Sustainable Forest Management in a Changing Climate
FAO-Finland Forestry Programme – TANZANIA

A Fire Baseline for Tanzania

Dar es Salaam
2013

Executive Summary

In Tanzania wild fires are reported to be increasing at an alarming rate. The problem of wildfires in Tanzania is complex and should not be addressed on a sectoral level as it concerns all the aspects related to forest and land management, prevention, suppression, and post-fire management. It is a problem of general policy, land policy and forest policy and legislation, as much as it is a problem of equipment and capacity building within any one sector. Despite the magnitude of threat suggested, hard data on the number and extent of wildfires are lacking, most statements on the wildfire issue are based on story and opinions (Madoffe *et al.*, 2005). Wildfires are considered to be a 'problem'. However, the data and information to describe the extent, nature, impacts and source of wildfires have not been compiled and analyzed; this is a Fire Baseline, which is the subject of the work reported here.

The main objective of this study was to elaborate "Tanzanian wildfire baseline information", as the starting point for a Fire Information System. The step taken in compiling this fire baseline for Tanzania is a sound strategic one and should be something that is repeated in most countries that are working to understand and account for fires in their landscapes. In the preparation of the Fire Baseline there have been a series of aspects that have been indentified, which can provide a set of ongoing analyses to further refine and contribute to enhancing the insights and understanding of fire in Tanzania. They include:

- An average of 11 million hectares burn annually (ranging between 8.5 and 12.9 million hectares) in Tanzania. This corresponds to between nine and 14 % of Tanzania´s land area. Most burned area is recorded in the months from May to October, with the peak fire activity in July and August.
- Fires were detected throughout the year. There have been over 900,000 fires detected in Tanzania by satellite since November 2000 with the number of fires per year in Tanzania reasonably consistent.
- The information on impacts was not readily available and there is very little information able to be collected during the field work from 1960 to present. Overall information appears incomplete and it is highly likely it is and the data collected is probably indicative of the impacts only.
- The consistency of the numbers of fires and area burned may indicate a persistent set of ignition sources. This conforms to the identification that Tanzania has mainly rural population with high dependence on agriculture, forest and land use.
- The regions with high numbers of active fire pixels detected tend to also have high area burned recorded. Five regions; Rukwa, Mbeya, Tabora, Kigoma and Lindi average more than 1 million hectares per year average area burnt per year.
- Two landcover types, Open to very open trees and Shrubs (sparse to closed), account for ~91 million of ~133 million hectares over 12 years (~68%) and ~7.6 million hectares of ~11 million hectares (~69%) on average annually.
- In croplands there is a very low number of fires detected. This may be due to the timing of land preparation being in December in many areas when it is not dry and concerns about the damage fire can do to crops and people care about fire.
- Gazetted lands account for the major proportion of burnt area, ~77%.
    - Seven Forest Reserves have significantly higher average burned area at >160,000 hectares and each more than 2 million hectares burned over the period 2000 to 2011. Eleven of 23 Game Reserves average more than 100,000 hectares each burned per year. Eleven of the 69 Game Controlled Areas had more than 1 million hectares each burned in the 12 years since 2000. Three National Parks; Serengeti, Ruaha and Katavi, incurred approximately 16.5 million hectares area burnt.

- The remaining gazetted areas show much less burned area. This clear point of difference should be investigated to assess the context for the large areas burned and the contributing factors as compared to the lesser average burned areas in gazetted lands.
- This strongly suggests that the fire management of gazetted lands needs considerable strengthening based on a sound analysis and clear appreciation of the fire 'problem' and the factors that contribute to it.

During the preparation of this Fire Baseline for Tanzania a series of ideas for additional work and analysis was identified or arises from this analysis. They are:

1. In 2006 there were over 30,000 less than the eight year average.
    a. NEXT STEP - An analysis of this difference should be undertaken to identify the causes of the reduction in the number of fires detected.
2. The availability of data and information on fire impacts was very limited.
    a. NEXT STEP – More analysis and research work is needed to systematically assess the economic, social and ecological impacts of fires in Tanzania.
3. Districts with high average area burnt per year, could be prioritized and subject to analysis.
    a. NEXT STEP – Initiate analysis of the circumstances of the Districts with respect to economics, ecology, social and cultural aspects, the land use(s) and land cover and the recent history.
4. Gazetted lands account for the major proportion of burnt area, ~77%.
    a. NEXT STEP – Undertake further analysis to strengthen the understanding of the contributing causes, drivers and underlying factors that lead to this very high level of burned area.
5. Two landcover types, Open to very open trees and Shrubs (sparse to closed), account for ~91 million of ~133 million hectares over 12 years (~68%) and ~7.6 million hectares (~69%) on average annually.
    a. NEXT STEP - Review the literature and consult expertise available to frame up the question as to the ecological requirement of this sort of landcover type, much of which is Miombo woodland – is fire needed to sustain or maintain it?
6. The work to develop a data set of fire sizes from the MODIS satellite information was not completed in the timeframe of this Fire Baseline report.
    a. NEXT STEP - Obtain the data on fire sizes for Tanzania over the period 2000 to 2011 and generate the size distribution and numbers of fires by size that will contribute to the improved understanding of fires in Tanzania.

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List of Abbreviations

DCFO	District Catchment Forest Officer
DFO	District Forest Officer
FAO	UN Food and Agriculture Organization
FP	Forest plantation
FTI	Forestry Training Institute
GFIMS	Global Fire Information Management System
GFMC	Global Fire Monitoring Center
MNRT	Ministry Of Natural Resources and Tourism
NR	Nature Reserve
RNRO	Regional Natural Resources Officer
SADC	Southern Africa Development Community
SUA	Sokoine University of Agriculture
TAFORI	Tanzania Forest Research Institute
TFS	Tanzania Forest Agency
GFIMS	Global Fire Information Management System
IGA	Income Generation Activities
KINAPA	Kilimanjaro national Park
NAFOBEDA	National Forestry and Beekeeping Database
NAFORMA	National Forest Resource Management and Assessment
RAS	Regional Administrative Secretary
RCFO	Regional Catchment Forest Officer
TANAPA	Tanzania national Parks
URT	United Republic of Tanzania

Glossary of Some Important Terms

The following terms have been selected from the updated FAO terminology (FAO 2003, in press.).

Wildfire -

(1) Any unplanned and uncontrolled Wildland fire which regardless of ignition source may require suppression response or other action according to agency policy.

(2) Any free burning Wildland fire unaffected by fire suppression measures which meets management objectives (cf. Wildland, Wildland fire, prescribed natural fire, prescribed fire).

Fire season -

(1) Period(s) of the year during which Wildland fires are likely to occur and affect resources sufficiently to warrant organised fire management activities.

(2) A legally enacted time during which burning activities are regulated by state or local authority.

Fire frequency - The average number of fires or regularly occurring fire events per unit time in a designated area.

Community-based fire management (CBFiM) - CBFiM is a type of forest and land management in which a locally resident community (with or without the collaboration of other stakeholders) has substantial involvement in deciding the objectives and practices involved in preventing, controlling or utilising fires.

Backfiring - A form of indirect attack where extensive fire is set along the inner edge of a control line or natural barrier, usually some distance from the wildfire and taking advantage of in drafts, to consume fuels in the path of the fire, and thereby halt or retard the progress of the fire front.

Early burning - Prescribed burning early in the dry season, before the leaves and undergrowth are completely dry or before the leaves are shed; carried out as a precaution against more severe fire damage later in the fire season.

Escaped fire - Fire which has exceeded or is expected to exceed initial attack capabilities or planned prescription.

Firebreak - Any natural or constructed discontinuity in a fuelbed utilised to segregate, stop, and control the spread of fire or to provide a control line from which to suppress a fire; characterized by complete lack of combustibles down to mineral soil (as distinguished from fuelbreak).

Fire control - All activities concerned with the protection of vegetation from fire.

Fire danger - A general term used to express an assessment of both fixed and variable factors of the fire environment that determine the ease of ignition, rate of spread, difficulty of control, and fire impact; often expressed as an index.

Fire history - The reconstruction and interpretation of the chronological record, causes and impacts of fire occurrence in an ecosystem in relation to the changes of past environmental, cultural and socioeconomic conditions. Fire history evidence is based on analysis of charcoal deposits in soils, sediments, and ice, dendrochronology (fire scar analysis), historical documents, and fire reports.

Fire information system - An information system designed to support fire management decisions. Advanced fire information systems integrate different sources of information required (e.g. vegetation conditions including fire history, topography, fire weather, fire behaviour models, real-or near-real time fire detection and monitoring data, fire management resources, infrastructures and pre-suppression information) on the base of a Geographic Information System (GIS) and allows real-time distribution or access via telecommunication.

