établissement de lot boisé). De plus, ce papier explore comment la gestion forestière jointe (JFM) et/ou la gestion forestière participative (PFM) pourraient être des stratégies potentielles dans la facilitation de la restauration et de l'établissement d'une gestion durable des ressources forestières en Afrique de l'est. En conclusion, une analyse de la nécessité d'une révision des politiques de foresterie et environnementales dans la région pour les rendre davantage capables d'améliorer la restauration forestière et les pratiques de réhabilitation de la terre, avec une opportunité de développer l'entreprise forestière, est effectuée

## Prácticas de gestión y de restauración de paisajes degradados de África Oriental y requisitos para su ampliación

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El artículo analiza los labores de restauración y rehabilitación forestal, así como los factores que contribuyen a la ampliación de las prácticas de restauración exitosas en África Oriental. Se debaten los principales tipos de medidas de restauración que incluyen tanto las tradicionales como las modernas (agroforestería, plantaciones y establecimiento de rodales). Por otra parte, el artículo discute la gestión forestal conjunta (JFM, por sus siglas en inglés) y/o la gestión forestal participativa (PFM, por sus siglas en inglés) como una posible estrategia para facilitar la restauración y la gestión sostenible de los recursos forestales en África Oriental. Por último, se discute la necesidad de una revisión de las políticas forestales y ambientales de la región para que sean más propicias para la ampliación de las prácticas de restauración forestal y rehabilitación de tierras con oportunidades para el desarrollo de empresas forestales.

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## INTRODUCTION

The rate of deforestation and forest degradation in the last few decades in eastern Africa is unprecedented and demands urgent need for intervention (Lamb *et al.* 2005). Eastern Africa<sup>1</sup> is renowned for its wildlife resources. According to Lemenih and Bongers (2012), the region harbours three of the thirty-four global biodiversity hotspots and these include eastern Afromontane, the Horn of Africa and the Coastal Forests of eastern Africa. Forests in the eastern Arc and the Albertine rift have been found to be rich in biological diversity (UNEP 2002). The forests and woodlands of eastern Africa also support livelihoods of majority of the people through provision of substantive direct economic benefits (energy, food, timber and non-timber products) and indirect benefits through the provision of ecological services (water catchment, controlling erosion and moderation of local climate). Timber is extensively used in the construction industry while woodfuel is the main source of energy in eastern Africa (FAO 2003).

The most extensive dry woodland types in eastern Africa are in the semi-arid zone, covering 1.6 million km<sup>2</sup> and comprise deciduous microphyllous bushland and thicket dominated by spiny species of *Vachelia* and *Commiphora* (Timberlake *et al.* 2010). Other common woody plants include *Grewia* species, *Balanites*, and various members of the Capparidaceae family such as *Boscia* and *Cadaba*. The baobab tree (*Adansonia*) is also a characteristic species of the dry woodland at lower altitudes towards the coast and the environments of the Great Rift Valley. Parts of Tanzania are also covered by the Miombo woodlands which make up about 90% of all forested land in the country, with an equivalent of 44.6 million ha (Abdallah and Monela 2007).

One of the main problems affecting inhabitants in sub-Saharan Africa (SSA), especially those residing in the rural areas, is land degradation, which is defined in general terms as a temporary or permanent decline in the productive capacity of the land (Stocking and Murnaghan 2001). While part of the eastern African region is well endowed with forest resources which contribute significantly to carbon sequestration, all forest areas and types are under major threat of deforestation. The forest of the region is degrading at an alarming rate and therefore calls for restoration of the degraded landscapes; a process that is a step further in conservation (Lemenih and Bongers 2012). Major causes of deforestation and forest degradation in the region include clearing for agriculture and settlement, overgrazing, wildfires, charcoal burning and over-exploitation of wood resources for commercial purposes.

Moreover, forests and woodlands are the main source of fuel for the majority of the households and thus directly linked to the main threats of deforestation. Annually, eastern Africa produces about 173 million m<sup>3</sup> of woodfuel and about

5.2 million m<sup>3</sup> of industrial roundwood, most of which is consumed within the sub-region (FAO 2005). Throughout the sub-region, the rate of off-take from the forest is more than the natural regeneration capacity. There is very little investment in forest establishment and reforestation. These demands have created characteristic rings of deforestation around cities and towns where forests and woodland are still available. These activities contribute to the increased emission of carbon dioxide into the atmosphere as the carbon sink is progressively reduced.

Climate Change will further exacerbate the situation in the region, and species that will be more vulnerable are those with: limited geographical range and drought/heat intolerant; low germination rates; low survival rate of seedlings; and limited seed dispersal/migration capabilities (Chidumayo 2008, Chidumayo *et al.* 2011). On the other hand, the forestry sector has the greatest mitigation opportunities as net sinks of carbon dioxide through Reducing Emissions from Deforestation and forest Degradation (REDD). According to the eastern African Community Climate Change Policy (EACCCP 2011), the main challenges related to forests that have been identified in order to address climate change include: (i) maintenance or increase of biodiversity and generation potential due to ecosystem change; (ii) reduction of bush and forest fires; (iii) restoration of the degraded Wetlands; (iv) political will and creation of enabling environment to stakeholders; and (v) regeneration of forest cover due to human encroachment.

If restoration of degraded woodlands and forests is to succeed in eastern Africa, it is important to develop an understanding of how various factors cause land and forest degradation. Furthermore, it is important that practices and technologies that are employed in addressing challenges of implementing restoration programs are identified. Hence, our paper focuses on factors that need to be addressed in order to provide for easy up-scaling of the most successful restoration practices, approaches and technologies in the region. It also deals with the need to review forest and environmental policies in the region in order to enhance forest and woodland restoration.

