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## The role of fire in the Miombo forest

- And the adaptation of the Community-based forest management to meet local needs



*foto: Martina Westfahl- Backlund mars 2006, Duru-Haitemba, Babati district*

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*“A month before the rains set in, the Miombo covered hills burst all at once into reds, salmons, pinks and coppery tinges of all hues as the Brachystegia trees flush into young leaf and, within a week, all this riot of colour has blended into a forest of the freshest green carpeted with legions of flowers. In full leaf the miombo is delightfully cool and shady, and the scanty grass a pleasure to walk through. In the dry season, what a change! The whole miombo forest becomes entirely leafless, while grass fires burn up all the grass and leaf litter. The sun beats down unmercifully and whichever way one turns there is the same view, the grey stems of miombo trees fading into the shimmering distance. The buzz of insect life has vanished, except for the sharp hiss of tsetse fly.”*

*Source: Campbell 1996:2, Box 1.1*

## Abstract

The Miombo forest is represented in seven countries in the subtropical area of Africa and is an example of ecosystem adapted to the disturbance of anthropogenic fire. The forest yields a number of different ecosystem goods and services including fuelwood, honey and soil protection. Fire has found a worldwide acceptance during the last decade due to deeper understanding of their role in the ecosystem. The presence of fire prevents up-building of fuel and big fires, therefore a new fire management is now seen.

In general the Miombo forest is threatened by overexploitation. A similar situation was represented in Duru-Haitemba forest where the case study was situated in northern Tanzania. To conserve the forest and give the tenure of the forest to the villages in Duru-Haitemba a community-based forest management was established in the middle of 1990's. The management succeeded to save the forest with a fire management including several methods of fire preventions and now there is a well grown Miombo forest in the area. This essay deals with the topic how the fire is affecting the Miombo forest. From there, this paper examines how the current community-based forest management is formed concerning the role of fire and the objectives of the locals.

The conclusion of the essay indicates that the fire has an important role in the ecosystem of the Miombo forest and favour ecosystem dynamics and diversity of the Miombo forest. The result of the case study showed that the fire management was poorly adapted to the disturbance of fire and was not widely based on local knowledge or specific needs and objectives of the different villages.

Keywords: *Miombo forest, disturbance of fire, adaptation to fire, fire prevention, community-based forest management*

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## Introduction

Africa is called as a fire continent. Since 1, 5 millions years BP the humans have used the fire and today over 70% of the fires in Africa are anthropogenic (Sheuyange et al. 2004). Fire was first used to hunt mammals on the African continent and the anthropogenic fires increased with the carrying out of the slash-and-burn method that was used in agriculture (Burchard 1998).

The species in the savanna are adapted to the disturbance of fire. It has been showed that frequent anthropogenic fires positively influence the tree species richness and create a more heterogenic savanna since repeated burning creates a mosaic of vegetation patches in different stages of recovery (Sheuyange et al. 2004).

The Miombo forest, an area of 2.7 million km<sup>2</sup>, is part of the fire continent and belongs to seven countries; Angola, Democratic Republic of the Congo, Malawi, Mozambique, Tanzania, Zambia and Zimbabwe. The Miombo forest lies within the sub humid tropical zone and represents biotope extreme in the spectrum of different savannas. It is dominated by the genera *Brachystegia*, *Julbernardia* and *Isoberlinia* (Haanpää 1998).

The Miombo forest provides ecosystem goods and services as honey, fuelwood, soil protection and cultural and spirituals values and today 15 million urban dwellers need the forest for charcoal and firewood (Campbell 1996:2-3).

The Duru-Haitemba forest, Babati district in Tanzania, has been presented as a successful management for conservation of the Miombo forest. Since the middle of the 1990: s the villages have been charged with their own control of the forest and they were able to form their proper management within the community-based forest management. Previous problems such as wide spread production of charcoal threatened the forest but, the new community-based forest management made it possible to prevent overexploitation and conserve the forest (Wily 2000). Now, after several years the forest has recovered and high trees of the dominant Miombo genus *Brachystegia* are there to be found. An unchanged management with previous fire prevention proceeds even though the Miombo forest is adapted to the disturbance of fire.