Fire management - All activities required for the protection of burnable forest and other vegetation values from fire and the use of fire to meet land management goals and objectives. It involves the strategic integration of such factors as knowledge of fire regimes, probable fire effects, values at risk, level of forest protection required, cost of fire-related activities, and prescribed fire technology into multiple-use planning, decision making, and day to day activities to accomplish stated resource management objectives. Successful fire management depends on effective fire prevention, detection, and pre-suppression, having an adequate fire suppression capability, and consideration of fire ecology relationships.

Fire ecology - The study of the relationships and interactions between fire, living organisms and the environment.

Fire season -

(1) Period(s) of the year during which Wildland fires are likely to occur and affect resources sufficiently to warrant organised fire management activities.

(2) A legally enacted time during which burning activities are regulated by state or local authority.

1

1 Introduction

1.1 Background Information

Almost 50% of the land surface of the world was covered with forest before the industrial revolution. This area had been reduced by half in 1955, and in 1980 the original pre-industrial revolution forest cover was estimated to be only 20% of the land surface. (Heikkila *et al.*, 2010). Every country must be concerned about the threat of fire to their forest. When seeing a wildfire on communal land, grassland, savannah, and so on, many people may think that there is no reason to worry as there is nothing for the fire to damage and no losses will occur. On the contrary however, it can be proved that every wildfire causes some loss or damage to environment and to the balance of nature (Heikkila *et al.*, 2010). The full comprehension regarding the negative impact of forest fires on the environment and the economy might not be clear enough. Wildfires are a world-wide problem and uncontrolled. Fire is a disaster on society and on the environment. Globally, more than 350 million hectares of vegetation including forest burn each year and 90% of these wildfires are caused by human activities (FAO, 2005). Wildfires mainly occur in the tropical and subtropical open forests, woodlands and savannahs which have a distinct dry season and cover an area of about 23 to 26 million km^2 worldwide (GFMC, 1998). Intentional burning in tropical savannah Africa has been practiced for at least fifty thousand years and has changed little from those of the ancestors (Chidumayo, 1998).

Africa leads the world in the number of wildfires and area burned almost every year (FAO, 2003). For example, in 2000 it is estimated that 175 million hectares of forest, savannah woodlands and grasslands were burned south of the equator in Africa.Many fires were intentionally set to clear land for agriculture, and many of these went out of control to burn much larger areas than were originally intended. It is not possible to state conclusively that there is a long-term upward trend in wildfire at the global level, since historical data are available for only a few countries. However, the problems experienced by individual countries and regions are such that an increasing number of national and local governments are elevating wildfire as a priority issue requiring increased policy attention and increased allocation of resources (FAO, 2005).

One complication in formulating an approach to fires is that they can have both positive and negative effects on nature. In some ecosystems fires play an ecologically significant role in maintaining biogeochemical cycles. The tropics and subtropics burn annually or in intervals of several years (short fire cycles of one to three years) (GFMC, 1998). These fires are important to regenerate and stimulate the growth of grass and maintain the habitat structures of important wildlife species and domestic animals. Such "fire savannahs" are highly productive and are home to important plant and animal biodiversity. These are fire-dependent ecosystem (Myers, 2006). Fire has also become a conservation issue because many areas around the world depend on fire to maintain native species, habitats and landscapes and there is not enough fire (or the wrong fire) for these processes.

The disturbance of fire creates a selective response of the species and an adaptation which increases the resilience in the community to fire disturbance. However, it is difficult to determine an adaptation to one factor and it is difficult to generalize the adaptation to fire (Whelan, 1995). The long term impact of frequent fires may result in negative changes in productivity and population structure of a species (Zolho, 2005). Fires modify growth and reproductive rates, change the availability and use of resources and alter competitive and other relationships between organisms (Frost and Robertson, 1977). Frequent fires reduce woody plant densities, and can influence changes of floristic and structural composition by killing or suppressing individuals in the smaller diameter size classes (Zolho, 2005).

In other ecosystems fires are extremely destructive. The tropical rain forests are most vulnerable during extreme droughts such as those which repeatedly occur during El Niño years (GFMC, 1998). During such extended dry spells the rainforest trees must protect themselves against the loss of water and shed their leaves. Consequently, the forest canopy becomes more open, sunlight penetrates down to the forest floor where the shed leaves become highly flammable (GFMC, 1998). Fires escaping from agricultural sites or from pasture-burning are able to spread into the forest and result in reduction of biodiversity and contribute to long term site degradation. During the strong El Niño of 1997-1998 large areas of rainforest were destroyed by fire in Asia and the Americas. A major reason for these detrimental fires was the inappropriate use of fire in converting forest or secondary vegetation to plantations. (GFMC, 1998). Wildfire contributes in changing the landscape structure and species composition including grasslands, savannahs, closed forests and woodlands (Christensen, 1985; Goldammer, 1990; Tylor, 1995 in Madoffe *et al*, 2005).

1.2 Problem Statement

In Tanzania wild fires are reported to beincreasing at an alarming ratedue to insufficient plans and programs to control fire, inadequate human and financial resources; insufficient extension programme for local communities and lack of or weak integration of informal (Indigenous) knowledge and policy implementation relating to forest fires management (URT, 2008).

The problem of wildfires in Tanzania is complex and should not be addressed on a sectoral level. It concerns all the aspects related to forest and land management, prevention, suppression, and post-fire management. It is a problem of general policy, land policy and forest policy and legislation, as much as it is a problem of equipment and capacity building within any one sector. There are no official documented statistics on the fire problem (URT, 2008).

There are no reliable and updated records, of the intensity of fire and areas burnt MNRT, (2009). To date few systematic studies concerning the type and extent of forest fire risk in national terms in Tanzania has been undertaken (Hall and Gwalema 1985; Kimaryo, 1988; Madoffe *et al*., 2000). Despite the magnitude of threat, hard data on the number and extent of wildfires are lacking, most statements on the wildfire issue are based on story and opinions (Madoffe *et al*., 2005). Limited information is available at some institutions like SUA, TAFORI and TFS.

Tanzania, like other eastern and southern African countries, is significantly affected by Wildfires. Though estimating the spatial distribution and size of wildfires in Tanzania is currently hampered by the absence of a long-term fire monitoring programme, the limited number of existing information sources suggest that fire is a widespread phenomenon. Forest fire is a very prevalent disturbance in Tanzania's landscape with several hundred million hectares of vegetation burning every year. According to Archibald *et al* (2010) the fire affected area in Tanzania is about 12% yearly in 2001 to 2007, ranking fourth within the SADC region. Tanzania has about 33.5 million hectares of forests and it is estimated that forest fires destroy about 65,000 hectares of forests and other wooded areas annually MNRT, (1998). FAO (2011) reported that between 1990 and 2010 Tanzania lost an average of 403,350 hectares of forest or 0.97% per year due to fire.

Wildfires are considered to be a ‘problem’. However, the data and information to describe the extent, nature, impacts and source of wildfires have not been compiled and analyzed; this is the Fire Baseline, which is the subject of the work reported here. There is therefore, an urgent need for documentation of the problem if measures are to be made to reverse or slow the process.

1.3 Main Objectives

To elaborate “Tanzanian wildfire baseline information”, as the starting point for a Fire Information System

1.3.1 Specific Objectives

I. To identify the fire baseline for Tanzania and document available information on the problem of forest fires in Tanzania
II. To identify impacts of wildfires in Tanzania

1.3.2 Research Questions

i. What are the numbers of fires in Tanzania?
ii. Where do most fires occurs (land use, vegetation type; regional, district, tenure)
iii. What is the area burnt?
iv. Which is the timing (month and season) of fires?
v. What are the impacts of wildfires?
vi. Is there a wildfire problem in Tanzania?

2

2 Literature Review

Purpose of this section is to review various related fire literature.

2.1 Causes of Fire in Tanzania

In Tanzania, ignition sources are analogous to those found elsewhere in the world (Mnzava, 1980) basically lightning or caused by man.Ignition by lightning in Tanzania is rare (Poulsen, 1975) because thunderstorms usually occur in the rainy season when vegetation is too wet to support ignition. Most wildfires are caused by human activities particularly farm preparation (URT, 1998), game hunting, honey hunting, burning to simultaneously improve pasture quality and to eliminate parasites, charcoal burning, mining, pit sawing, grazing, controlled burning, arson and wildfire attributed to pedestrians (Poulsen, 1997). In recent years, wildfire has compromised efforts towards forest sustainability and biodiversity conservation causing concern among government authorities, and local and international researchers and conservation agents. The task of fire management is to ensure that fire is used in such a way that it's negative impacts are minimized and its positive impacts maximized.

2.2 Effects of Fire

The review of current fire content analysis was carried out through documents and sectoral policies namely; forest, wildlife, beekeeping, agriculture and livestock, environmental and land. The analysis was extended to Acts in the respective sectors so as to assess the consistency between policies and Act. Analysis was also made to assess the effectiveness of by-laws made by local government authorities in respect of fire management.

