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The Role of Fences for Managing Land Resources

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ABSTRACT

Local, national or international measures are taken to maintain status of resources or to rehabilitate degraded lands by excluding disturbing agents (animals and humans) through different forms of fences. Fences are commonly understood as barriers, especially of wood or wood and wire, for enclosing, bounding or protecting land which show physical structures. However, there are mechanisms which can be described as non-physical. One form of non-physical fences are categorized as *metaphorical fences* which indicate defense mechanisms by using chillis, barriers of noise, guard dogs or biofences of scent from the faeces of territorial species to direct or inhibit their movements. The second form of non-physical fence can be described as *social fences* where institutions (rules and regulations) are used to regulate access and use of conservation areas. The benefits of fences for managing land resources are assessed and widely published whereas comprehensive critical analyses on their use as the resource management tools are scanty. This paper assessed and analyzed the application of the three forms of fences and the associated benefits and costs through reviews of published sources. Since physical and metaphorical fences commonly exclude local people from involvement in decision-making, people feel as *outsiders* to the closed system. There are more costs than benefits both ecologically and socio-economically in the long-term when physical fences are applied. Mostly, conservation professionals given attention on the improvement of biodiversity, soil and water conditions with only a cursor on the benefits local people get from fenced/closed areas. In other words, the assessments lack the livelihood improvement though it is equally important as the natural resource conditions for sustainability. Therefore, for sustainability to be practical, the changes in the natural elements (vegetation, soil and water) should be considered along with the improvements in the livelihoods. Given the negative ecological impacts of physical fences in the long-term, they should not be permanent part of a land even though local people and professionals apply it as part of the strategies to rehabilitate degraded lands as opposed to the *social fences* which are more favorable in terms of the ecology and social acceptance.

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1. INTRODUCTION

1.1. Land and Land Resource Management

Land is a particularly valuable resource for human survival and development. Hence, reasonable, effective and sustainable land use is very important for the human life not only to current but also future generations. Before further discussion, it is first important to conceptualize land and land resource management.

Land refers to the entire ecosystem, which includes water, air and living things and their interactions (Richardson, 1989). A more elaborative definition is based on FAO (1997) – land and land resources refer to a delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface. Therefore, climate, soil and the terrain forms, the surface hydrology (including shallow lakes, rivers, marshes and swamps), the near-surface sedimentary layers and associated groundwater and geo-hydrological reserve, the plant and animal populations, the human settlement pattern and physical results of past and present human activity (terracing, water storage or drainage structures, roads, buildings, etc) are included. Besides, all activities occurred on land such as forestry, mining, hunting and fishing also belong to land resources (van Kooten, 1993). Sustainable management of land resources, therefore, requires a coordinated approach which combines economic, social and environmental factors.

On the contrary, humans have focused more on basic and economic benefits that can be extracted from land. Such use of land has degraded its resources throughout the world. “Human-induced degradation has taken place all through history, such as during the Mediterranean and Middle East civilizations and during the time of European expansion in the Americas, Australia, Asia and Africa,” (FAO, 1995).

Land degradation is expressed in terms of the loss of productivity or utility (Eswaran et al., 2001). Therefore, land resource degradation affects the life of every citizen of the globe directly or indirectly. For example, the food we eat comes from land. If the physical soil itself or its fertility is lost, it will be practically impossible to feed the growing population particularly in developing countries with the currently available technology. Some countries of the world are already facing serious challenges of feeding their population partly due to the

fact that lands that had been productive for sometime have lost their productive capacity. People can have access to drinking water as long as its quality and quantity are maintained which, in turn, depends on the extent of land management. The same is true for access to clean air. These cases are mentioned only to show the importance of land and land resources for human beings and, as a result, the consequences that follow when land resources are degraded.

The trend of land resource degradation tends to be accelerated due to indirect drivers like increasing demographic, economic, sociopolitical, cultural and religious as well as scientific and technological changes (Millennium Ecosystem Assessment, 2005). The Millennium Ecosystems Assessment (MEA) report summarizes the direct drivers of ecosystem change as changes in local land use and cover; species introduction or removal; technology adaptation and use; external inputs like fertilizer, pesticide and irrigation; harvest and resource consumption, climate change, as well as natural physical and biological drivers.

Therefore, it is important to note that the development in any of the drivers without balancing with the condition of land resources will degrade the natural resource base more and more. In the recent decades, there has been no such a balance. For example, referring to deforestation, the MEA report indicates that more land was converted to cropland in the 30 years after 1950 than in the 150 years between 1700 and 1850. Cultivated systems (areas where at least 30% of the landscape is in croplands, shifting cultivation, confined livestock production, or freshwater aquaculture) now cover one quarter of Earth's terrestrial surface. Therefore, integrated management of land resources is in an urgent need to be part of all development activities.