## **Aim**

The aim is to answer the following questions:

*How is fire affecting the ecosystem of the Miombo forest?*

*How is the current community-based forest management in Duru-Haitemba adapted to the fire and the objectives of the locals?*

My case study is an attempt to present an example of a current fire management within the community-based forest management in Eastern Africa. The aim is to see if the management in Duru-Haitemba is conserving the forest with the intention to conserve the ecology with the disturbance of fire or to prevent the disturbance and change the previous fire ecology. The main purpose of this essay will however be to see what part the fire plays in the ecosystem of the Miombo forest.

## **Theory and background**

### ***The dynamic ecosystem***

There are several points of view from which the humans interpret the nature. One common view is that the nature is seen as resilient. The ecosystem is constantly changing and it is dynamic. Within the ecosystem there are periods of disturbance, collapse, reorganization and recovery. This is called succession and is determined by the physical and the biological environment, competition and coexistence between the species and a changing energy flow (Söderqvist et al. 2004:40).

Resilience is one way to explain the stability of the community. Resilience is explained as the ability to return to a former structure after a disturbance (Townsend et al. 2003:323).

The repeated pattern of collapse, reorganization and recovery creates different live-history patterns. In general the organisms can be divided in two different groups. Species adapted to fast invasion after disturbance and collapse in gaps, new habitats and disturbed land are called *r species*. These species multiply quickly and are short-lived and spend most of the time in the r-dominated phase of reproduction in the lifecycle. Thus the r species are first established after disturbance however the habitat will later be taken over by the *K species* that rather grow

than reproduce and therefore spend most of the time in the K-dominated phase of growth in the lifecycle. The K species are successful in the competitions of the limited resource and will dominate the habitat before a new disturbance occurs (Townsend et al. 2003:181-183).

### ***Intermediate disturbance hypothesis***

Thus the r species and K species are establishing in different stages after a disturbance. If there is no disturbance and no gaps the K species will remain with no interference of the r species. When there is too much disturbance the different species will be unattainable to exist and the result will be low diversity (Townsend et al. 2003:174-176). Therefore “*communities are expected to contain most species when the frequency of disturbance is neither too high nor too low*” (Townsend et al. 2003:344).

### ***The occurrence of fire***

Fire is seen as a disturbance creating gaps for r species to establish. Few of the fires are caused by lightning. Most of them are man-made and occurs during the hot, dry season (Chidumayo 1994:63). During the dry season it is hot and the average wind speed is the highest. The average flame height is 2,5 meters and the fire normally spreads with 10-60 cm per second (Chidumayo 1994:60).

The intensity of the fire determines the effect and disturbance. Depending on the fuel the intensity varies (Haanpää 1998). All of the dominant genera in the Miombo forest are deciduous and the leaves are coming off during the dry season. Approximately 91 % of leaf litter falls during May-October with the peak of leaf fall in July- August (Campbell 1996:29). Gullies and ridges are natural firebreaks and different plants such as eucalyptus tree can also act as firebreakers (Whelan 1995:48).

## ***The adaptation and effects of fire in the Miombo forest***

The disturbance of fire also creates a selective response of the species and an adaptation to the fire. The adaptation increases the resilience in the community to fire disturbance. Fire adaptation can be defined by the characteristics of the organisms in a fire-prone ecosystem. A fire-prone ecosystem is an ecosystem where many of the species have evolved to tolerate the fire in different ways (Whelan 1995: 280-283).

However, it is difficult to determine an adaptation to one factor and it is difficult to generalize the adaptation to fire. The author of *The ecology of fire*, Robert J. Whelan, however gives examples of probable adaptations to fire such as timing of germination and flammability. The dormancy occurs when the frequency of fire is high and the fire releases the seeds (Whelan 1995:127-128).