2.2.1 Positive Effects of Wildfires

The tropics and subtropics burn annually or in intervals of several years (short fire cycles of one to three years) (GFMC, 1998). These fires are important to regenerate and stimulate the growth of grass and maintain the habitat structures of important wildlife species and domestic animals. Such "fire savannahs" are highly productive and are home to important plant and animal biodiversity.

Figure 1: Early burning in Mikumi National Park 23 June, 2010

Fire has become a conservation issue because many areas around the world depend on fire to maintain native species, habitats and landscapes. These are fire-dependent ecosystem (Myers, 2006).

A disturbance by fire creates a selective response to the species and an adaptation which increases the resilience in the community to fire disturbance. However, it is difficult to determine an adaptation to one factor and it is difficult to generalize the adaptation to fire (Whelan, 1995). Fires modify growth and reproductive rates, change the availability and use of resources and alter competitive and other relationships between organisms (Frost and Robertson, 1977)

2.3 Negative Effects of Wildfires

The long term impact of frequent fires may result in changes in productivity and population structure of a species (Zolho, 2005).Forest fires reduce plant biomass and litter, thereby altering the energy, nutrient and water fluxes between the soil, plants and atmosphere. These changes in turn may affect the long term nutrient status and productivity of the system and consequently population structure of a species, the composition of communities and ultimately, the probability and characteristics of future fires (Frost and Robertson, 1977).Fire also kills animals that are unable to escape or avoid excessive heat and smoke (Frost, 1996). The ranges that have burned are habitats for different species with restricted home range. Herbivores and birds are also specifically affected by fire through changes in their habitat (used for cover, shelter and structure and breeding conditions), food supplies and increased risk of predation due to loss of vegetation (WCS, 2009). The effect of fire frequency on the vegetation is mostly related to its impact on the soil, water, atmosphere and their interconnectedness. Also frequent fires reduce woody plant densities, and can influence changes of floristic and structural composition by killing or suppressing individuals in the smaller diameter size classes (Zolho, 2005).

Long term experience of fires has shown that they are difficult to control without sound practices, and therefore that fires may spread out of control (Heikkila et al., 2010). That is why a number of fires start from some kind of prescribed burning. There are also problems in not being able to differentiate exactly between arson and unintentional fires.

2.4 Policy Harmonization

Currently each natural resource management sector e.g. forestry, agriculture and livestock, beekeeping, wildlife, land and environment, has a separate sectoral management policy and separate management act and most often, these policies and acts conflict widely on the wildfire issues. Almost all the sectoral policies and acts don't treat wildfire with the attention it deserves; only the Forest Act dedicates a section on it. All the other sectoral policies Agriculture policy, Wildlife policy, Livestock and Fisheries policy and environmental policy do not mention wildfires as an issue. The legislation mentions wildfire in passing and often as a useful management tool in cleaning up farms and reactivating forage growth in pasture and wildlife. The reviewed policies and Acts needs to include the National Forest Policy of 1998 and Forest Act of 2002, Wildlife Policy (1998) and Wildlife Conservation Act of 1974, The Beekeeping Policy (1998) and Beekeeping Act (2002), National Environmental Policy (1997), The National Agriculture and Livestock Policy (1997) and respective Acts, and National Land Policy of 1999 and Land Act of 1999.

Harmonized fire policies and acts together with the established fire networks at all levels, would potentially provide convenient and effective platforms for common land use stakeholders dialogue. Government Ministries having a direct stake in fire control need to develop this joint fire control strategy (Madoffe *et al.*, 2005).The ministry responsible for Local Government and other Ministries notably Agriculture, Livestock and Natural Resources need to work-out a jointly agreed implementation programme. When a policy of forest fire management is worked out for all relevant sectors the first step is to formulate clear directives and rules, and if needed, guidance for the people and farmers on how, where, and when to light a fire. A person may be allowed to light a fire on common land but who is then responsible for it? A shift is needed towards more holistic, inter-sectoral and participatory approaches to forest fire management in policy, implementation, rehabilitation and monitoring. This requires strengthening the capacity for the responsible authorities to address the different issues related to forest fires.

2.5 Impacts of Fires in Tanzania

2.5.1 Economic Impacts

In Tanzania information on the economic impacts of unwanted fires is not available and generally very poor. The data that is occasionally presented represents only a sub-set of the information available. From time to time an effort at estimation of fire costs and losses is made mainly on forest plantations rather than natural forests.

The effect of economic losses and the total damage caused by forest fires will affect the people and the country as a whole. It will be possible to give a more accurate estimate of economic losses if there is a clear view of the natural resources and if the full values placed on them are used. In addition, information of burnt areas and fires occurring during past years is needed.

From accurate analysis of loss and damage a regional fire risk map, based on fire records, can be created. This fire risk map is needed for decision making by the fire management organization to determine the level of its involvement and its authority.

The key question to put forward to the authorities of government would be; What funds are available each year to support fire management and protection? How much damage (in hectares) is caused and how much money is lost per year? Two options may follow on from the answers. If the minimal funds are spent on fire protection then weak protection will result and the consequences could be a lot of damage. If sufficient funds are spent on fire protection then an effective protection will result and consequent damage will likely be very small. The optimum solution must be option between these two

2.5.2 Environmental Impacts

There have been no assessments prepared of ecological or environmental impacts. These types of impacts are difficult to quantify, but there have been efforts to establish environmental costs and losses for significant fire events. Although not all that satisfactory in some respects to date, the evaluation of the impacts on environment is required and improved methods for doing so should be supported by research efforts. This information is particularly essential to underpin changes in land management practice and support the evolution of policy, a need emphasized by the public and persistent descriptions of large and damaging fires as “environmental disasters”.

2.5.3 Losses

A traditional and simple method for evaluating forest fire losses is to evaluate the loss against the amount of burn area and to apply this to establish an average price per hectare for the different type of forest. By using these initial facts the annual forest fire losses have been calculated, based on the total burnt area. In plantations timber production represents a large share of the national economy and the effects of fire protection can best be calculated by showing the actual value of the timber.

2.5.4 Deaths, Crops and Livestock

The loss of human life caused by a forest fire is not an everyday occurrence, but is so rare that it should be considered negligible. Also financial resources are used in fire fighting and assets are consumed in the fire. Both these must be calculated in order to identify losses caused by a forest fire. The loss of houses, other buildings, roads, farmland, and such like must also be added to the total value lost.

2.5.5 Forest Values and Biodiversity

Evaluating the real and total loss is not simple or straight forward. In addition to the burnt forest and vegetation, many other type of loss can occur. The total loss caused by fires may only be known several years afterwards, for instance, in regard to soil erosion and the damage that follows soil erosion. The appraisal of fire damage in the case of recreational resources for instance is also difficult.

Statistics based on average figures obtained from many countries shows that less than 10% of all fires cause more than 90% of all the damage, and that these larger, more damaging fires have a higher than average intensity.

3

3 Methodology

3.1 Field Analysi

Field analysis was done where by the expected products on compilation of the examples of fire records, relevant information on fires, interviews notes and records of the meetings, report that sets out, current procedures for fire recording, description of data collected, assessment of the data coverage and reliability of fire recording, analysis of needs and recommendations for improvement

3.1.1 Data Collection

Data were collected from six (6) regions and discussions held with government staff, private sector and officials at region and district level.[1]

3.2 Impact Analysi

In Tanzania information on the economic impacts of unwanted fires are not available and generally are very poor. The data that is occasionally presented represents only a sub-set of the information available. From time to time an effort at estimation of fire costs and losses is made mainly on forest plantations rather than natural forests.

There have been no assessments prepared of ecological or environmental impacts. Also these types of impacts are difficult to quantify, there have been efforts to establish environmental costs and losses for significant fire events. Although not all that satisfactory in some respects to date, the evaluation of the impacts on environment is required and improved methods for doing so should be supported by research efforts. This information is particularly essential to underpin changes in land management practice and support the evolution of policy, a need emphasized by the public and persistent descriptions of large and damaging fires as "environmental disasters". Data collected through Internet and literature researches and from various institutions are presented in *Table 1*.

3.3 Spatial Analysis

Spatial data acquired from satellite imagery, photographs and topographic sheets were analyzed and presented.