## LAND USE CONVERSION AND HABITAT CHANGE AND DEGRADATION

Across eastern Africa, habitat change is largely driven by anthropogenic factors resulting from competing uses of the land, deficient regulatory and enforcement instruments, poor or non-existent land tenure, and lack of appreciation by policy makers of the intricate link between forest resource and people's livelihoods. The main human-induced habitat changes in the dry regions of eastern Africa include low input agriculture and especially pastoralist practices. For example, using

<sup>1</sup> The term Eastern Africa is adopted for countries in the region of East Africa and include countries such as Burundi, Djibouti, Ethiopia, Eritrea, Kenya, Rwanda, Somalia, Tanzania, and Uganda (but **not** Sudan).

rainfall and evapotranspiration indicators, 83 percent of the land is classified as arid to semi-arid, characterized by low rainfall (Kabubo-Mariara and Karanja 2007). These areas are used for pastoral farming. In Tanzania, the unreserved areas are under heavy pressure, being converted to other land uses such as agriculture, wildlife protection, grazing, land settlement and industrial activities. Deforestation is caused mainly by unsustainable agricultural practices, intensive livestock grazing, and wild fires.

According to UNEP (2006), eastern Africa has limited forest and woodland cover amounting to approximately 13 percent. Forest and woodland cover is varied in different countries (Table 1). Tanzania is the most forested, followed by Ethiopia and the Somalia while Djibouti has the least forest cover (FAO 2011). Information provided on the percentage annual change rate of forest in the region for 2000–2010 showed that while Tanzania is losing the most forests in

terms of land area (400 000 ha), Uganda has the highest loss (2.6%) in terms of percentage land area.

Land degradation is wide spread in eastern Africa (Table 2). In particular, Burundi and Rwanda face a serious threat of land degradation, where about 76 and 71 per cent of the respective country's total area encounters very severe degradation problems (FAO 2005 in UNEP 2006). These countries are followed by Eritrea, Uganda, Kenya and Ethiopia, where areas with severe to very severe degradation constitute about 63, 53, 30 and 26 per cent respectively of total land area. In Djibouti, wind erosion is the principal form of erosion but is mainly viewed as "natural" due to the absence of agricultural land. The areas with the most severe land degradation are also those with the highest population density. Rwanda has the highest population density in Africa, with 340 people per km<sup>2</sup> followed by Burundi, with a population density of 265.8 (FAO 2005 in UNEP 2006).

TABLE 1 *Forest area and area change in the eastern African countries*

Country	Extent of forest 2010				Annual change rate			
	Land area	Forest area	Percent of land area	Area per 1,000 people	1990–2000		2000–2010	
	'000 ha	'000 ha	Percent	ha	'000 ha	Percent	'000 ha	Percent
Burundi	2,568	172	7	21	–9	–3.7	–3	–1.4
Djibouti	2,318	6	0	7	0	0	0	0
Ethiopia	100,000	12,296	11	152	–141	–1	–141	–1.1
Eritrea	10,100	1,532	15	311	–5	–0.3	–4	–0.3
Kenya	56,914	3,467	6	89	–13	–0.3	–12	–0.3
Rwanda	2,467	435	18	45	3	0.8	9	2.4
Somalia	62,734	6,747	11	756	–77	–1	–77	–1.1
Tanzania	88,580	33,428	38	787	–403	–1	–403	–1.1
Uganda	19,710	2,988	15	94	–88	–2	–88	–2.6

Source: FAO, 2011

TABLE 2 *Land degradation in eastern Africa*

Country	Total area ('000 km <sup>2</sup> )	Severe		Very severe	
		Area (%)	'000 km <sup>2</sup>	Area (%)	'000 km <sup>2</sup>
Burundi	26	0	0	76	0
Djibouti	23	0	0	0	0
Ethiopia	1 000*	8	88.08	20	17.62
Eritrea	101	55	51.7	8	4.14
Kenya	569	19	108.11	11	11.89
Rwanda	25	0	0	71	0
Somalia	627	0	0	15	0
Tanzania	885	-	-	-	-
Uganda	197	41	82	12	9.84

Source: UNEP, 2006

## RESTORATION APPROACHES AND PRACTICES

In eastern Africa, restoration practices take different forms in the different countries depending on the needs. The main forms include protection of the area through enclosures (e.g. Ngitili in Tanzania) where natural regeneration or assisted regeneration can be promoted. However, most rehabilitation of natural woodlands in areas where communities are involved has been through natural regeneration with coppicing whereas new afforestation is in the form of artificial regeneration through tree planting with fast growing species or multipurpose trees if it is in the farmers' fields. Plantations and woodlots seem to be mainly through government and private sector and development partners with woodlots mostly being for energy and construction.

Sustainably managed forests and woodlands provide a wide range of goods and services to society at large, and forest adjacent communities in particular. In Uganda, the government, nongovernmental organisations (NGOs), communities, individual households and the private sector have all been involved in forest restoration initiatives over the past decades with considerable success. This is also evident in most of the eastern Africa countries, especially in countries like Burundi, Rwanda and Uganda (see Table 1). For instance, in Kenya, the government banned tree harvesting in state forests and encouraged farm forestry as one of the strategies to counter the decrease in forest cover. The Agriculture Act (Cap. 318) on Farm Forestry rules, 2009, stipulates a 10% forest cover on farms while the forestry policy provides enabling environment for tree planting, utilization and marketing. The choice of techniques for rehabilitating specific degraded areas depends first on the priorities and management objectives of stakeholders followed by the costs and benefits associated with available rehabilitation techniques and the economic, social, and environmental values of the land resources in their current and desired future states. Some of the rehabilitation techniques identified as playing major roles in rehabilitation of degraded lands in eastern Africa include natural regeneration, assisted natural regeneration, enrichment planting, agroforestry and artificial tree planting. The common traditional land management system most common in the dry areas inhabited by pastoralists is the use of enclosures to promote restoration of degraded lands.