Annual plants normally survive the fire because their seeds are buried and protected by the soil. By scheduling the growing and regeneration the species protect themselves from fire. Most of the woody suffrutices have small sprouts in the absence of fire (Chidumayo 1994:64-65). If fire appears before all the leaves have fallen, the fire accelerates the leaf fall and the leaves will later protect the surface from solar radiation and raindrops. The biggest ignition to fire is grass that normally is burned during the first occurrence of fire and it reduces the possibility for the area to be burned again during the dry period. If the fire occurs after leaf fall the ground is left bare without protection for heavy rain or sun radiation (Chidumayo 1994:62).

The fuel is partly, as already mentioned, undecomposed litter and grass. Parts of the nutrient return to the soil and the fire accelerates the decomposition in the soil. That results in an increased pH and a larger amount of decomposing bacteria. The vegetation in the forest is positively related to rainfall and nutrient availability. Lack of fire greatly modifies the forest structure and the result is a dense dry forest (Haanpää 1998).

## ***The ecology of the Miombo forest***

Miombo forest in general occurs in the sub-humid areas in central Africa on old and nutrient-poor soil. The annual rainfall varies from 650-1400 mm (Campbell 1996:4). Miombo forest is divided into dry Miombo woodland and wet Miombo woodland (Chidumayo 1994:8). The Miombo forest in Duru-Haitemba has less than 1000 mm of rainfall per year. In Babati district there is a bio-modal rain period from November to April that gives a mean of 807 mm per year (Sandström 1995:19-20).

The amount of organic matter is low in Miombo soil. Top soil in the dry Miombo has a content of 2% organic matter and it reduces with deepness (Chidumayo 1994).

The ground cover can contain a thick grass cover or only a spare cover of herbs and grass species. The canopy comprises of woody plants, dominated by umbrella shaped trees (Campbell 1996:2). The dominant tree genera; *Brachystegia*, *Julbernardia* and *Isoberlinia*, vary in number of species in the different areas (Chidumayo 1994:8).

In dry Miombo such as the Miombo in Duru-Haitemba the tree species are dominated by the genus *Brachystegia*. Totally there are 21 species of *Brachystegia* and three species of both *Julbernardia* and *Isoberlinia*. The composition of species is believed to depend on the soil moisture, soil nutrients and frequency of fire. The three genera are rare to find outside the Miombo. Their dominance in the Miombo may be correlated to the ectomycorrhizae in their roots that facilitate the up-taking of nutrients. That may be in favour for them in the nutrient-poor soil (Campbell 1996:11). Although the soil is poor the species variety is relatively high and the species are able to coexist probably because of variation of nutrient retention. The nutrient concentration varies in different species. The high diversity of species is important to maintain the ecological stability and nutrient cycling. In the course of decomposition the nutrient is returned from litter to soil mainly during rain season (Chidumayo 1994:15).

## ***The ecosystem goods and services of the Miombo forest***

The Miombo forest provides different types of ecosystem goods and services that are necessary for the people in the surrounding areas (fig 1). Goods can be charcoal, honey, fruit and firewood. Services provided by the forest can be protection of the soil, water regulation and grazing land (Campbell 1996:3).



*Fig 1. Goods and services of the Miombo and the need of the human*

*Source: Campbell 1995:3*

The biggest demand is for fuelwood such as firewood and charcoal. Today, 15 million urban dwellers are relying on the charcoal and firewood from the Miombo areas in Africa (Campbell 1996:2). In Tanzania 91 % of the total energy consumption is fuelwood from the Miombo forest (Campbell 1996:139). Charcoal is positively related to the price and commodity. It is relatively cheap compared to electricity and petroleum-based fuels and charcoal is easily used by a metal or a ceramic stove. The demand for charcoal is rising with the growing population especially in the urban areas. The area of Miombo forest near the big city Dar-es-Salaam in east of Tanzania is particularly badly affected by the big demand for fuelwood (Luoga et al. 2000). As will be mentioned later in the result for the case study, one forester said that the normal consumption for a family is 4 bags per month. Each bag weight 28 kg and costs around 600 Tanzanian shillings.