1 *Data were collected from Rongai Forest Plantation, KINAPA, South Kilimanjaro Catchment, West Kilimanjaro Forest Plantation ,TFS Northern zone, Arusha catchment, FTI Olmotonyi, SUA Olmotonyi plantation, Meru Forest Plantation, TANAPA HQ Arusha, Ngorongoro Conservation, Manyara National Park, Manyara Regional Catchment, DFO Babati, Forest Publicity andExtension SHZ, TFS Southern Highland Zone, RAS Rukwa, RNRO Rukwa, District Forest OfficeSumbawanga, Rukwa game Reserve (Nkasi), District Forest OfficeMpanda, Kilombero Nature Reserve, District Forest Office Kilolo, Ruaha National Park, Iringa Catchment, District Forest Office Mufindi, Green Resources Limited, Saohill Forest Plantation, Rungwe Nature Reserve, Mbeya Regional Catchment, Kawetere Forest Plantation , Kiwira Forest Plantation, Forest Surveillance Unit Mbeya and District Forest Office Mbeya*

3.3.1 The Active Fire Analysis (“Hotspots”)

The MODIS Active Fire/Hotspot Data from the FAO Global Fire Information Management System (GFIMS) were used to analyse frequency by province and inter annual variability of fires. The GFIMS integrates remote sensing and GIS technologies to deliver MODIS hotspot/fire locations and burned area information to natural resource managers and other stakeholders around the World. GFIMS is a monitoring system hosted at the Department of Natural Resources (NRD) of the Food and Agriculture Organization of the United Nations (FAO) (NASA/Food and Agriculture Organization of the United Nations, 2010). This product derives from the Fire Information for Resource Management System (FIRMS) developed at the University of Maryland on NASA funds. The Africa Monitoring for Environment and Sustainable Development (AMESD) and the Advanced Fire Information System (AFIS) are both activities supported in Southern Africa, also provides access to this data and is working with the Government of Tanzania to install, operate and maintain the data through AFIS. Among the data sets and services available through AFIS is 10 years of data for hotspots, burnt area, (the same data that will be used in the FAO-Fin IFM TZ Fire Baseline Study) and Fire Danger Rating (FDR) and a three day forecast of FDR.

The MODIS Terra and Aqua satellites provide coverage twice per day each, so four passes at approximately six hour intervals. The Council of Scientific and Industrial Research (CSIR) in South Africa, has been working to obtain the data, which will enable coverage of all of Tanzania and some other countries. MODIS is a 36-band instrument with capabilities for fire mapping. The first MODIS sensor is on board the Terra satellite, which was launched in December 1999 and the second MODIS sensor is on the Aqua satellite, launched in May 2002. One of the land products derived from the MODIS sensor is fire detection with resolution at the pixel level. There are also geostationary satellites that provide data at 15 minute intervals but at a much coarser resolution than MODIS. They also detect fires but the fire has to be large to be detected.

It is important to understand “how” and “what” is detected as a “hotspot”. MODIS detects a fire in a pixel and indicates the centre of the pixel as the location. It can not differentiate fires below pixel size which is 1km by 1km (100 ha). So a pixel identified as a hotspot does not necessarily mean the whole pixel is on fire. It means only that a fire is detected in that pixel. The minimum fire size for detection is 50m by 50m (0.25 ha) and the MODIS satellite passes each six hours or so. Consequently it needs to be appreciated that:

- A fire could be a short time post-ignition and be detected or more than 5 hours post ignition before it is detected
- A fire could be less than 0.25 hectares and never be detected
- A fire could be ignited and burn out between passes and not be detected
- A fire burning for a long time, many passes of the satellite, could be monitored as it burnt across the landscape
- A Fire Management System to make effective use of the satellite data and respond to it in the field is a critical requirement.

Importantly the Hotspot information from satellites is “supplementary” NOT a replacement for ground based fire spotting by local people, field staff, fire towers and other means of fire detection or the operational capacity to manage fires. The MODIS Active Fire Data was analysed using GIS to identify fires in Tanzania by:

1. Month of the year for the entire data record from 2003 to 2011
2. Annually for the period 2003 to 2011

3. By District and by Region for the period 2003 to 2011
4. By Land Cover Class, using Globcover 2005[2]. The classes were combined to provide an indication of the fire incidence in:
    a. Mosaic forest, vegetation and cropland
    b. Closed to open vegetation (>15% of area)
    c. Closed forest (>40% of area) (>5m)
    d. Open forest/woodland (15-40% of area) (>5m)
    e. Cropland

3.3.2 The Burned Area Analysis

The South African- German Trilateral Cooperation Fund is implementing the Tanzania-South Africa Fire Management Coordination Project aims at supporting and facilitating the establishment of a coordinated system of fire management at national, regional and district level in Tanzania to reduce the negative impacts of fire and enhance the use of beneficial fires. In addition, the project supports the set up of a Regional Fire Management and Coordination Centre to be based at the CSIR. The 2012 work programme of the Tanzania-South Africa Fire Management Coordination Project foresees the establishment of a Fire information Database. The Fire information Database comprises the use and application of the Advanced Fire Information Systems (AFIS) services provided through the AMESD project, a fire reporting system, information on resources available as well as the analysis of historical fire data and statistics.

Remote sensing techniques and remote sensing based products have made considerable progress in the monitoring and assessment of wildland fires providing georeferenced information and products on fires. The Moderate-Resolution Imaging Spectrometer (MODIS) is a key instrument on board of the Terra and Aqua satellites providing information on active fire locations as well as information on the area burned from 2001 (active fire) and 2000 (burned area)onwards.

The GIZ TriCo project as well as the FAO-Fin NAFORMA project and its fire management component, Integrated Fire Management for Tanzania (IFM TZ) jointly support the capacity development in use, processing and interpretation of satellite based fire data and products.

NASA and the University of Maryland have developed and made available a Global "Burned Area" Product based on MODIS image data with 500m resolution from 2000 onwards. The product is available from the University of Maryland free of charge via ftp download. The analysis of the historical burned area data in conjunction with secondary GIS data such as administrative boundaries as well asland cover, tenure and use will provide fire statistics of the area burned (hectare) per:

- Year and month
- Region and district
- Land and vegetation cover
- Land management and tenure
- Size of individual fires

2 *The GlobCover initiative of ESA developed and demonstrated global land cover maps, based on Envisat MERIS Fine Resolution (300 m) mode data. In October 2008 the GlobCover global land cover map for the year 2005/2006. The system is based on an automatic pre-processing and classification chain. Both of the two global land cover maps (2005/2006 and 2009) have been validated by international experts.*

The results of the GIS analysis provides a major basis to understand the fire "problem" and defining important parameters of the existing fire regimes in Tanzania. Analysing the historical fire data in relation to land mark features and boundaries gives information on the origin of the fires and also raises the level of awareness regarding fire occurrence and the likely ecological and economic impacts. Such information can be a major stepping stone in seeking political will and funding for the necessary development of an Integrated Fire Management System in Tanzania. The trilateral Fire management project of GIZ and FAO supported the development of this product and the associated analysis for the years 2000 to 2011.

Figure 2: Discussion during data collection (Left) West Kilimanjaro plantation and (right) Manyara national park

4

4 Results

4.1 Desk Top Study

Data from various publications were obtained and compiled (Table 1). Most of the data was incomplete, and has some gaps and does not show the impact in terms of economic value caused by those fires. However some of data from plantations showed the area affected and some cost incurred during fire suppression, but the costs shown were not of really value for the losses

Table 1: Compiled Fire Incidents in Tanzania

Region	Date	Area Burnt (Ha)	Source of Information	Impacts: Lives, Property, Crops, Livestock, Environment
MWANZA				
Rubya FP	1960	16.4ha	Mnzava,1980	
KILIMANJARO				
Kilimanjaro	1963	19736ha	Forest Division 1963	
KINAPA	2001/2004	300ha		
KINAPA	2004	7810ha	Madoffe *et al*, 2005	
Kilimanjaro Catchment Forests	1980/1983	320ha	Madoffe *et al*, 2005	
Chome FR	1967		Forest Division 1984	
Barankata Forests	1967	200 Camphor Trees	Tanzania Forest Division 1967	Tshs 10 M.
RUVUMA	1967	19.2 ha		
IRINGA				
Sao Hill FP	1983	5000 ha	Forest Division, (1984).	
Sao Hill FP	1985/1987	5665 ha	Lulandala, (1995).	
Sao Hill FP	1999/2001	7644 ha	MNRT, (2001b).	
MBEYA				
Chunya district Mbiwe NFR and Kalambo VLFR	2000	651 ha	Mpya, 2010	
	2009	303 ha	Mpya, 2010	
Kiwira Forest Plantation	1962	2ha	Tanganyika Forest Division 1962	
Plantations	1999/2000		MNRT, 2001	Tshs 8.8 million
MOROGORO				
Uluguru	1997/98	300 ha		
	1999/2000	100 ha		
Natural forest Tanzania	1980/83	7810ha	Madoffe *et al*, 2005	
TANGA				
Lushoto	1997	33280 stem/ha	Maliondo *et al* 2000	

While there is very little information able to be collected during the field work some key points can be identified from the table:

- Data is from various sources internet results of compilation from thesis, government records, inquiries and institutions.
- Very little information available from 1960 to present
- Most useful information was from plantation (after visiting - information is not easily available). Data is not centralized in any way
- Overall information appears incomplete and it is highly likely it is
- The data collected is indicative of the impacts only
- More analysis and research work is needed

4.2 Field Studies

Findings showed that 56 respondents interviewed (94.8%) were experiencing the wildfires problem; only 2 respondents (5.2%) said the problems were minimal. These results imply that wildfires are still a problem that needs to be solved in integrated manner.