There are different mechanisms of land management ranging from addition of manure or artificial fertilizer to improve soil fertility to large-scale watershed management programs and establishment of national parks. Practices like physical and biological conservation measures that consider the socio-economic and environmental benefits are parts of land management. The application of fences as part of land resource management is also becoming more and more important as resource degradation is resulting in species extinction and bare lands that are not suitable for agriculture. This paper focuses on the use of fences in managing land resources.

The first question to raise then is what are fences? The Chambers Dictionary (2003) defines fence as a barrier, especially of wood or wood and wire, for enclosing, bounding or protecting land. To fence means to enclose with a fence; to fortify; to shield; to keep off. There are varieties of purposes to use fences in managing land resources. Areas that are completely devoid of vegetation and soil are closed by fence to facilitate their rehabilitation. Some ecosystems, which are known to have a high importance for biodiversity conservation, are closed to protect them from threats (Hayward and Kerley, 2009). Farmers use fences to protect their productive lands from entrance of humans and animals. Real estates are also fenced to secure ownership right and protect properties from intrusions. These all can be taken as part of land resource management.

Based on the works of Hayward and Kerley (2009), there are two major categories of fences – physical and metaphorical. Physical fences refer to physical structures like wood, barbed wire, etc. whereas metaphorical fences function like the physical ones but established with non-physical mechanisms like sound barrier, smell, etc. In this paper, we would like to add the third category of fences which can be described as *social fences* (Saxena et al., 2001) in which institutions are used to manage resources in a given area.

1.2. Objectives of this Paper

The general objective is to critically assess the role of fences in land resource management. Specifically, the focus will be on the effects of fencing on the biophysical resources as well as the socio-cultural aspects. Therefore, the specific objective is to assess justifications given to reason-out why fences are used in managing land resources and the benefits obtained as well as costs and lessons learnt from the use of fences in the resource management. Based on the assessment, the paper finally makes conclusions for improvement in the land resource management approach using fences.

2. AN OVERVIEW OF FENCES IN MANAGING LAND RESOURCES

2.1. Why Fences?

The use of fences began during the Neolithic revolution in which the objective was to demarcate resource-rich areas and exclude threats/intruders (Hayward and Kerley, 2009). The reasons for global and national uses of fences worldwide for biodiversity conservation are

reviewed and elaborated by Hayward and Kerley (Ibid). Nowadays, the application of fences in managing land resources generally aims at enabling the resources to maintain their status or to develop or recover resources in areas that have been degraded.

However, there are differences in defining the objectives of using fences in land resource management. The traditional thinking of conservation professionals is that maintaining the status of a resource or enabling recovery of degraded areas is possible by excluding disturbing or damaging or threatening agents including humans (Berisso, 2009). The professional natural resource managers focus more on the natural resource recovery (ecological objectives) whereas the local people attach multiple objectives to be considered together (Table 1). Hence, undoubtedly, there are differences between the local people and conservation professionals representing different organizations in defining degradation, the need for management measures and the types of measures.

Professionals and local people also have different perspectives with regard to exclusion of people from conservation areas. The intention of the professionals is that exclusion of threatening agents including humans will enable nature to maintain its status or facilitate its recovery. On the other hand, there are contextual differences among local people with regard to their exclusion from having access to natural resources in their surroundings. For example, in the Salonga National Park of the Democratic Republic of Congo, the local people have the belief that unless the people enter into such areas, they become frightening for them since the areas become full of evil spirits (Ibesoa, 2009). In other cases, people take locally initiated measures to achieve variety of objectives by establishing protected sites through exclusion of people (for example, Kelboro, 2008).

Table 1 Comparison of the perspectives of local people and other interest groups in defining objectives for managing land resources

| Interest groups | Objectives | Indicators | Reference |
|--|---|--|--|
| Conservationists | Biodiversity | Biological (Population trends, trends in the threatened species and habitat conditions, coverage of protected areas) | EASAC (2005) |
| | Soil and water | Trends in soil fertility, silt load, water quality, etc. | Blum (2004), Ochola et al. (2003) |
| Local people living on the site where the resource is found | A combination of scio-cultural, economic and biophysical | Visible and invisible (visible: products like timber and non-timber, crop; aesthetic; nature like soil, water, trees, birds; income; etc; invisible: psychological, cultural, etc) | Eshete (2007), Beshah (2003), Borrini-Feyerabend (2002), Grimble et al. (undated), Kelboro (2008), Marti´n-Lo´pez, et al., (2007), Ngouffo and Tchoffo (2001), Roberts and Gautam (2003) |
| Governmental and non-governmental organizations | Timber extraction, tourism development, resource and catchment protection | Timber volume, water quantity and quality, national sectoral aggregate income | Grimble et al. (undated) |
| International groups | Biodiversity conservation, climatic regulation | Trends of threatened species, measure of carbon sequestration | Grimble et al. (undated) |