The firewood is preferred as wood with a hot flame, little smoke and long-lasting embers. In Malawi, a neighbouring country to Tanzania, the most mentioned species was *Julbernardia paniculata*, followed by *Brachystegia boehmii* and *Brachystegia spiciformis* (Campbell 1996:103).

The trees of the Miombo forest provide timber for construction of buildings, making fence for the cattle. It is also used as fibre for making different types of rope. Many of the Miombo species have local names and are for medicinal purpose (Campbell 1996:102-103). In *Miombo ecology and management – an introduction* (Chidumayo 1994) 106 documented trees were presented as medical species. The wood, fruit and seeds was used less frequent and the bark and roots of the trees were the most common way to extract medicine from the trees (Chidumayo 1994:53). Some species are sold in markets for a more religious or *black magic* purpose. The species are sold to the people in urban areas to clean the body or solve different types of problems (Campbell 1996:109).

In many areas the Miombo forest has a spiritual value for the locals. The natural resources are seen as guarded by the spirits of the ancestors (Campbell 1996:110).

The Miombo provide the population with bee and nectar for honey production. The most common bee species are *Apis mellifera* (Chidumayo 1994:57). Beekeepers use hives made of trees from the Miombo forest and harvest in connection to the forest. Honey is an important income for the families and it can be exchanged in the Babati district for cattle. It is also important for the extraction of honey beer. In Tanzania the honey beer has a social importance for the Barabaig. Within the ethnic group honey is used as means of payment and for ceremonies. An example of cropping season in Zambia is in October to November, during rain period, when *Brachystegia spiciformis* provides nectar. Another is when the *Julbernardia paniculata* provides nectar in the end of rain period. Trees can be viewed as a source for nectar but also as the opposite. *Isobertinia angolensis* is condemned for the honey because of its great amount of pollen that fastens the reproduction and increases the brood in the hive. The harvest occurs before the flowering of *Isobertinia angolensis* and before the honey store is used for reproduction (Fisher 1993).

The trees of the forest prevent soil erosion and water balance in the catchment areas. To provide the services old-growth forest should be maintained especially on hills and

escarpments (Chidumayo 1994:144). The Miombo forest is a shelter for strong winds and heavy rains. The soil protection works in three different levels at tree canopy, herbaceous plant canopy and at ground level by surface litter (Chidumayo 1994:17). Frequently the conservation of the forest justifies with the water conservation (Campbell 1995:110). Although the water conservation varies during the year and water conservation can be negative because of high evapotranspiration during the leaves flush and canopy greenness from August to October (Chidumayo 1994:19). The infiltration can increase with the vegetation but also depends on the structure of the soil (Sandström 1995:46-47). The water flow keeps steady with a forest and increases its variability with deforestation. Lake Babati in Babati district overflowed in 1979 and 1990 due to hydroclimate variability but primary to landscape conversion (Sandström1995:41).

### ***Ownership and management***

The citizens are using the Miombo forest for different ecosystem services and goods but the land of Tanzania belongs to the government. In the end the owner will always be the state, and the farmers have their cultivated land for borrow. However, since the middle of the 1990's the villages are now trusteeships of the Miombo forest in Duru-Haitemba.

Some believe that it is important to have an ownership and a management to prevent a situation of *the tragedy of the commons*. The theory of *tragedy of the commons* was presented by Hardin 1968 and was an attempt to explain the occurrence of overexploitation of the natural resources when ownership is not clearly defined. Natural resources owned by the commons run a bigger risk for exploitation because of the rationality. It is often more rational for the individuals to proceed the use even though it is not rational for the commons. After a certain time the natural resource use will exceed the carrying capacity and collapse. To avoid exploitation, the natural resource is need of private ownership or ownership by the national government as a public property. The right to enter or use the natural resource is needed to be allocated (Hardin 1968).

The idea of tragedy of the commons was later developed by Ostrom and another type of ownership of a common-pool resource was suggested in the article "*Coping with the tragedies of the commons*" (Ostrom 1999). As many of the developing countries nationalized

the land in the 1960's to protect the natural resources, the users of the resources lost their legal standing and the ownership was held by the national government. However the national government lacked monetary resources for a proper management of the resources.