The main causes of wildfires mentioned by respondents were; Farm preparation, Hunters, Charcoal makers, Honey collectors, Livestock keepers, Arsonist and Poachers. In National Parks poachers were mentioned as the main cause of fires. It was observed that people use fire in the preparation of land for cultivation before the rainy season; to clear and suppress bush and undergrowth; to remove old growth and stimulate the growth of grasses on grazing lands for livestock and wildlife. Also the beekeepers in the visited area practiced traditional beekeeping using fire during honey harvesting. Men were more likely to cause wildfires followed by youth. Men do farm preparation, charcoal making while youth do hunting and charcoal making.

Wildfires occurred during the dry season, from May to November and the peak periods were September followed by August and October. 42 respondents (72.4%) don't have a responsible officer for fire data 16 (27.6%) do have. There is a need for fire data recording and this data should be in integrated manner.

Table 2: Summary Table for Historical Data for Wildfires Documented in Various Offices

Zone/Region Institution name/ District	Date	Number offires	Area owned (ha)	Area burnt(ha)	Impacts: Lives, Crops, Trees, property, Livestock and Environment	Tshs/US$
South Kilimanjaro catchment	2006-2011	39	5467	3311.5	Trees and wild animals affected	Tshs 50,000
West Kilimanjaro FP	2008-2011	4	7300	2.65	Trees destroyed	
Meru FP	1996-1999	615	5530		Trees	
Saohill FP	2000-2011	77	43000	7658.5	Trees and property	Tshs 5,569,035.416
Green Resources LTD	2009-2011	3	30000	1904	Trees	5,800,000,000
Mufindi DC		1433			Trees and 33 houses	

4.2.1 Negative Impact of Wildfires

The negative impacts were grouped on Soil, animals, water and people as follows; Loss of nutrient, pH change, elimination of organic matter, erosion and degradation, Spoil the forest soil by killing microbes, Enhance leaching, Elimination of grass & vegetation cover, exposure to enemies, Killing young and slow moving animals, small mammals and reptiles Vegetation, Death of trees, Change of type, Disturbance of ecological succession, Forest degradation, Loss of fauna and flora, Environmental degradation, Damage riparian forest, fire sensitive vegetation, quality and quantity affected in the catchments areas of the reserve, Damage riparian forest, fire sensitive vegetation, small mammals and reptiles, Loss of property, Pasture reduction, Loss of human life and livelihoods, biodiversity degradation, Hunger and Poverty.

Overall negative impacts of wildfires are climate change, Increase in Extreme weather events such as Droughts, Floods, air pollution, melting of glacier in Mt Kilimanjaro, increase of diseases (Malaria in Highland areas), intrusion of salt water in coastal freshwater wells, Hurricanes and Heat waves

Climate change is any long-term change in the statistics of weather over durations ranging from decades to millions of years. It can be manifested in changes of averages, extremes, or other statistical measures, and may occur in a specific region or covering the Earth as a whole. Climate change is caused mainly by; Natural variations (solar radiation and deviations in the Earth's orbit), human activities, industrial activities e.g. Burning of coal, oil, and natural gas and deforestation.

Air pollution is the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or cause damage to the natural environment or built environment, into the atmosphere. The atmosphere is a complex dynamic natural gaseous system that is essential to support life on planet Earth. Stratospheric ozone depletion due to air pollution has long been recognized as a threat to human health as well as to the Earth's ecosystems. Indoor air pollution and urban air quality are listed as two of the worlds worst pollution problems in the 2008 Blacksmith Institute World's Worst Polluted Places report.

4.2.2 Positive Impact of Wildfires

The positive impact were also grouped into vegetation, people, soils, animals as followed Breaking of seed dormancy, encouragement of regeneration, speed up germination of plants especially grass, improvement of accessibility and open areas for tourist viewing, management tool in woodlands- early burning for land preparation, fertilizing effect, change of soil pH, elimination of diseases, parasites and insects (e.g. ticks), improvement of quality of pasture, make new fodder for wildlife, scaring of predators.

4.2.3 Improvements for Recording and Documentation of Fires

To improve current records the participants suggested the following;

To have a trained, responsible officer for records and documentation, (Proper records keeping and documentation), training village government on fire record keeping to all levels, Up–Down-Up exchange of information, there should be designed Uniform data template and reports form to complete for fire events, develop a follow up mechanism and compilation of data, practice integrated fire management institutional-wise, cooperate with neighbors – nearby villages; other agencies and institutions, capacity building on proper management of fire incidence and information, management, fire data compiling and analysis for the District, Region and National level, and to use and strengthen NAFOBEDA.

4.3 Active Fire Product

The analysis of the Active Fire Product yielded tables, graphs and some notes and questions for most of them. These are set out below followed by appropriate notation or discussion of the implications and further work or research that may be required**4.4** Policy Issues, Challenges and Gaps

4.3.1 Fire Distribution for Tanzania by Year

The record of Active Fire Pixels was used to generate an assessment of the potential number of fires in Tanzania.

Table 3: The active fire from the FAO's Global Fire Information Management System

Year	No Active Fires Detected	Average (8 years complete data: 2003 – 2010)	Difference from Average
From Nov-00	655		
2001	29527		
2002	46683		
2003	112732	100853	11879
2004	92755	100853	-8098
2005	109153	100853	8300
2006	69236	100853	-31617
2007	104794	100853	3941
2008	109358	100853	8505
2009	105674	100853	4821
2010	103122	100853	2269
To Jul-11	41374		
Total	**925063**		

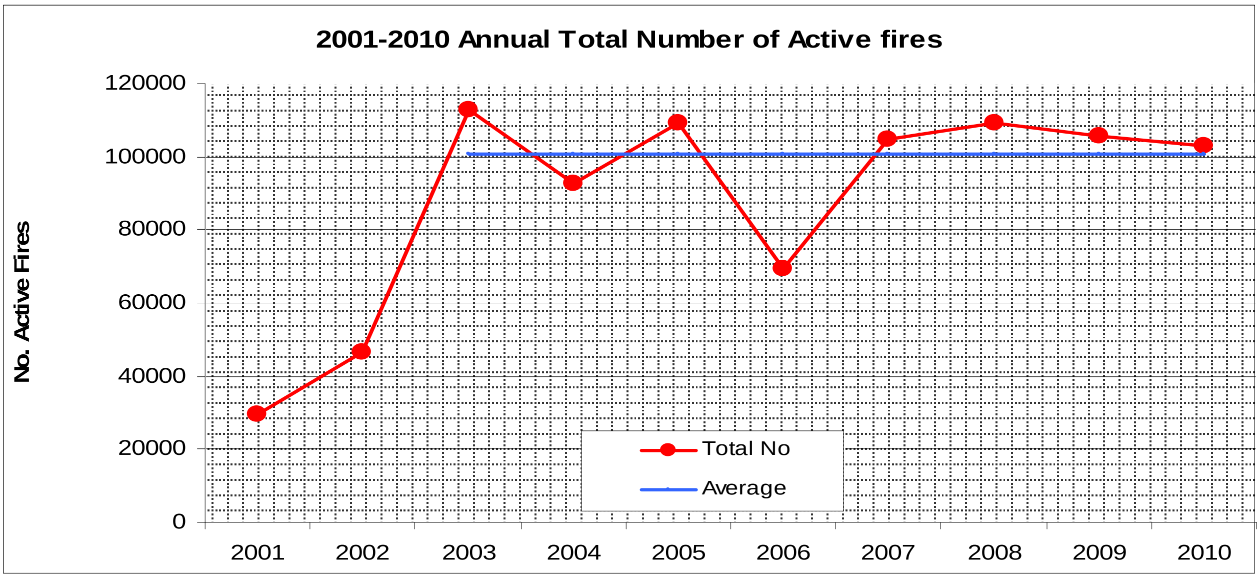
Notes and Questions

1. There have been over 900,000 fires detected in Tanzania by satellite since November 2000.
2. For the eight years where an average of active fires detected can be made (2003 – 2010) with one exception (2006) the difference between years is ±12% and for six of eight years it is ±8.5%. This suggests that the number of fires per year in Tanzania is reasonably consistent (see Figure 3).
3. One key question is as to the reasons that 2006 with 69,236 detected fires is so different at over 30,000 less than the eight year average. Analysis of this difference should be undertaken to identify the causes of the reduction in the number of fires detected. Those causes may provide some insights of interest for fire management in Tanzania.
4. The consistency of numbers of fires may indicate a persistent set of ignition sources. This conforms to the identification that Tanzania has mainly rural population with high dependence on agriculture, forest and land use. In rural areas fire use is common, widespread and frequent for various purposes related to livelihoods and production.