### Natural regeneration

Miombo woodland species regenerate largely through coppice regrowth and root suckers rather than through seeds. Chidumayo (1988) observed that stumps of almost all miombo woodland trees have the ability to produce sucker shoots. According to Malimbwi and Mugasha (2001), although seeds of majority of miombo trees and shrubs germinate immediately after dispersal when there is enough moisture, tree density in regrowth miombo woodland decreases with time due to moisture and heat stress. The majority of seedlings of miombo trees experience a prolonged period of successive shoot dieback during their development phase in order to cater for these stresses. Shoot dieback is caused by water

stress and/or fire during the dry season. In the case of suckers and coppice, fire can either slow or accelerate growth. If a destructive fire occurs before dominant shoots attain a safe height to escape mortality, the process of sucker shoot domination reverts to the initial stage and stumps respond by producing an equal or larger number of replacement shoots (Chidumayo 1988). However, resistance to these environmental factors varies with species.

Fire was found to be the major ecological factor, which leads to the development of miombo woodland (Lawton, 1978). The impact of fire on miombo depends on time and frequency of burning and on the flammable biomass. Trapnell (1959) reported that repeated late and hot fires may destroy the woodland. While early burning allowed maintained regeneration, complete protection leads to the development of a more closed, partly evergreen forest. On the other hand, complete protection for a few years leads to an accumulation of fuel which is more detrimental to tree biomass if a fire occurs. It therefore follows that for the woodland forest to thrive better, fire management regime should be practiced. There is a general perception that one of the best ways of protecting and managing miombo woodlands is to carry out early burning, that is; to burn patches of grass and undergrowth in the early dry season before the grass gets too dry in order to avoid more intense and more damaging fires later in the season. Despite this, research on fire management has not been conclusively conducted with most of the evidence being sketchy.

In summary, with the exception of Kenya, both natural and assisted natural regeneration have been reported to be used in forest restoration in Ethiopia, Tanzania, and Uganda (Table 3). On the other hand, forest management in the form of coppicing and pollarding is practiced in almost all the countries of the region. Fire as a management tool has only been reported in Ethiopia while other countries like Tanzania have acknowledged prevalence of fires especially in the Miombo as part of the ecological dynamics.

### Agroforestry practices

Rehabilitation of the land through agroforestry is the most common on human dominated landscapes where trees with multipurpose characteristics are deliberately incorporated on a piece of land. Such trees include those that provide environmental services such as nitrogen fixing for soil fertility improvement, as well as those that supply tangible products such as fruit, wood and fibre. Tree species that contribute to improving soil fertility have been popularised both in eastern and southern Africa as fertilizer trees. Fertiliser tree systems involve soil fertility replenishment through on-farm management of nitrogen-fixing trees (Sileshi *et al.* 2014, Mafongoya *et al.* 2006). They represent a new paradigm because they use a completely different approach to land-use management by smallholder farmers. First, fertiliser tree systems capitalise on biological N fixation by legumes to capture atmospheric N and make it available to crops. Secondly, they permit growing of trees in association with crops in space or time to benefit from complementarity in resource use (Gathumbi *et al.* 2002).

TABLE 3 Some natural regeneration management techniques practiced in some countries of eastern Africa

Country	NR	ANR	Coppice	Pollarding	Fire
Burundi			√	√	
Djibouti			√	√	
Ethiopia	√	√	√	√	√
Eritrea			√	√	
Kenya		√	√	√	
Rwanda			√	√	
Somalia			√	√	
Tanzania	√	√	√	√	
Uganda	√	√	√	√	

NR = natural regeneration; ANR = assisted natural regeneration.

Thirdly, they address most of the biophysical and socio-economic limitations identified with the earlier technologies based on using N-fixing tree legumes such as green manures (see Akinnifesi *et al.* 2008, 2010).

The different types of agroforestry systems and technologies use in eastern Africa are presented in Table 4. The most common of these systems are promoted in the region include improved fallows in western Kenya and rotational woodlots in dryland western Tanzania. Traditional systems include the *Faidherbia albida* parkland systems. Studies in Tanzania by Kaoneka and Solberg (1994) demonstrate that the *Sambaa* people use their traditional agroforestry and intercropping systems to improve soil productivity and crops yields. This traditional agroforestry system consists of the multi-storey tree garden, which involves the mixing of trees and farm crops in a spatial arrangement. The system includes a spatial mixture of an under-storey of coffee (and fruit), food crops such as maize/beans and a variety of pulses, a middle storey of *Grevillea robusta*, a multipurpose species commonly used for timber, fuelwood and building poles. The Ngitili is also a

form of traditional agroforestry system that allows the trees to either naturally regenerate or assisted to regenerate while at the same time providing for animal fodder.

#### Plantations and woodlots

The general overview of plantations in eastern Africa indicates that public forest plantations dominate the region with a coverage of approximately 1.4 million ha compared to 323 332 ha for private sector plantations (Table 5). In the 1970s and 1980s; emphasis was put on the establishment of fuelwood woodlots as individual or community forestry undertakings and for environmental rehabilitation purposes as a result of increasing concern over the rapid deforestation in many tropical countries (Chamshama 2011). However, the performances of the woodlots are affected by many silvicultural, political and financial constraints.