The opinion that users only act in short-term rationally and only for their own benefits has a poor foundation. The users are in fact able to learn from previous mistakes. With the right tools and rules the situation can be improved. If the resource and the owners of the resource are defined, and these individuals are able to create their own regulations, the situation of the tragedy of the commons could be avoided (Ostrom 1999).

The Miombo forest is in general endangered by an overuse of the natural resources such as charcoal production. Before 1995 the forest in Duru-Haitemba was threatened of overexploitation (Wily 2000) and the Miombo forest was then owned and controlled by the national government. Two new land laws were presented in Tanzania 1999, the *Land Act* and the *Village Land Act*. The Land act deals with general land, outside the villages, and the majority of the land of Tanzania. The land within the village falls under the Village Land Act. The development of the Village land act started in 1995 to develop new policies concerning the land trusteeship and with the aim to set up community-based system for managing natural resources. With the implementation of the Village Land Act the law hands over an important role of management from central government to village government (Wily 2003).

### ***Community-based forest management***

Before the Village Land Act a community-based forest management was established in the Duru-Haitemba. As the idea of Ostrom (1999), the new management was to effectively protect the Miombo forest, a common-pool resource, and to decentralize the power to the people. The local knowledge was implemented in the management of the resource (Wily 2000). The community-based forest management is built upon all the stakeholder's standpoint and objectives. Stakeholders contribute with information concerning the evolution and development of forest. The knowledge and needs serve as the base for the forest management (Mendoza et al. 2005).

It is important that the local communities have tenure over the resource so that the local participation is a powerful instrument to supervise the resource. Local empowerment is

transition for a more enhanced role for the citizens. The community based forest management in the forest Duru-Haitemba is a good example of an effort to decentralize and share power concerning the forest. From the middle of the 1990's the people has been responsible to secure the forest by giving the control of the forest to people (Wily 2000).

Forest management with a participatory approach as community-based forest management has today broad acceptance world wide. However it has been criticized of lacking good structure and analytical capabilities (Mendoza et al. 2005).

The forest management consists of a forest committee in every village. It is in the forest management the fire management is found all under the responsibility of the forest committee.

### ***Fire management***

According to Chidumayo (1994) much of fire management consists of preventing fire to not harm the shoots of seedling and young generation. It is suggested that irregular burning is the most economical silvicultural practice in old-growth Miombo. Silviculture is the part of the forestry concerning the cultivation of the trees. The fire management should be adapted to the age and size of the Miombo forest (Chidumayo 1994: 132-133). In general fire in late dry season harms the woody plants but the grasses are less affected. The opposite situation occurs in the early dry season when fire affects grasses negatively and not woody plants. The fire management therefore depends on the management of forest, if it is for timber production or livestock. Framers normally burn at the end of the dry season to improve regrowth of the grasses for livestock (Campbell 1996: 190).

Taylor (1998) suggest that the objectives of the forest management is to be a maintained late-successional forest ecosystem but with natural variability (Taylor 1998).

To change fire management to accept the presence of fire reflects the changing ideas of stability and dynamics of the ecosystem. The fire should not be either too frequent or too rare to maintain the variation of species. The ecosystem is resilient and after a disturbance it returns along with the succession to the former stage. The forest managers should focus on achieving variability in fire variation to provide the survival of the tree species (Van Wilgen 2004).

Young forest should be protected from fire especially during late dry season by allowing fire in early dry season until the young forest has reach to the level of leaf production of an old-growth Miombo forest. It is important that a grown Miombo forest is burned to prevent the build-up of litter (Campbell 1996:190). Big fires, that occur worldwide today, reflect the fire exclusion for almost 100 years that has build up a heavy volatile fuel. It also reflects those who previously have enjoined a safe environment by preventing the risk of fire (MacGregor 2005).