However, fences are applied around the world dominated with the views of conservation professionals. Fences are considered as important input to managing land resources with a general understanding as strategies to give the resources time for maintenance of their status and, in cases of degradation, to rehabilitate, by excluding the disturbing or damaging agents including humans.

2.2. Forms of Fences

There are several ways to keep off unwanted threatening agents (humans and/or animals) out. Three major forms of fences can be identified based on the mechanisms of their establishment and implementation. These are physical, metaphorical, and social fences.

2.2.1. Physical and metaphorical fences

Physical and metaphorical fences differ in terms of their visibility. As the name implies, physical fences involve establishment of physical structures that prohibit people and other disturbing agents from entering into protected areas. In this case, non-living fence (wood, barbed wire, rocks) and living fence (hedgerows, trees, etc.) or a combination of them can be used to form physical barriers to avoid people and other disturbing agents from having access to the area that should be protected. On the other hand, metaphorical fences do not involve installing physical structures. They function in a similar way to the physical fences while there are no visible things shielding or closing the area to be protected. This includes defense mechanisms by using chillis, barriers of noise, guard dogs or biofences of scent from the faeces of territorial species to direct or inhibit their movements (McNutt, undated quoted by Hayward and Kerley, 2009).

Use of physical fences emerged with the human civilization as a mechanism of protecting resource-rich areas and the wealth created through human development (Hayward and Kerley, 2009). They can be taken as a form of defense mechanism to show the boundary of an area that should not be intruded by unwanted animals and humans. In managing land resources, physical fences are structures created to protect the resources by excluding various threatening agents and processes (Ibid) that disturb the degraded land rehabilitation or damage the existing resources. In establishing physical fences for communal or state-owned areas, there is an implied assumption that lands open to communities are susceptible to degradation. In other words, such activities are justified implicitly by the argument of *tragedy of the commons* (Hardin, 1968) in the case of communal lands, or as an indication of failure to co-evolve with nature (Hayward and Kerley, 2009).

2.2.2. Social fences

The other form of fence which does not need physical structures involves institutions and organizational arrangements to close an area from access for animals and/or humans in which local people may decide to close the area for managing the land resources. Such approaches can be described as *social fencing* (Saxena et al., 2001). People establish rules and regulations

as part of their culture with traditional sanctioning mechanisms to control intrusions (Kelboro, 2008). Every member takes responsibility to keep away from the area which is declared as protected by the people themselves. Some community-initiated closed areas may be established and its management may be passing from generation to generation. In Sidama area of Southern Ethiopia, for example, sacred groves are so strongly attached to their cultural history that some elders say “destruction of the site means the end of our history” (Ibid).

The sacred sites are also characterized by strong social sanctioning mechanisms. There is an elders group and a leader to make sure that the members respect the rules. In cases of breach, they follow procedures that are more of *supernatural*. The person who is said to be guilty should come and give sacrifices to be part of the system again. In cases of persistence, the consequence will be severe to the extent of exclusion from participation in all social activities and events including the death of a community member. No one will provide help in cases of need without which life is nearly impossible in rural communities. For example, if a family member of the person who violated the rules died, no one would go for mourning and burial unless the issue of rule-violation is resolved. This shows how life is virtually impossible without following the rules of protecting the sacred sites.

Another study carried out in Ethiopia gives a vivid example of how people save forest resources through institutional and organizational arrangements.

In Northern Ethiopia, Forests in other areas have been completely destroyed and converted into farms and grazing lands over centuries. Hence, when a traveler sees a patch of indigenous old-aged trees in the northern highlands of Ethiopia, he/she can be sure that there is an Orthodox Church in the middle. They are visible from a great distance, with a majestic appearance, usually built on small hills “overlooking” the surrounding villages. The local people call these churches with the surrounding trees as “debr” or “geddam”. “Debr” or “Geddami” is seen by the followers as the most holy place religiously as well as a respected and powerful institution socially (Eshete, 2007).