Eucalyptus is reported as one of the most planted genera of trees in eastern Africa (Table 6). For over a century, people in the region have accumulated important local knowledge on

TABLE 4 Some agroforestry systems and technologies in eastern Africa

Country	Agroforestry System/Technologies						
	Improved Fallows	Rotational Woodlots	Contour Hedgerows	Enclosure/ Ngitili	Boundary planting	Home-gardens	Farm-forestry
Burundi							
Djibouti							
Ethiopia				√		√	
Eritrea							
Kenya	√		√		√		√
Rwanda	√		√		√		√
Somalia							
Tanzania		√		√		√	
Uganda	√		√		√	√	√

TABLE 5 Area (ha) of forest plantations in eastern African countries

Country	Public	Private	New Areas	Afforestation species
Burundi	80 829	4 226	-	-
Ethiopia	972 000	-	2 132	<i>C. lusitanica</i> , <i>P. patula</i> , <i>G. robusta</i> , <i>Eucalyptus</i> spp. <i>Juniperus procera</i>
Kenya	125 000	-	-	-
Rwanda	138 348	2 058	-	-
Tanzania	86 615	40 000	167 000	-
Uganda	14 140	48 090	154 100	<i>Pinus</i> , <i>Cupressus</i> , <i>Eucalyptus</i>
Total	1 416 932	94 374	323 332	

Source: Adopted from Chamshama (2011)

TABLE 6 Some common *Eucalyptus* species grown in eastern Africa

Species	Ethiopia	Somalia	Djibouti	Kenya	Uganda	Rwanda	Burundi
<i>E. grandis</i>	X			X	X		
<i>E. saligna</i>	X			X		X	X
<i>E. camaldulensis</i>	X			X	X	X	X
<i>E. globulus</i>	X			X		X	
<i>E. paniculata</i>					X	X	
<i>E. tereticornis</i>					X	X	X
<i>E. maculate</i>						X	
<i>E. regnans</i>							
<i>E. fastigata</i>				X			
<i>E. microcorys</i>						X	
<i>E. maidenii</i>						X	X
<i>E. robusta</i>					X	X	X
<i>E. viminalis</i>	X			X			
<i>E. rudis</i>							X
<i>E. citiodora</i>	X						X
<i>E. botryoides</i>						X	X
<i>E. resinifera</i>						X	X
<i>E. bicostata</i>	X			X			
<i>E. longifolia</i>							
<i>E. punctate</i>						X	
<i>E. urophylla</i>					X	X	
<i>E. microtheca</i>							
<i>E. gomphocephala</i>							
<i>E. intertexta</i>							
<i>E. melanophloia</i>							
<i>E. largiflorens</i>							
<i>E. ochrophloia</i>							

Source: Adopted from Chamshama (2011)

the management of Eucalyptus (Dessie and Erkossa 2011). Most of the plantations of the Eucalyptus were established through funded forestry projects to communities, private farmers and NGOs (Dessie and Erkossa 2011). According to Chamshama (2011), several countries in the region have their forest plantations dominated by a few tree species. For example, in Kenya, *Cupressus lusitanica* comprises 54 percent of the plantation area followed by pines at 24%. In Ethiopia, the main plantation species are Eucalypts covering 56 percent and *C. lusitanica* which covers 32 percent of the total area; other plantation species include *Juniperus procera* (2%), *Pinus patula* (1.8 percent) and other species (8 percent). In Tanzania, pines are the dominant species in most of the government and private plantations with about 78 percent of the total area planted and the remaining 22 percent is shared among hardwoods and other softwood species. In Rwanda, *Eucalyptus* spp (*E. globulus*, *E. maidenii*, *E. grandis*, *E. saligna*, *E. camaldulensis*, *E. tereticornis*, *E. maculata*, *E. dunnii*, and *E. microcorys*) cover over 55 percent of the area. In Uganda, *Pinus caribaea* and *E. grandis* are the main plantation species.

There is obviously a greater need to diversify the tree species used especially at farm level due to the different product needs by the farmers. A wide range of partnerships exists between companies and communities with different arrangements between the growers and processors. Other than woodlots and plantations established under out-grower schemes, woodlots are also established by individual farmers and communities using their own, government or development partner resources for various products, e.g. woodfuel, building poles, sawn timber or environmental services. The major problems identified in tree planting by the individuals include poor land tenure, limited extension services and financing mechanisms; and low quality germplasm. Notwithstanding, the introduction of participatory forest management seems to have encouraged natural and assisted regeneration, control of fires and respect for boundaries in the case of Ethiopia and Tanzania (Tsegaye, 2008 in Chamshama, 2011; MNTR, 2008). Avenues for promotion of tree planting in the region include national forest funds as is the case in Tanzania, private sector, development partners, international conventions and agreements and lately carbon financing activities

## Enclosures

Enclosures are a type of land management implemented on degraded land. It is open access land in many dryland areas of eastern Africa. These are mechanism for environmental rehabilitation with a clear biophysical impact on large parts of the formerly degraded lands (Tucker and Murphy 1997). It has been shown that enclosures in Ethiopia resulted in the frequency distribution of two woody species having almost an inverted *J* – shape with high number of woody species at lower diameter classes showing the potential of enclosures to restore degraded lands (Mekuria 2007). Similarly in Tanzania, forests have been reserved by rural communities for a range of objectives, including cultural, traditional, ceremonial

and more utilitarian purposes such as the conservation of dry season grazing areas (MNRT 2008).