The GFIMS showed fluctuation of fire active pixels for eight years, with year 2003 ranked as the peak. The same year 2003 was also reported by (Madoffe *et al*, 2005) as a significant year of drought and fires in the Morogoro region. The trend is for fluctuations of fire incidence up and down, between years.

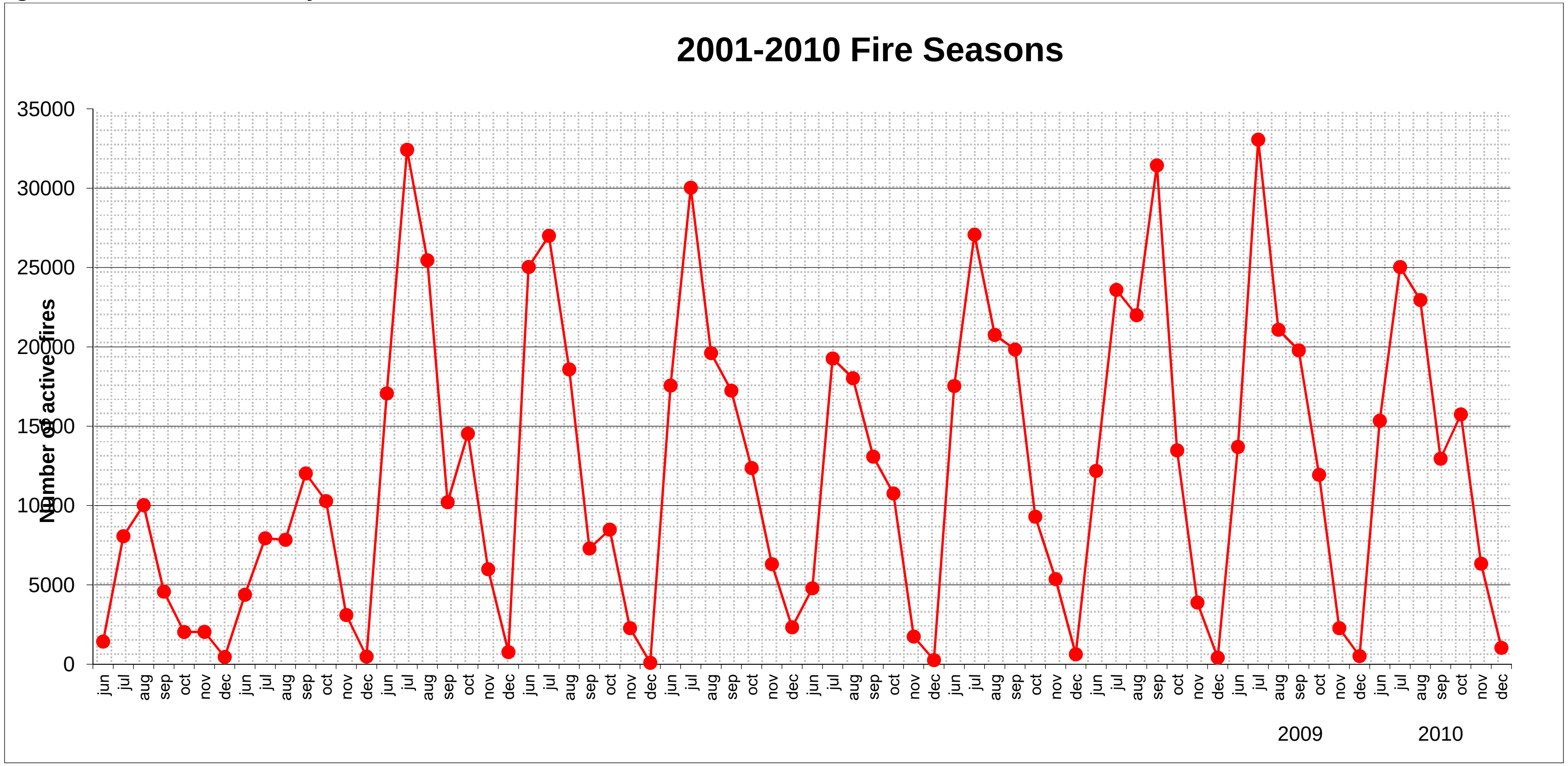
The variation between years is not largely different for 7 of the 8 years where an average is feasible (2003 – 2010) with the total active fire pixels fluctuating plus or minus ~11,000 from the annual average of nearly 101,000.

Figure 3: Trends of active fires in different years



The graph depicts active fire counts by year; the highest peak is Year 2003 with 112,732 fires; the year with the lowest active fire count is Year 2001 with 29,527 though this is due to recording with only one satellite operational, the Terra satellite, so the next lowest full year count is 2011 with 41,374. The average active fire count (period 2003-2010) is 100,853. Note that the years 2000-2002 are not considered in the averaging because the Aqua satellite started collecting data only on 4th July 2002.

Figure 4: Annual Fire Counts by Months



Notes and Questions

1. The ‘shape’ of the fires seasons is reasonably consistent with most fires detected in June to November.
2. Fire seasons have similar peaks occurring mainly in July.

Table 4: Monthly Fire Detection Active Pixels

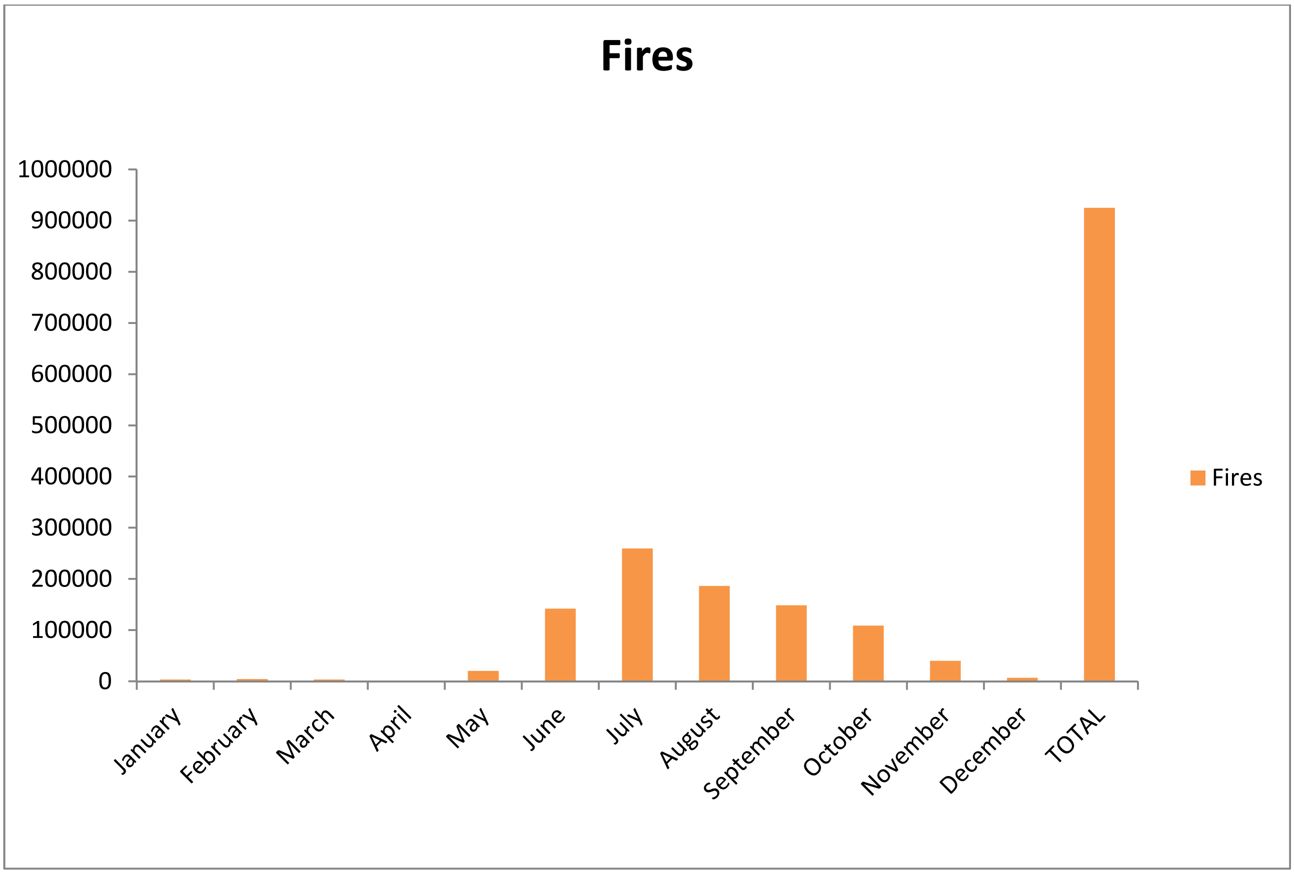
Year Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
January	-	13	46	459	192	155	627	77	465	1033	77	319	3463
February	-	15	76	1255	114	873	469	587	162	274	185	324	4334
March	-	84	17	1633	77	296	64	340	140	333	276	257	3517
April	-	15	80	179	22	253	17	518	33	81	103	42	1343
May	-	761	410	2751	3571	2110	117	2775	1553	1602	3065	1619	20334
June	-	1430	4382	17071	25040	17565	4787	17536	12186	13697	15348	12912	141954
July	-	8072	7936	32422	27003	30035	19270	27076	23595	33063	25034	25901	259407
August	-	10028	7844	25460	18584	19612	18027	20757	21999	21082	22957	-	186350
September	-	4575	12024	10214	7298	17245	13087	19835	31438	19783	12957	-	148456
October	-	2035	10284	14534	8483	12369	10761	9299	13479	11939	15747	-	108930
November	615	2043	3104	5987	2277	6310	1747	5367	3889	2273	6338	-	39950
December	40	456	480	767	94	2330	263	627	419	514	1035	-	7025
TOTAL	**655**	**29527**	**46683**	**112732**	**92755**	**109153**	**69236**	**104794**	**109358**	**105674**	**103122**	**41374**	**925063**