By understanding the strength of social fences, sometimes, governmental and non-governmental organizations work in collaboration with local people in land resource management. Both the government and local people worked in selecting the site to be closed for rehabilitation in some areas of Ethiopia (Mengistu et al., 2005b). The objectives were defined collaboratively in which the ecologically-oriented objectives of the government’s

interest were combined with the visible benefits like grasses for thatching and construction materials as well as grazing interests of the local people. Bylaws were then formulated by the people to guide how the area should be used. In this way, the people could establish and protect closed areas.

In the north highland of Vietnam, the Ha Nhi ethnic group has its own social fence through local knowledge for forest protection and land management. The knowledge is passed from generation to generation through the memory and social practice and has been a very effective way to protect the forest. According to Son (2008), the approach consists of the following elements:

- *Spiritual belief in forests*: the people consider the animals and plants as humans having their own soul. Therefore, man, plants and animals are attached together in a good relationship. As a result, the Ha Nhi people respect and take care of the forests and regard them as hosts for a supernatural power.
- *Protection of forests and forest lands by establishing preserved forest areas*: three types of forests surrounded the village of Ha Nhi people: spiritual, forbidden and common. In the first two forest areas, people and animals are not allowed to enter. It is also prohibited to construct house or to exploit (to cut trees and harvest other products) because it is believed that gods reside inside the forests.
- *Institutions*: customary laws, rules and regulations that define the right and control mechanisms as well as punishment are based on the community's interests. Hence, the institutions are respected by the community members. The regulation system of the forest protection in the community was established to give guidelines on how to handle the forest along with the sanctioning mechanisms in cases of breach.
- *Communication system*: The community members are informed of the rules and regulations at the beginning of every year.
- *Organizational system*: Managing the forest and land property rights of the community is well-organized. Every year, two persons are elected by special procedures to head the rituals and to serve as representatives of the local people to manage the forests. Once the persons are elected, the people believe that they are selected by supernatural power. Consequently, the local people follow and respect

the guidance provided by their leaders as part of the supernatural system to manage the forests and forest lands in accordance with the rules and regulations.

The close inter-relationship of the above factors with each other has established a strong mechanism for sustainable land and forest management in the Ha Nhi community. The community members follow the rules and regulations strictly due to the invisible power. As a result, in the last fifty years, there was only one person found of breaking the customary law.

2.3. Functions of Fences

2.3.1. Ecological

Primarily, fencing aims at preventing damaging agents or conditions from access to sensitive areas or ecosystems. For land resources managers, fencing provides “defined units” thereby enabling them to have a limited and clear focus to exclude threatening agents like human persecution, invasive species and diseases (Hayward and Kerley, 2009). This also helps the managers to monitor the progress in improving and maintaining the status of resources in ecosystems.

In general, fencing mechanisms may be used to maintain the existing status or rehabilitate degraded areas. That may be one reason for recommendation of enclosing along with privatization (Hardin, 1968). In Northern Ethiopia, degraded areas had been enclosed to facilitate land rehabilitation. Studies of the enclosures show that remarkable achievements were observed (Aerts et al., 2007; Aerts et al., 2002; Asefa et al., 2003; Descheemaeker et al., 2006a; Descheemaeker et al., 2006b; Herweg and Ludi, 1999; Mekuria et al., 2007; Mengistu et al., 2005a; Moges and Kindu, 2006). Natural vegetation could be rehabilitated in area enclosures, which, then, reduced erosion and improved nutrient recycling processes. The vegetation has provided litter inputs to the closed sites. It may be because of this that such areas had higher soil organic matter content, total nitrogen and available phosphorus. Hence soil physical properties could be improved thereby resulting in higher water infiltration rates into the soil and, consequently, decreased runoff. The canopy of shrubs and under-story vegetation has been restored; the soil surface is protected from the erosive energy of falling raindrops, which prevents splash erosion.

The studies also show other ecological benefits. In general, the vegetation cover improvement in closed areas resulted in a negligible runoff when the status of vegetation cover reaches more than 65%. In addition, area enclosures are fast, cheap and lenient methods for facilitating recovery and maintenance of biodiversity. Controlling/limiting threatening agents is very critical in dry lands since organisms are already under stress due to shortage of water. If plants are eaten by animals while struggling to grow in such environments, their growth and later performance will be hampered a lot. For the overall vegetative restoration of woodlands, therefore, excluding livestock is essential for growth of trees and shrubs in which pioneer species may develop faster providing shelter for the next generation of succession.

Although the question on the extent to which the original diversity of plants and animals could recover through area enclosure remains unanswered, a better regeneration could be achieved by excluding animals and humans from degraded areas. The composition, diversity and density of woody species were higher in area enclosures when compared with open lands.