The most widely reported example of restoration through enclosures (*Ngitili*) and woodlots in eastern Africa is found in western Tanzania where it has proven very successful. Various estimations have been made by community members and researchers. For example, Kaale *et al.* (2003) estimated about 78,122 ha (46,593 individual and 31,529 communal) of *Ngitilis* from 172 villages in 2001 while Monela *et al.* (2005) estimated about 500,000 hectares from the 833 villages. Other authors have estimated that there are currently between 500,000 and 600,000 ha of conserved areas under all interventions (Otsyina *et al.* 2008).

Enclosures are also reportedly used in Borana and Somali Region Pastoral Areas of Ethiopia (see Zeleke 2009, Napier and Solomon 2011). Borana pastoralists' traditional enclosures were called *seera yabbii* (literally 'protected grazing for calves'). They were relatively small, around 10 hectares or less, and had a very specific purpose – to conserve pasture or put aside a section of the rangeland for milking cows, calves and sick animals during the dry season/times of drought. They have mostly been replaced through the introduction of *kallos*, which are larger, fenced enclosures and which have different functions. These are semi-private / communal *kallos* since although they are organised on the basis of a community or group of communities, they are fenced, either physically (using thorn bush) or socially (through by – law or community agreement), and therefore they exclude some people from what was previously open rangeland. There are different types of semi-private or communal *kallos*; their uses, establishment and management vary and can be initiated by community, non-government organisation, or government. There are also private enclosures (*Dhunffaa*) which are for commercial livestock fattening or marketing enterprises. The practice has grown whereby individuals fence a large area, purportedly for crop cultivation, but then plant crops on a small part of the land and keep the rest as pasture for rent or for hay production and sale. This type of enclosure is expanding all over the Borana lowland. Most of these 'farmlands' are located in the flat valley bottoms, taking the most productive and fertile land from the common range.

Finally, there are cooperative enclosures (*Weldaa*) which were first established in the 1980s by Southern Rangelands Development Unit (SORDU). The main purpose of the ranches is to generate income for the cooperative members by providing access to grazing for livestock traders. There are reportedly five big ranches (two of which are cooperative ranches) in the Borana rangelands currently, occupying around 33,000 hectares. Only members and those that pay a fee are allowed to use the grazing in the ranches. Before, these were open areas including important grazing and watering resources for the Borana pastoral system. In Somali region, there are broadly, four types of 'seero' (enclosure): private; government; communal and/or NGO supported (in some areas); and cooperative. The two types of private enclosures "seera" within an existing farm, and "beer" outside the farm.

## POLICY AND LEGAL FRAMEWORK RELATED TO FOREST REGENERATION

The practice of joint forest management (JFM) and/or participatory forest management (PFM) in recent times has been accepted as the way for sustainable management of the forest resources. It is well documented that PFM provides opportunities for local people to participate in forest restoration activities through conservation and management, thereby contributing to improved status of the forests and the well-being of the local communities (Alden-Wily 2002). Some countries in the region have changed their policies to address the involvement of communities in the management of the forest and woodlands. Most notable are Tanzania and Uganda. In Tanzania, the Forest Act (2002) used the Land Act (1999) and the Village Land Act (1999) as the basis for creating various forms of community involvement (Akida and Blomley 2007, URT 2002, URT 1999a, URT 1999b). The Tanzania Forest Act (2002) provides for local communities or individuals to jointly manage Central and Local Government Forest Reserves through Joint Forest Management agreements, and to have their own Village Forest Reserves, which are managed by Forest Management Committees (Akida and Blomley 2007). On the other hand, Uganda provides for different forms of land tenure including customary ownership of land. The National Forest Plan (Republic of Uganda, 2013) distinguishes between forests owned individually or institutionally under freehold and leasehold tenure (“private forests”), and those owned communally under customary tenure (“customary forests”).

In some countries of eastern Africa, a few policies have direct relation to forest restoration in terms of environmental and ecosystem conservation (see Table 7). In Tanzania, the policy sectors that have very supportive statements on forest restoration include forestry, environment, wildlife, fishery, energy and land. In Kenya, most of the policies, including forestry, only stated that the government will promote tree planting and land rehabilitation by natural regeneration for wood production as well as for the protection of soil and water resources. The Environmental Management and Co-ordination Act of 1999 specifically address forest regeneration by proposing for the re-afforestation and forestation of

hilltops, hillsides and mountainous areas that will be identified by respective District Environment Committees (GoK 2000). The Water Policy of 1999 proposes the identification and protection of water catchment areas; this protection aims at reducing pressure to allow for natural regeneration (GoK 1999). In Ethiopia, many of the policies that influence the rate at which forest and land restoration may be applied, such as the national forest policy, land use and land administration policy, the livestock policy, are not yet available. However, the policies on the environment and conservation allude to forest and land restoration (Bekele-Tesemma, 2002). In Rwanda and Uganda, the forest and environmental policy are also very enabling. For example, Rwanda has a strong legislative and policy framework, guided by the Organic Law Nr 4/2005 which lays out the modalities to protect, safeguard and promote environment in the country (Twagwiramungu 2006).

## CONTRIBUTING FACTORS TO UP-SCALING RESTORATION PRACTICES

Some of the factors that have contributed to forest degradation are highlighted in the preceding sections. Table 8 presents the different practices and activities for ensuring up-scaling restoration practices in eastern Africa. The different countries seem to have different forms of practices for restoration. For example, Tanzania and Ethiopia promote enclosures and natural regeneration in areas associated with overgrazing. Artificial regeneration is advocated for community woodlots in Tanzania and Rwanda.