## **Case study**

### ***Background***

The case study was situated in the Miombo forest area Duru-Haitemba in Babati district, in Tanzania. In the area there are eight villages and each one is active in participatory forest management. Seven villages are active in community-based forest management since 1993-1995. One village is active in joint forest management, a cooperation with the state of Tanzania because the village lies in the area of a natural forest reserve. As previously described the villages are responsible for the management of the Miombo forest and the natural resource is controlled through by-law. The forest committee is elected by the village council (village government). The village council has executive and juridical function, by governing and legislating the by-laws. Community-based forest management also gives the villages the opportunity to charge entrance for those who want to visit the forest. About ten years ago the forest was threatened by overexploitation foremost by charcoal production. The new management succeeded to recover the forest and maintain different types of services and goods of the forest.

The national law prohibits fire since more then 40 years back and since around 1990 it is implemented locally as a by-law. Nowadays different types of fire preventions are used to prevent a new situation of overexploitation and overrunning of the carrying capacity of the Miombo forest.

## **Method**

My case study is based on a number of semi-structured interviews with members from forest committees and experts in forestry concerning fire management in the Miombo forest in Duru-Haitemba. A semi-structured interview contains some questions that are predetermined and some of the questions arise during the informal interview (McCracken et al. 1988:20). The interviews with the forest committee and the experts were group interviews with 2-10 members from the forest committees, and several interviewers were present to ask their specific questions. The experts in forestry were interviewed one by one and the number of interviewer was normally two.

The main questions in my interviews were, independent of who was being interviewed:

*Why does fire occur in the forest?*

*How does fire affect the forest?*

*What kind of fire preventions are used in the area?*

*Why is the forest conserved?*

Further questions, depending on the direction of the interview:

*What are the positive effects of fire?*

*How are the villagers punished for braking the by-laws concerning fire?*

## **Result**

### **Why is the forest conserved?**

All interviewees were convinced that a good forest management of the Miombo forest includes a non-fire management with effective fire preventions. They also agreed that the big issue is the anthropogenic fire and that natural fires are rare in the area.

They all agreed that fire does not result in any benefits for the population near the forest. The current management results in increased water resources, locally described as “*we don't lose the rain*”. With the vegetation on the mountain slopes the villages also benefit from a

decreased frequency of gullies, leaching of the soil and soil erosion. The forest also prevents Lake Babati to overflow, like it did in 1990, and caused a big damage.

Ecosystem goods of the forest are fruits, mushroom, honey from the wild bees and firewood. It is allowed to use these ecosystem goods but only picked with bare hands.

A member of the forest committees also expressed a wish concerning the wild animals. If more wild animals could return to their forest they could in the future offer ecotourism. Then wild animals would graze instead of the cattle.

## **Fire prevention**

The most frequent fire prevention methods are grazing and patrolling. The allowed number of cattle per person varies in the different villages from a very small number up to 15 cows per household. It is the result of different ethnic groups and their traditions concerning cattle.

Exotic cows with zero-grazing was the majority in one village, while another village kept mostly indigenous cows that was in need of a much bigger area to graze than other villages.

Normally the cattle are allowed to graze in the forest during the period February-May and not during the dry season June- October. In the catchment areas in the forest it is always prohibited to grazing during all the year and it is also prohibited to graze slopes because it can result in soil erosion. One interviewee said that in some parts with tree sprouts the grazing is regulated too.

The patrolling is done by the guides in the village and the patrolling is most intense at peak season of fire, normally during October-December, although this year (2006) has been very dry and the peak season has extended to February. The patrolling was in one village two times a week and more frequent in the prohibited areas. The guides are elected by the village and they patrol without any payment. Their incentive is usually less community work and a percent of the fines. The fines for having cattle grazing in the catchment area or to put on a fire is normally 50 000 shillings. Although the patrolling is seen as a fire prevention it seems that it is more used to control the grazing.

Awareness of the people is an effective prevention for fire. In case of fire the villagers react and *fire shout* is used to warn for fire. The villagers gather and put down the fire with water,

branches or soil. It is the village responsibility to put down the fire since there is no national fire-brigade available.