2.3.2. Socio-economic

Land areas closed for the purpose of rehabilitation or nature protection can provide benefits to the local people. In some parts of Ethiopia, such land areas are used as sources of diverse products like construction materials and grasses (Mengistu et al., 2005b). The local people observed that enclosures increased land productivity, as they resulted in more grass (for thatching) and more construction material. About 79% the interviewees found the availability of grasses for thatching after enclosure attractive in financial terms, as they previously had to purchase grass from other areas at considerable expenses (Ibid).

Farmers use fences for protection of agricultural fields and for boundary delineation. In many countries, fences are used to keep animals out of crop field to avoid damage to the crops. Fences also protect agricultural fields from entry of people. In addition, fences are the boundary lines to distinguish the farms and can be used to divide fields for various purposes. When they are established as boundary lines they may also reduce the possible boundary conflicts between bordering farmers (Kotchemidova, 2008).

Living fences such as hedgerows have many additional benefits. Hedgerows are defined as lines or groups of trees, shrubs, and grasses that are planted along roadways, fences, field edges or other non-cropped areas (Earnshaw, 2004). They enhance wildlife, barrier separating adjacent fields, diversify income, conserve water and soil, and decrease wind damage (Forman and Baudry, 1984).

In agriculture, especially in regions with sloping lands, hedgerows used as living fences can be effective barriers to protect soil erosion. Some hedgerow species grow very fast and after a short time become dense barrier, which can prevent flow and surface water runoff and reduce soil erosion. Moreover, soil properties are also improved considerably through biomass (leaves, branches/stems, and roots) pruned and applied as mulch to the top soil: improving soil organic carbon, balancing soil moisture, and increasing content of nutrients in the soil. This, in turn, improves agricultural productivity and, hence, household food availability and income.

The potential additional benefits of the use of hedgerows as fences can be clarified from studies made on the contour hedgerows for soil and water conservation. When comparing the field having hedgerow contour barriers with a non-hedgerow treatment field, research results showed that the contour hedgerow system allows an efficient mechanism to recycle nutrients, maintain soil organic matter and protect the soil from surface erosion (Kang et al., 1990). Indirectly, when nutrients in the soil are maintained, crop yield could significantly increase.

Living fences have potential to improve soil fertility. In some countries, farmers have the tradition of establishing dense hedgerows as a symbol of their property holding or to protect their farm fields or surroundings from unwanted entrance of humans or animals. In some parts of southern Ethiopia, for example, farmers use a thorny *Caesalpinia decapetala*, a thorny shrub, among others, for the purpose of repelling animals (personal observation). This species fixes nitrogen and improves fertility as a sideline benefit. In Vietnam, *Tephrosia* hedgerows produced an average of 0.5-1.0 t/ha/year of dry biomass for incorporation into the soil which may contribute to 10-20 kg N/ha (Phien and Vinh, 2007). This shows the potential the species have to contribute to soil fertility improvement and, hence, agricultural productivity if used as living fences.

One more advantage of fence includes protection function for crops from external influences. For instance, some crops are very sensitive to winds, and in this case, fence is an effective method to protect against winds and thus to permit the growth of crops and ensure the high product. In some cases, crop diseases and pests could be controlled with the green hedgerow, though more research is needed for testing the effectiveness of living fences of hedgerows in providing pest control in various agricultural situations (Earnshaw, 2004). Control of airborne diseases is a rather effective function of hedgerows in this case.

The effect of fence in reducing potential disasters caused by extreme rainfall events like landslide and flooding is also recognized. To prevent landslides, a direct physical fence can be made from construction materials (concrete, brick and stone), wood, trees and green hedgerows to establish the wall where the risk of landslide is high. Trees, hedgerows and forests also have a role in remote protection of landslide and flood by reducing run-off and soil erosion.

From living fences, farmers get multiple uses. In developing countries, firewood is usually used to cook. Therefore, the branches and stems can be trimmed to use as firewood. Farmers can get money or goods when they sell firewood to the market. Leaves, flowers, seed, fruit and small stems of many hedgerow species are the feed for livestock; even they are also used as food for people. The big trees from fences can be used as source of construction materials for farmers. Moreover, some plant species from living fences provide traditional medicine as well as material for indigenous and local people making handicrafts.

Fences also reduce human-wildlife conflicts that may ultimately lead to intensified persecution by humans. For example, when an elephant is kept away from damaging crops of farmers through fencing, the farmers, in turn, may not want to kill the elephant. In the other way round, this is an advantage related to conservation as well (Hayward and Kerley, 2009).