The success stories on forest landscape restoration (e.g. *Ngitili* in Tanzania) have always been associated with situations where communities were actively involved, and their interests, local knowledge and practices taken into account. In Tanzania and Ethiopia, community based approach are advocated when implementing activities that address conservation of forest biodiversity, water catchment and soil fertility. According to Desanker and Magadza (2001), the most promising adaptation strategies to declining tree resources in sub-Saharan African countries include natural regeneration of local species, sustainable forest management and community

TABLE 7 Analysis of policy and legal framework related to forest regeneration

National Sector Policy	Tanzania	Kenya	Ethiopia	Uganda	Rwanda
Forest Policy	++	+	-	++	++
Environmental	++	+	+	++	++
Land	++	-	-	-	++
Water/Fisheries	++	-	-	-	-
Wildlife	++	-	-	-	-
Conservation	-	-	+	-	-
Energy	++	-	-	-	-

Key = + supportive, ++ very supportive, - neutral or no information available

Source: Modified from IUCN Forest Landscape Restoration Country Reports (Ethiopia, Kenya, Tanzania, Uganda)

TABLE 8 Drivers of degradation, common practices for restoration and requirements for up-scaling in eastern Africa

Country	Type and cause of degradation	Objectives	Activities for restoration	Potential Practices for restoration
Tanzania	<ul style="list-style-type: none"> <li>- Agricultural expansion</li> <li>- Human settlements and infrastructure development</li> <li>- Increased resource extraction</li> <li>- Overgrazing</li> <li>- Uncontrolled timber and firewood extraction and charcoal production</li> </ul>	<ul style="list-style-type: none"> <li>- Collaborative forest management</li> </ul>	<ul style="list-style-type: none"> <li>- Ensured ecosystem stability through conservation of forest biodiversity, water catchment and soil fertility</li> <li>- Nation-wide tree planting campaign</li> <li>- Participatory forest management</li> </ul>	<ul style="list-style-type: none"> <li>- Develop community based approaches</li> <li>- Forest fire management</li> <li>- Artificial regeneration (Afforestation in degraded lands) &amp; Multi-purpose trees community woodlots</li> <li>- Natural forest regeneration in enclosures</li> </ul>
Ethiopia	<ul style="list-style-type: none"> <li>- Agricultural expansion</li> <li>- Soil erosion</li> <li>- Deforestation</li> <li>- Uncontrolled forest exploitation</li> <li>- Desert encroachment</li> <li>- Recurrent drought</li> </ul>	<ul style="list-style-type: none"> <li>- Community Based Rehabilitation of Degraded Ecosystems in selected parts of Ethiopia</li> </ul>	<ul style="list-style-type: none"> <li>- Reforestation of hill areas in the Northern parts of Ethiopia</li> <li>- Promotion of Agroforestry Systems and Home-gardens</li> </ul>	<ul style="list-style-type: none"> <li>- Natural regeneration in enclosures</li> <li>- Artificial regeneration (reforestations)</li> <li>- Agroforestry practices</li> </ul>
Uganda	<ul style="list-style-type: none"> <li>- Frequent droughts and floods</li> <li>- Increased resource extraction</li> <li>- Poor agricultural practices</li> </ul>	<ul style="list-style-type: none"> <li>- Promote the cultivation of forest medicinal and edible plant species</li> </ul>	<ul style="list-style-type: none"> <li>- Farm forests</li> </ul>	<ul style="list-style-type: none"> <li>- Artificial regeneration</li> </ul>
Rwanda	<ul style="list-style-type: none"> <li>- High degradation of arable land due to erosion</li> <li>- Desert encroachment</li> <li>- Prolonged seasonal drought</li> </ul>	<ul style="list-style-type: none"> <li>- Develop alternative sources of wood energy</li> </ul>	<ul style="list-style-type: none"> <li>- Preparation and implementation of a forest development plan?</li> </ul>	<ul style="list-style-type: none"> <li>- Agroforestry practices</li> <li>- Artificial regeneration through woodlots</li> </ul>

based natural resources management. In Tanzania, studies found that more than 350,000 ha of land were occupied by restored or newly established *Ngitili*, of which about 50% was owned by groups and another 50% by individuals. Benefits from *Ngitili* were estimated at US\$ 14 per person per month, which is much higher than the average monthly spending per person in rural Tanzania (US\$ 8.5) (Otsyina *et al.* 2008). This notion is already part of the current policies and legislation in almost all sectors in Tanzania, which provide the necessary enabling environment for restoration of degraded lands (Alden-Wily 2008).

In Uganda, the success of the 'farm forest program' has been necessitated by clear land and/or tree tenure in the forest policy. Chamshama (2011) also reiterated that successful tree planting by the individuals in eastern Africa can only be achieved with clear land tenure, improved extension services and financing mechanisms, and availability of high quality germplasm.

## CONCLUSIONS

Various anthropogenic factors have been responsible for the loss of forest and woodlands in eastern Africa. However, majority of the countries in the region have not been taking

appropriate measures to prevent further loss of its forest estate as well as put in place strategy for forest restoration. The practice of joint forest management (JFM) and/or participatory forest management (PFM) has been identified as potential strategy in facilitating restoration and sustainable management of the forest resources. This strategy entails active involvement of local communities, supported by the new forestry legislation, and is by far the most successful and promising option for restoration of the large areas of degraded land in eastern Africa. In some communities where JFM or PFM has been used, success stories in forest restoration and rehabilitation have been recorded.

With respect to potential restoration and rehabilitation practices in eastern Africa, natural regeneration through enclosures are prevalent in livestock farming areas, artificial regeneration through woodlots or farm forests are prioritized in some countries for various reasons including commercialization of tree planting in Uganda as out-growers, energy production in Rwanda and reforestation of bare hills in Ethiopia. There is also an opportunity to promote tree planting for carbon markets as is the case in Tanzania Community-Based REDD Mechanisms for Sustainable Forest Management REDD pilot projects. Agroforestry is also recognized as an important avenue for rehabilitation of degraded areas especially to improve soil fertility and soil conservation. This is

particularly of great importance in agro-ecosystems that support food and energy production while at the same time providing other ecosystem services.