To protect the forest from the surrounding fire activities different types of preventions can be used. Eucalyptus tree, a fire-tolerant tree, can be planted around the forest border. It is not permitted to cut these trees for the villagers. Another fire prevention is different types of fire-brakes. One is to cut vegetation and construct a road linked to the Miombo forest. Sometimes a fire ring is used, a burned circle that prevents fire from outside to spread into the area.

### **Fire use today**

Fire was first used by human on the African continent to hunt wild animals. This activity is now rare in the current area. However there are still different human activities in the Miombo forest that include fire.

For example fire is used to track honey. It is not clear how frequent this activity is. The bees in the forest sting in contrast to the domestic bees that sting less. To chase out the bees fire is used and honey can easier be collected. The villagers can freely apply for a permission to hunt honey. The restrictions included in this permission are not clearly defined.

The demand for charcoal is big in urban areas in Tanzania. It is normally used for cooking and a monthly use for a family is 4 bags per month. Each costs 600 Tanzanian shillings. There are very few places where it is allowed to produce charcoal. Only when new farmland is cultivated the cut trees are allowed to be converted in charcoal. Before it was also legal in some areas to report the charcoal production to the forest committee and ensure that new trees were planted. It was called controlled charcoal burning but has been abandoned by the government since 2005, and this type of reporting is no longer permitted. However the illegal charcoal production is frequent (Fig 2). The cutting of trees and the charcoal is packed in bags and sold along the roads.



*Fig 2. An illegal production of charcoal in Babati district, March 2006, photo: Mikael Lindstam*

Fire is traditionally used to increase the regrowth of grass after dry season. Just before the rain period the ground cover is set on fire. According to the interviewed it was done by shepherds to increase the amount of grass for their cattle.

## **Discussion**

The anthropogenic fire has formed the African landscape during thousands of years. According to Townsend (2003) the ecosystems are dynamic and disturbance such as fire, in the short-term provides gaps for r species. In the long term the fire has developed certain types of adaptations as dormant trees and flammability of the tree species (Whelan1995). By allowing the disturbance of fire mainly caused by human activity the diversity of the species will maintain, within the frame of the resilience of the Miombo forest.

A management that includes fire also reflects the idea of the ecosystem as a dynamic and changeable entity (van Wilgen 2004). The conservationism reflects an image of the nature as something permanent, although the fire can achieve the goal of the conservationism a heterogeneous area with species in different stages.

It is important to calculate how frequent the fire should be to maintain the diversity, prevent an up-building of fuel for big fires and at the same time not allow too much of disturbance of fire so the resilience remains.

During all the interviews the same fire management was presented and the fire was not a part of the management. Rarely the discussion was about the needs of locals or the disturbance of fire. One forester admitted that the Miombo forest needed the fire but it was too confusing to inform the villagers about the issue. He was afraid that the people would burn the whole forest intensively with the knowledge. The reason is not for me to comment but it might have some historical reasons and a tradition of top-down structure in decision making. There might be a risk for overexploitation if the information concerning the role of fire in the ecosystem of the Miombo forest was presented to the locals. But it rather reflects the idea that the locals are not aware of the role of fire although they withhold the information concerning the history and development of the forest. It also reflects the idea that the locals only use the forest in the short-term and only for their own benefits instead of the whole village.

Ostrom describes that if the natural resource and the number of owners is defined the natural resource will be safer in the hands of the locals than in the control of the state because of lacking resources and adaptation of the state. The locals do not in general only act in short-term for their own benefits (Ostrom 1999).

In Tanzania there has been a law prohibiting fire for more than 40 years. However reading the *Indicators and Tools for Restoration and Sustainable Management of Forests in East Africa* produced by the State of forests and forestry Research in Tanzania the necessity of fire is strongly supported. It is clearly expressed that great fire preventions modifies the structure of the forest and the result will be a dense dry forest (State of Forests and Forestry Research in Tanzania 2004).

The development of another composition of other species in the absence of fire is also confirmed by Haanpää (1998). The Miombo species will be overtaken by fire-intolerant, evergreen trees and lianes in the absence of fire (Haanpää 1998). The dominant genera of the Miombo is rarely found outside the Miombo (Campbell 1996).