Notes and Questions

1. Fires were detected throughout the year. (See Figure 5) but there are a series of months where most fires occur.
2. There may be some 'permanent' hotspots due to industrial processes, though this is not likely to contribute many to the count of fires.

Social economic impacts assessed from field work suggest the major fire months, the 'fire season', was from June to October. This is consistent with the fires season analyzed through active fire counts recorded by satellite, which showed the fire season from June to October, which is the dry season. The highest counts were in July, while the peak period identified for fires was September in field results, though this relied on memory and impressions. This difference may reflect the level of damage or the profile of fires later in the dry season. Further research is required to examine this. The important thing to remember is that fire is present in all months even in rainy season (when the number of fire is very insignificant).

Figure 5: Monthly distribution of active fire and total number of active fires



4.3.2 Fire Distribution by Region

The active fire data from the FAO's Global Fire Information Management System (GFIMS) obtained allow collation of the Tanzania regions with respect to active fire detection. These active fires do not show the actual area burnt, it gives an overview of fire trend and concentration regionally in the country. The GFIMS showed the most affected regions are: Rukwa at 16 %, Kigoma with 11%, Tabora with 10%. Ruvuma, 8% and Morogoro is 6% for highest six regions (***Figure 6***)

Figure 6: Average active fire counts per regions 2003-2010

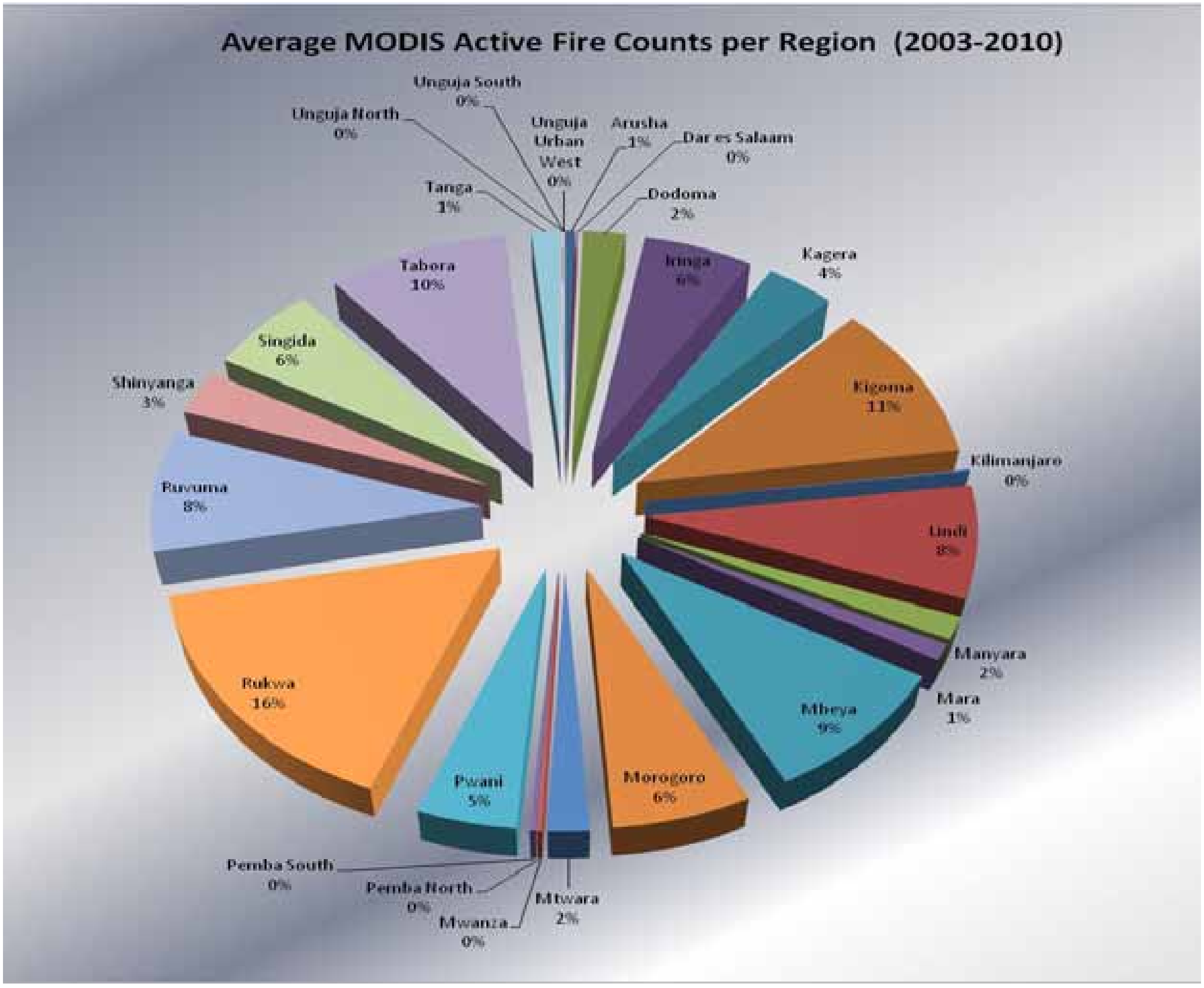


Table 5: Active Fire Pixels by Region by Year

Region	Nov-00	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Jul-11	TOTAL
Arusha	4	589	508	857	266	380	153	1133	334	168	486	59	4937
Dar es Salaam	2	12	24	55	35	72	34	66	46	78	19	16	459
Dodoma	83	762	1746	2520	2040	2782	674	3829	1873	1992	2428	178	20907
Iringa	125	2101	3132	7648	3415	7233	2397	6344	6136	6134	7499	1493	53657
Kagera	-	888	2115	4220	4377	3579	2826	2551	3218	3307	3497	1491	32069
Kigoma	-	2412	3684	10212	11531	10643	9210	9018	10382	10831	10162	6770	94855
Kilimanjaro	9	95	39	145	116	129	86	260	51	60	118	62	1170
Lindi	41	2341	3181	9708	5324	8887	4569	7963	9354	9381	7877	1667	70293
Manyara	20	635	1247	1452	1351	2125	709	2707	1392	1052	1887	219	14796
Mara	5	562	943	1387	1129	1330	614	1306	677	1108	898	238	10197
Mbeya	14	2657	3918	9161	9284	9771	7205	9199	10305	10241	9897	4793	86445
Morogoro	111	1880	3116	8492	3573	8848	1977	8211	7350	7881	7380	245	59064
Mtwara	22	435	1217	2514	1323	2590	943	1988	2405	2241	1533	470	17681
Mwanza	-	117	235	335	234	229	56	97	76	180	197	45	1801
Pemba North	1	2	1	1	5	6	4	2	1	5	6	-	34
Pemba South	-	1	-	1	1920	2	2	2	1	1	-	-	1930

Pwani	25	550	920	3278	19210	3270	1016	3712	2563	3594	2914	455	41507
Rukwa	4	5259	7282	17696	4534	18660	15627	16764	18490	18169	18308	10062	150855
Ruvuma	92	1763	4343	10290	3178	8245	6992	7659	14183	9224	9166	598	75733
Shinyanga	2	1145	1575	3113	5128	2598	2232	3283	2619	2439	2530	1453	28117
Singida	44	1658	2768	5560	13273	4476	2491	5749	5130	5378	5028	3370	54925
Tabora	12	3336	4192	11659	1477	11110	8844	10632	10852	10605	9825	7375	89919
Tanga	37	320	488	2393	9	2138	549	2269	1868	1530	1428	294	13323
Unguja North	1	3	9	4	21	10	3	11	10	7	12	5	96
Unguja South	-	4	-	31	2	39	22	37	41	66	25	15	282
Unguja Urban West	1	-	-	-	-	1	1	2	1	2	2	1	11
TOTAL	**655**	**29527**	**46683**	**112732**	**92755**	**109153**	**69236**	**104794**	**109358**	**105674**	**103122**	**41374**	**925063**