Majority of the countries in eastern Africa are faced with policy and legislative deficiencies in support of sustainable management of their forest and woodlands. There is therefore the need for formulation of adequate and appropriate policies that directly address restoration and rehabilitation of degraded forests from the local to national levels. In addition, policies that promote forest and land restoration through clear land tenure and the linkage of the energy policy to forest restoration will be prudent because of the overreliance on the forest resource for energy in the region. Finally, in a bid to facilitate and encourage adoption of restoration strategies, the countries should explore avenues that create forest enterprise development through empowerment and livelihoods support programmes such as training on plantation establishment and management, farm forestry, and payment for ecosystem services especially to the local communities.

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#### REFERENCES

- ABDALLAH, J.M. and MONELA, G.G. 2007. Overview of Miombo Woodlands in Tanzania. Working Papers of the Finnish Forest Research Institute **50**: 9–23
- AKIDA, A. and BLOMLEY, T. 2006 Trends in Forest Ownership, Forest Resources Tenure and Institutional Arrangements: Are They Contributing to Better Forest Management and Poverty Reduction? Case Study from Tanzania. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
- AKINNIFESI, F.K., CHIRWA, P.W., AJAYI, O.C., SILESHI, G., MATAKALA, P., KWESIGA, F.R., HARAWA, R. and MAKUMBA, W. 2008. Contributions of agroforestry research to livelihood of smallholder farmers in Southern Africa: 1. Taking stock of the adaptation, adoption and impact of fertilizer tree options. *Agricultural Journal* **3**(1): 58–75.
- AKINNIFESI, F.K., AJAYI, O.C., SILESHI, G., CHIRWA, P.W. and CHIANU, J. 2010. Fertilizer trees for sustainable food security in the maize-based production systems of Eastern and Southern Africa. A review. *Agronomy for Sustainable Development* **30**: 615–629
- ALDEN WILY, L. 2002. Participatory Forest Management in Africa: An Overview of Progress and Issues. Keynote paper presented at the Second International Workshop on Participatory Forest Management in Africa, Arusha, Tanzania, February 18–23, 2002.
- BEKELE-TESEMMA, A. 2002. Forest landscape restoration: Initiatives in Ethiopia. IUCN-EARO and WWF-EAROPO.
- CHAMSHAMA, S.A.O. 2011. Forest Plantations and Woodlots in the Eastern and North Eastern African Countries: A Regional Overview. *African Forest Forum Working Paper Series* **1**(18): 1–69
- CHIDUMAYO, E., OKALI, D., KOWERO, G. and LARWANOU, M. (Eds.). 2011. Climate change and African forest and wildlife resources. African Forest Forum, Nairobi, Kenya.
- CHIDUMAYO, E.N. 1988. A re-assessment of effects of fire on miombo regeneration in the Zambian Copperbelt. *Journal of Tropical Ecology* **4**: 361–372.
- CHIDUMAYO, E.N. 2008. Implications of climate warming on seedling emergence and mortality of African savanna woody plants. *Plant Ecology* **198**: 61–71.
- DESANKER, P. and MAGADZA, C., 2001. Africa. In: McCarthy, J., Canziana, O., Leary, N.A., Dokken, D.J. and White, K. (eds.), Climate change 2001. Impacts, adaptation and vulnerability. Cambridge University Press, Cambridge, pp. 489–531
- DESSIE, G. and ERKOSSA, T. 2011. Eucalyptus in East Africa: Socio-economic and environmental issues. Working Paper FP46/E. Food and Agriculture Organization of the United Nations (FAO). 30 p
- EACCCP. 2011. East African Community Climate Change Policy (EACCCP), EAC Secretariat, Arusha, Tanzania.
- FAO. 2003. Forestry Outlook Study for Africa – African Forests: A View to 2020. African Development Bank, European Commission and the Food and Agriculture Organization of the United Nations, Rome.
- FAO. 2005. State of the World's Forests 2005. Food and Agriculture Organization of the United Nations, Rome.
- FAO 2011. State of the World's Forest 2011. Food and Agriculture Organization of the United Nations, Rome, Italy. 100–156 pp.
- GoK 1999. Government of Kenya (1999) National Policy on Water Resources Management and Development, Sessional Paper No 1 of 1999. Government Printer, Nairobi.
- GoK 2000. Environmental Management and Coordination Act, EMCA (Act No 8 of 1999), Kenya Gazette Supplement No. 3, Acts No. 1, January 2000.
- GATHUMBI, S., NDUFA, J., GILLER, K.E. and CADISCH, G. 2002. Do species mixtures increase above- and below-ground resource capture in woody and herbaceous tropical legumes? *Agronomy Journal* **94**: 518–526.
- KAALE, B., MLENGE, W. and BARROW, E. 2003. The potential of Ngitili for forest landscape restoration in Shinyanga region, a Tanzanian case study. Paper presented at an International Conference on Livelihoods, Forests and Biodiversity, Born, German. 35 p.
- KABUBO-MARIARA, J. and FREDRICK, K.K. 2007. The Economic Impact of Climate Change on Kenyan Crop Agriculture: A Ricardian Approach. Policy Research Working Paper 4334. The World Bank. 40 p.