The community-based forest management in Duru-Haitemba follows the national law concerning the prohibition of fire and it is a way to prevent an overexploitation of the resources in the Miombo forest. The situation before, with too much of human activities such as charcoal production, created a low resilience in the ecosystem of the Miombo forest. Now

the forest has recovered and the work of the forest committee including fire preventions and restrictions of exploitations of the forest has been successful.

Reasons for the prohibition of fire today perchance not are clear. Except the risk for overexploitation several reasons were presented during the interviews. The soil and water conservation, bees and fruits are examples of reasons that justify the absence of fire. It is not clear how these ecosystem goods and services would remain if a dense dry forest would establish in Duru-Haitemba.

The forest in Duru-Haitemba has recovered after a collapse and is now about 10 years old and to develop to an old-growth Miombo it will need a few more decades. So a further question would be *when should the management in Duru- Haitemba change?*

Even though this question is not included in my main study questions it is high relevant for the ongoing discussion concerning the topic of this essay.

The forest might need more time to develop in to an old-growth Miombo but the needs of the people are the needs of today. The human activities are important in the dynamics of Miombo ecosystems (Campbell 1996).

A management containing human activity such as honey hunting, using Miombo trees for medical purposes and a legal and regulated charcoal production, is a sustainable management including fire as an accepted disturbance in the ecosystem. The adaptation of the management should now be discussed and formed, partly to provide a democratic discussion and also to provide the forest management with knowledge from both locals and experts. This kind of discussion takes time and may be difficult to arrange because of lack of infrastructure and communication in Tanzania.

The adaptation is easier to arrange with a community-based forest management than with a national management. With a community-based forest management the management can be developed for the specific needs of the village. For example with different types of cattle, exotic or indigenous cows the management aim changes. With indigenous cows grazing the forest the fire is less frequent and with exotic cows other methods of fire prevention can be used.

The community- based forest management provides democratic decisions and the experts should therefore rather than direct the different villagers provide them with information concerning the ecology of the Miombo, free from political influence of the time.

It is important to let the villages create their own theory of development and not only implement the ideas of the experts.

To end the discussion it should be pointed out that the area in Duru-Haitemba is rather an exception than a typical situation in for the Miombo forest. Campbell (1996) expresses that the need of energy in firewood and charcoal that comes along with a growing population will be a problem that needs to be solved in the future. The resilience of the Miombo needs to be included. Duru-Haitemba on the other hand has already achieved that goal and the management should now be adapted to the disturbance of anthropogenic fire to maintain the ecology of the Miombo forest and included the objectives of the people for a sustainable management.

## Conclusion

Many of the species of the Miombo are adapted to the disturbance of the anthropogenic fire. The species have evolved with the anthropogenic disturbance during thousands of years. The dormant species during the dry period is one example of such adaptation. When an ecosystem contains such fire-tolerant species the ecosystem is a fire-prone ecosystem.

The fire provides effects, such as increased pH in the soil and increased amount of bacteria that in the end increases the decomposition. With the decomposition nutrients in the litter become available. The fire also creates gaps where r species are able to establish and a high diversity is provided by the fire.

The occurrence of fire is mainly in Duru-Haitemba during dry season June-October when it is hot, dry and the average wind speed is the highest. The intensity of the fire determines the effects and disturbance of the fire. The intensity is determined by the available fuel. By preventing fire the fuel is built up and big fires with high intensity can establish.

The community-based forest management is an attempt to give the tenure to the local villagers to provide a good and sustainable management of the forest. The community-based forest management in Duru- Haitemba is formed after the previous situation of overexploitation and several methods of fire prevention were included. It is not adapted to the disturbance of anthropogenic fire. The outcome of this kind of management can be a transformation to a dry dense forest with another type of composition of species.

The recommended fire management within the forest management is to prevent fire so an old-growth forest develops. That fire should be allowed in the beginning of dry season or in the late dry season depending if the management is established to provide grass for livestock or timber.

The objectives of the locals were not given during the interviews with the forest committees and foresters. For a sustainable management the point of views and need should in the future be integrated in the community-based forest management.

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