2.3.3. Aesthetic

Fences as green hedgerows, such as the vetiver system, have very good application for landscaping in many different areas, including infrastructure, building sites, and gardens (TVNI, undated). In urban land areas of many countries, living fences as green hedgerows are particularly important in separating private lands. They are also a part of culture. In such

areas, well-managed and creatively designed hedgerows can enhance the landscape where they are established as fences. Even in agriculture, there are many hills, mountains and sloping areas with beautiful landscapes that involve such fences as contour hedgerow intercropping systems with other food crops and plants. Flowers, fruits and foliage of some species from hedgerow with the plants' seasonal display of colors provide a very attractive landscape.

In addition, hedgerows create the habitat for many living organisms including both plants and animals. After a long time of development, a mature hedgerow will make a large environment with a lot of plant species and a wide variety of animals including mammals, birds and invertebrate species. Hedgerows not only serve as sources of food but also provide the shelter and protection for livestock and crops. Hedgerow, in this case, plays an important role in maintaining biodiversity and beauty of the landscape.

3. ANALYSIS OF THE USE OF FENCES FOR LAND RESOURCE MANAGEMENT

3.1. Costs and Benefits

The decisions to use fences and, then, their forms depend on the analysis of benefits and costs. Hence, it is important to show costs and benefits associated with fences in different forms of property rights and land uses.

3.1.1. Costs and benefits of physical and metaphorical fences

The use of physical and metaphorical fences as mechanisms of protection against threats raises several pragmatic questions. The qualitative descriptive comparison (Table 2) shows that the costs seem to outweigh the benefits. This conclusion is similar to a finding in the assessment of benefits and costs of fences for biodiversity conservation (Hayward and Kerley, 2009).

There is the element of a high cost related to establishing and maintaining fences. The first basic question is related to budgets. Constructing physical fences to protect large areas of ecological interest like natural forests and national parks is nearly impractical. It also becomes a challenge for poor countries to allocate budget and human labor on an annual basis for

maintenance even in case construction is possible. The other important issue is related to its effectiveness. Despite the amount of investment in terms of finance and human labor, when it comes to controlling human beings, physical fences result in less than anticipated results. People can climb over physical fences or destroy them by some means unless they are convinced of having such a fence for protection.

Hayward and Kerley (2009) summarize the major problems related to use of physical fences as means for conservation as follows:

- They are costly to build and maintain
- They have ecological costs through blocking migration routes, restriction of biodiversity range use which may result in overabundance, in-breeding and isolation
- Restriction of evolutionary potential
- Amenity and ethical costs

Particularly striking is the negative consequences of physical fences in ecosystems. For example, they can become barriers against free movement of wild animals (Table 2). When the western part of the Makgadikgadi Pans National Park in north central Botswana was bounded by fence, roughly a hundred zebras died in a single month in 2004 in the dry season due to the seasonal drought, before the fence was even completed (Flores, 2006). A more elaborate assessment of the ecological impacts related to poorly designed and aligned fences is described by Hayward and Kerley (2009). For instance, restriction on the altitudinal migration of Cape mountain zebra *Equus equus* and eland *Tragelaphus oryx* in South Africa to areas that may not have been occupied, particularly in limiting seasons, such as winter shows the possible negative impact on the natural adaptive process in the interaction of these species with their environment.

Fences that prevent dispersal of individuals from populations may exclude the natural processes that regulate these populations within particular levels in response to resource availability (the so-called “carrying capacity”). The consequence of this may be the overuse of resources within the fenced area, which may in turn lead to catastrophic declines or even local extinctions within the fenced area (Ibid).

Table 2 Costs and benefits compared qualitatively under different scenarios for physical fences

| Factor | | Costs | Benefits |
|----------------------------|--|--|--|
| Property right | State | Financing the establishment and maintenance of fences, hostility with the local community | Formal enforcement through government involvement |
| | Private | Investment of resources (labor, finance), loss of benefits for interests of community-level and beyond (e.g. biodiversity), possible loss of nature conservation areas through conversion to other uses of economic interest | Exclusion of non-right holders is easy (McKean, 1998) |
| | Common | Virtual impossibility to raise funds for common gains; difficulty to control private ambitions | Possibility to protect large-scale conservation areas |
| Management | | High financial investment; more intensive management due to the hard edge and complete restriction, additional burden to farm labor | Defined boundaries |
| Land uses and sizes | Large areas like national parks and rangelands | High budgetary requirement; limits seasonal large-scale migration of animals, restriction of evolutionary potential, ethical costs | Reduced human-animal conflicts; reduction of disease transfers between domestic and wild animals |
| | Small areas like farms or patches of nature conservation areas | Conflicts with livestock herders; high finance; potential genetic problems as fences divide populations into smaller parts; overabundance of organisms in one area; restriction of animals during fires, limiting their ability to escape; the problems associated with rodents and other animals that might spread disease vectors into adjacent crops; the potential to attract factors that damage crops; the time for management | Effective exclusion of unwanted animals, and humans |
| Population size | High | Conflicts with conservation professionals and organizations | Availability of labor for implementation of fencing |
| | Low | Financial cost of establishment and maintenance | Ease of exclusion |