- KAONEKA, A.R.S. and SOLBERG, B. 1994. Forestry related land use in the West Usambara Mountains, Tanzania. *Agriculture Ecosystems & Environment* **49**: 207–215.
- LAMB, D., ERSKINE, P.D. and PARROTTA, J.A. 2005. Restoration of Degraded Tropical Forest Landscapes. *Science* **310**(5754): 1628–1632
- LAWTON, R.M. 1978. A study of dynamic ecology of Zambian vegetation. *Journal of Ecology* **66**: 175–198
- LEMENIH, M. and BONGERS, F. 2012. The role of plantation forests in fostering ecological restoration: Experiences from Eastern Africa. In: Hall, J., Fehr, C., Bongers, F., Huss, J. and Tennigkeit, T. (eds) *Degraded Forests in Eastern Africa: Management and Restoration*. Earthscan, New York. 384 p.
- MAFONGOYA, P.L., BATIONO, A., KIHARA, J. and WASWA, B.S. 2006. Appropriate technologies to replenish soil fertility in southern Africa, *Nutrient Cycling in Agroecosystems* **76**: 137–151.
- MALIMBWI, R.E. and MUGASHA, A.G. 2001. Inventory Report of Kitulungalo Forest Reserve in Morogoro, Tanzania. Ministry of Natural Resources and Tourism, Forest and Beekeeping Division, Dar es Salaam.
- MEKURIA, W. 2007. Vegetation Restoration in Area Closures: The Case of Douga Tembein, Central Tigray, Ethiopia. Tropentag 2007. Conference on International Agricultural Research for Development. University of Kassel-Witzenhausen and University of Göttingen, October 9–11, 2007. 6 p.
- MNRT. 2008. Participatory Forest Management in Tanzania: 1993–2009: Lessons learned and experiences to date. United Republic of Tanzania Ministry of Natural Resources and Tourism Forestry and Beekeeping Division.
- MONELA, G.C., CHAMSHAMA, S., MWAIPOPO, R. and GAMASSA, D.M. 2005. A Study on the Social, Economic and Environmental Impacts of Forest Landscape Restoration in Shinyanga Region, Tanzania. Ministry of Natural Resources and Tourism Forestry and Beekeeping Division and IUCN – The World Conservation Union Eastern Africa Regional Office.
- NAPIER A. and DESTA S. 2011. PLI Policy Project Review of Pastoral Rangeland Enclosures in Ethiopia. United States Agency for International Development (USAID).
- OTSYINA, R., RUBANZA, C.D.K. and ZAHABU, E. 2008. Contribution of tree planting and conservation activities to carbon offsets in Shinyanga. NORAD Report, 2008.
- REPUBLIC OF UGANDA 2013. The National Forest Plan 2013. Ministry of Water and the Environment, Directorate of Environmental Affairs, Uganda.
- SILESHI, G.W., MAFONGOYA, P.L., AKINNIFESI, F.K., PHIRI, E., CHIRWA, P., BEEDY, T., MAKUMBA, W., NYAMADZAWO, G., NJOLOMA, J., WUTA, M., NYAMUGAFATA, P. and JIRI, O. 2014. Agroforestry: Fertilizer Trees. In: Neal Van Alfen (ed.) *Encyclopedia of Agriculture and Food Systems*, Vol. 1, Elsevier; San Diego. pp. 222–234.
- STOCKING, M. and MURNAGHAN, N. 2001. Handbook for the field Assessment of Land degradation. Earthscan, London. 169 p.
- TIMBERLAKE, J., CHIDUMAYO, E. and SAWADOGO, L. 2010. Distribution and characteristics of African dry forests and woodlands. In: Gumbo, E.C.D.J. (ed.) *The Dry Forests and Woodlands of Africa: managing for products and services*. Earthscan, London. pp 11–41.
- TRAPNELL, C.G. 1959. Ecological results of woodland burning experiments in Northern Rhodesia. *Journal of Ecology* **47**: 129–168.
- TSEGAYE, T. 2008. Participatory Forest Management (PFM) in Ethiopia: Achievements, Opportunities and Challenges. A paper presented at the workshop “Communal Ownership of Forests” in Chilimo and Addis Ababa, November 2008. pp 1–11.
- TUCKER, N.I. and MURPHY, T.M. 1997. The effects of ecological rehabilitations on vegetation recruitment: some observations from the wet Tropics of North Queensland. *Forest Ecology and Management* **99**: 133–152.
- TWAGWIRAMUNGU, F. 2006. Environmental profile of Rwanda. European Union/Republic of Rwanda.
- UNEP. 2002. African Environment Outlook: Past, Present and Future Perspectives. United Nations Environment Programme, Nairobi.
- UNEP. 2006. Africa Environment Outlook 2: Our environment, our health. United Nations Environment Programme (UNEP). 534 p.
- URT (UNITED REPUBLIC OF TANZANIA) 2002. The Forest Act, No. 7 of 7th June 2002. Ministry of Natural Resources and Tourism, Dar es Salaam, Tanzania.
- URT (UNITED REPUBLIC OF TANZANIA) 1999a. Tanzania Land Act, 1999, (Act No.4 of 1999). Ministry of Lands and Human Settlements, Dar es Salaam, Tanzania.
- URT (UNITED REPUBLIC OF TANZANIA) 1999b. Village Land Act (and Regulations) No. 5 of 1999. Ministry of Lands and Human Settlements, Dar es Salaam, Tanzania.
- ZELEKE A.W. 2009. Status of Traditional Agroforestry and its Future Potential Development as Buffer Zone Agroforestry for the Natural Forest Conservation in Burkutu Peasant Association, Oromia, Ethiopia. M.Sc. Thesis, Hawassa University, Ethiopia.