In case of living fences of farmlands, there are some competitions between fence plants and crops for nutrients and water. To control the competition, additional management practices may be required. If the species are not properly selected, trees in the living fences may grow excessively and, hence, pruning may be required as an additional management practice (Martin, 1991). This also adds a burden on the farm labor (Table 2). It can be justified only in case the benefits that will be obtained from the living fences outweigh the cost of additional work burden. Farmers may also have their own way of evaluation that may necessarily be not

only monetary. Hence, their evaluation should be a component of benefit/cost analysis to make decisions to apply fences.

3.1.2. Costs and benefits of social fences

In social fences, the main task is ensuring that members of a given social group respect the socially acceptable norms of behavior. For this purpose, members of a local-level organizational system, usually traditionally-based, should invest their time and wisdom/knowledge to make social fences effective. Whenever there are violations the responsible members of the social group should take corrective measures by investigating the cases.

Different forms of benefits can be mentioned from the use of social fences for managing land resources. When responsibility is given to them, local people develop a sense of ownership feeling. Improved status of the resources, accessibility of the products and services from conservation areas in a socially acceptable way are also among the benefits of social fences. Managing land resources in this way helps the people to perform other social functions like conflict management in their daily life which helps to strengthen the social cohesion. The negative attachments to the physical fences are not applicable in the case of social fences. There is no physical barrier that limits movement of animal populations and, hence, the negative ecological consequences attached to physical and metaphorical fences are also overcome in social fences.

3.2. The Question of Sustainability

There is little argument against the need to achieve sustainability in managing land resources. On the other hand, the endeavor towards this end requires integrated efforts that combine the ecosystem integrity with meeting the needs of people. The broad concept of sustainable land resource management is embedded in the Brundtland declaration of sustainable development by UNCED (1987) which is also described as *our common future*: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” The report indicates the three major aspects that should be met in a balanced way to say a development is sustainable: environmental protection, economic growth and social equity.

Hence, leaning more towards any of the three components (environmental, economic and social aspects) may imbalance our development and may put sustainability at risk. Therefore, measures should be taken in such a way that ecological benefits can be achieved while enabling the people to fulfill their needs in a way that does not harm the potential of the systems to be productive for the future generations. More explicitly, sustainable land management (SLM) is defined as a knowledge-based procedure that helps integrate land, water, biodiversity, and environmental management (including input and output externalities) to meet rising food and fiber demands while sustaining ecological functions and livelihoods. SLM is necessary to meet the requirements of a growing population (Worldbank, 2006).

Studies based on area enclosures in Northern Ethiopia have clearly shown that the achievements are tremendous in terms of improved biophysical resource conditions (Aerts et al., 2007; Aerts et al., 2002; Asefa et al., 2003; Descheemaeker et al., 2006a; Descheemaeker et al., 2006b; Herweg and Ludi, 1999; Mekuria et al., 2007; Mengistu et al., 2005a; Moges and Kindu, 2006). On the other hand, there are no clear indications with regard to what changes can one observe in the livelihoods of people living around areas designated as enclosures. From the socio-economic benefits reported by some of the studies (Mengistu et al., 2005b; Nedessa et al., 2005), it is possible to say that people are getting something out of such areas as inputs to the household economy. However, the important questions such as who makes decisions on how, when and from where to take what products for what purpose and how much that contributes to the household economy remain clearly unanswered.

One may argue that if there was participation of the local people, it could be possible to rehabilitate protected areas through collective actions (Knox and Meinzen-Dick, 2001). Even if there is a claim that local people have participated in establishing a closed area, participation as it appears may not automatically lead to sustainability (Kelboro, 2000). The levels of participation and how the whole process is organized and how much it is effective to engage all socio-economic strata are the important questions that need to be answered.

Therefore, still the question of sustainability needs further investigations on issues related to empowerment of the people and nature of professional guidance provided to facilitate the whole process. For example, area enclosure as an approach was initiated in Tigray (Northern Ethiopia) in the early 1980s (Nedessa et al., 2005). This was the time of the revolutionary regime in Ethiopia which was one of the worst times in the history of the country in which

there was no way to hear the voices of those who directly depend on natural resources as a means of subsistence livelihoods. The federal and regional governments have shifted their policies since 1991. However, how much the approach has been modified or changed at local level practically when compared to the time of initiation of area enclosures needs explanation.

In the case of area enclosures in Northern Ethiopia, it may be said that it is premature to raise such questions for research in area enclosures since the time is only about three decades. The issue here is rather about the need for critical evaluation of the approach and introduction of modification or changes where they are needed to make *enclosed systems* sustainable environmentally, socio-economically as well as politically. Farmers should be able to see the incentives why the areas are taken as enclosures. Here incentives may not indicate the food or money provided to local people when they involve in the implementation of conservation measures. When materials are provided in the form of food or money for work, the perception may be distorted to the temporary benefits that the people get as a reward for their participation (Kelboro, 2000). Only about less than 40% of the farmers participated voluntarily in the case study of soil and water conservation in the Blue Nile while more than 50% of the population was forced by the village administration and the development agents (Bewket and Sterk, 2002). A means of mass mobilization is used in Northern Ethiopia by assigning about 20 days of free labor for constructing soil conservation structures and maintenance, which farmers did not want in Wello (Beshah, 2003).

The temporary achievement may seem to be *impressive* (Bewket and Sterk, 2002), but expecting sustainability from such an approach is questionable. Sometimes, interventions that lack full and genuine willingness of farmers may even lead ultimately to more degradation in the future (Pretty and Shah, 1997). Communities should primarily play their own roles in designing strategies for closing areas for objectives defined in a collaborative manner. Hence the favor towards community-based approaches does not undermine fences developed by communities themselves as part of their strategies to control entrance of animals.

A case study by Damene (2008) at Kobo is a good example of how to work with communities to manage a closed forest area and help the people to get economic benefits.

[When observed some years after area enclosure, which was established during the Ethiopian Military Government], the area had a well-established forest vegetation cover rich with indigenous species and

grass. The people were, however, excluded from decision-making processes until recently and, hence, its sustainability was at risk. But the situation was changed through the facilitation of the Kobo-Girana Valley Development Program (KGVDP) which was an initiative of the Amhara Regional Government. Discussion forum organized for the communities living around the forest and the general assembly developed bylaws to guide the overall management process. The bylaw is used by the people as guideline for the activities of the committee and to use the forest without harming it. The community also elected seven community members to serve as managing committee. The committee consisted of a chairperson, secretary, cashier, and four ordinary members, and 35% of the committee members were women.

Damene (2008) also shows that KGVDP has moved some steps ahead to help the people get economical benefits. The community formed Gerado Forest Users Cooperative having 175 member households (Ibid). The cooperative could generate income for the households. However, still the question of how much it is contributing to improvement of the household livelihood remains unanswered.

4. CONCLUSION

Fences have many advantages that can be described as ecological, socio-economic and aesthetic. This shows that fences play an important role in land resources management. Whether existed in visible form (physical structures) or invisible form (metaphorical, social fence), fence excludes disturbing or damaging or threatening agents; maintains land resources; creates landscape; and plays pivotal roles in conserving and rehabilitating soil, distinguishing the farms, providing some products and generating household income. In general terms, fencing results in improved conditions of resources (vegetation, biodiversity, soil and water). That, however, may not be an end in itself. The improved resource condition should be sustainable.

In the broader context of fences which range from the physically observable ones to the social system where agreed upon rules restrict access and use of land resources, it is possible to compare alternatives. The costs of physical and metaphorical fences tend to outweigh the benefits. Therefore, their application as long-term solutions to deal with land resource management should be re-considered. Local people who are directly dependent on land resources should be able to develop strategies in partnership with conservation professionals. In this process, physical and metaphorical fences may be devised as part of the strategies.

Given the negative impacts such fences have on the ecology and socio-cultural aspects, however, they should not be taken as lasting solutions to problems of land resource degradation.

To achieve sustainable land resource management and development through fencing, the social and natural aspects should be taken as inseparable. The objectives for fences and the types should be defined in collaboration with conservation professionals and local people. Also, when sustainability of fences in managing land resources is assessed, improvement of local people's living conditions should be considered as equally important as the status of biophysical resources. In cases where physical fences are taken as temporary means of protection, the design and alignment should be based on the investigation of the possible impacts on the ecological processes as well as the humans. The need to accommodate socio-cultural and local economic aspects to achieve sustainability in using fences for land resource management makes fencing a more intricate process than what it seems superficially.

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