Table 6: Regions Listed in Order of Active Fire Pixel Numbers

No	PROV.	TOTAL	Average (2003-10)
1	**Rukwa**	150855	16031
2	**Kigoma**	94855	10249
3	**Tabora**	89919	9376
4	**Mbeya**	86445	9383
5	**Ruvuma**	75733	8617
6	**Lindi**	70293	7883
7	**Morogoro**	59064	6714
8	**Singida**	54925	5886
9	**Iringa**	53657	5851
10	**Pwani**	41507	4945
11	**Kagera**	32069	3447
12	**Shinyanga**	28117	2993
13	**Dodoma**	20907	2267
14	**Mtwara**	17681	1942
15	**Manyara**	14796	1584
16	**Tanga**	13323	1523
17	**Mara**	10197	1056
18	**Arusha**	4937	472
19	**Pemba South**	1930	241
20	**Mwanza**	1801	176
21	**Kilimanjaro**	1170	121
22	**Dar es Salaam**	459	51
23	**Unguja South**	282	33
24	**Unguja North**	96	10
25	**Pemba North**	34	4
26	**Unguja Urban West**	11	1
	Total	**925063**	**100853**

4.3.2.1.Social economic activities within region prone to fires

The areas critical to forest fires in Tanzania were identified in a report prepared by the United Republic of Tanzania (URT, 2008). The five regions with highest fire occurrences were noted as Rukwa, Tabora, Morogoro, Ruvuma and Tanga. The GFIMS data also identifies Rukwa, Tabora, Ruvuma and Morogoro in the ten regions with the most detections, but Tanga ranks 16th of 26 Regions. The GFIMS data suggests six other regions in the 'top ten'; Kigoma, Mbeya, Lindi, Singida, Iringa and Pwani that all had nearly 5,000 detections per year on average. This suggests that fire is definitely a persistent issue with almost the same regions identified with the most fire incidents in both assessments.

Key characteristics of livelihoods in zones have been mapped for a livelihood context analysis undertaken for a set of proposals developed for investment in water infrastructure (FAO Water, 2012). The investment brief notes the main criteria for livelihood activities; the natural resources available to people and the way they are used may have some indirect influence on fire occurrence. The characteristics of livelihoods in the most fire prone Regions are set out in ***Table 7***.

Table 7: Key characteristics of livelihood zones linked with fire

Regions	Major production system	Rural population	Farmers typology	Main constraints for development
Rukwa	maize-rice unimodal zone	1,572,330	80% traditional,15% emergent, 205 commercial	Poor market development, accessibility, animal health.
Kigoma	Coffee-banana humid zone	7,531,890	Mostly traditional farmers (over 90%)	Soil fertility, low producers price
Tabora	Tobacco-cotton zone	920,689	Mostly emergent farmers (60%). 30% traditional and 10% commercial	Low rainfall, tsetse poor accessibility
Mbeya	Rice, maize unimodal	570,461	40% traditional,40% emergent, 20% commercial	Farmer- herders conflicts, lack of technology
Ruvuma	Maize tobacco zone	768,817	70% traditional,20% emergent, 10% commercial	Poor infrastructures, soil fertility
Morogoro	Sisal- sugar cane-cattle zone	1,492,906	40% traditional, 40% emergent and 20% commercial	Poor market development, accessibility, floods in rainy season
		12,857,093		

Notes and Questions

1. These six regions with very high counts of active fire pixels, all more than 6,500 per year, also have high rural populations, a total rural population of over 12 million people.
2. The site preparation and post harvest activities for most of the crops may involve fire at one or both stages, especially tobacco, which also uses a lot of wood as fuel for drying.
3. There is an important, sometimes dominant, proportion of traditional farmers in these regions.

4.3.3 Active Fire Pixels by Land Cover Class

The number of Active Fire Pixels by land cover class was prepared by GFIMS. The results are presented in ***Table 8***

Table 8: 2000-2011 Active Fires by Land Cover Class

2000-2011 Active Fires by Land Cover Class; Globcover (regional) 2005		
Vegetation Category	**Active Fire Pixels**	**% of Total**
Closed forest (>40%) (>5m)	221111	23.90
Closed to open Vegetation (>15%)	234063	25.30
Mosaic forest, vegetation and cropland	170454	18.43
Open Vegetation (15-40%)	261451	28.26
Croplands	36516	3.95
Other	1468	0.16
Total	**925063**	**100.00**

Notes and Questions

1. In croplands there is a very low number of fires detected. This may be due to:
    a. The timing of land preparation being in December in many areas when it is not dry.
    b. It is very unusual for fires to burn in cropland. People are concerned about the damage fire can do to crops.
    c. In cropland, people care about fire. There are sometimes rules about using fire for land preparation, including seeking permission, assistance from neighbours and other steps along with penalties for rule breaking.
2. In vegetation generally:
    a. In Game Reserves and National Parks fire is prescribed for renewing pastures and ecological objectives.
    b. This is where farmers clear land for new crops, especially under the influence of Kilimo Kwanza, which is the "Agriculture First" programme of Tanzania.
    c. Pastoralists burn for pasture on open areas and also to control pests such as tsetse fly.
    d. This is also the area that is general land, which in formal terms is under government control. In practical terms this tends to be "no man's land" and people will move in and undertake activities without formal title or permission.
    e. In Miombo woodland burning is a widespread practice. This is partly as much of the vegetation is Miombo woodland and hence is impacted by the full range of potential fire sources and causes. There is a question as to the ecological requirement of Miombo woodland – is fire needed to sustain or maintain it?
    f. Forests other than Miombo woodland in Tanzania are much less in area and have high population (Kilimanjaro, Arusha) and it is closed forest. Areas of these forest types do not tend to burn as most area is under some form of management and some of this is for coffee, banana and other crops where fire is not used.

4.4 Burnt Area Product for Tanzania

4.4.1 External Sources

Some information on burned area was obtained from previous reports and estimates. Archibald et al, (2010) calculated that from 2001-07 12% = ~12 million hectares of Tanzania was burned and the Global Burned Area Assessment results in 2000 showed similar figures of ~12.2 million ha. A report by the Ministry of Natural Resources and Tourism (1998) identified 65,000 ha of forest burned as a yearly average.

4.4.2 MODIS Burned Area Analysis[3]

Eleven years of data from the globally available burned area product at 500 m resolution derived from remote sensing data obtained by the MODIS sensor on board the NASA Earth Observation Satellites Terra and Aqua, were analysed for Tanzania by Zebris a consulting firm that specializes in remote sensing and GIS under a joint agreement with GIZ and FAO-Fin IFM TZ. Data beginning 2000 through 2011 have been analysed in conjunction with GIS data provided by the Tanzania Forest Service and meteorological data provided by the Tanzania Meteorological Service.

3 *Extract from the Zebris Report for GIZ TriCo Project also supported by FAO-Fin IFM TZ*

The analysis suggests, an average of 11 million hectares burn annually (ranging between 8.5 and 12.9 million hectares) in Tanzania. This corresponds to between nine and 14 % of Tanzania´s land area. Most burned area is recorded in the months from May to October, with the peak fire activity in July and August. Most of the burning occurs in the West of the country in the Rukwa, Mbeya, Tabora and Kigoma regions, while in the Eastern part of the country, the Lindi region is most affected by fire. Each of these four regions has an average burned area of over one million ha annually, and their average burned areas together comprise over 60% of the average annual burned area of Tanzania, suggesting they are the most fire affected regions in the country.

The land cover types most affected are woodland and shrubland cover types: they comprise almost 70 % of Tanzania's average annual burned area or 6.8 million ha. Most burning occurs in gazetted land, with an annual average of 3.7 million ha in forest reserves, 3.3 million ha in game reserves and 1.46 million ha in national parks, totalling close to 8.5 million ha or 77 % of the annual average burned area of Tanzania. There are considerable spatial overlaps between forest reserves on one side and game reserves and national parks on the other, reducing the area share of these gazetted lands to the total burned area. The same holds true for the game controlled areas, which add another 2.8 million ha annual average to the burned area.

Despite the overlaps in the different gazetted land types, it is clear that the vast majority of burned areas in Tanzania were recorded by MODIS on these lands. Annual variability of burned area is moderate for most of the analysed classes, and in most cases there is no clear trend to be detected in burned area, except for the Lindi region were annual burned area appears to be increasing.

There was no close correlation between annual rainfall and burned area identified using monthly aggregated data of 17 stations and the burned area in the districts that contains those stations. To obtain a clearer picture of the meteorological drivers of burned area, a more detailed fire occurrence analysis, e.g. using fire weather data, is warranted.

An analysis of the MODIS input data themselves shows that for the more mountainous and Northern coastal parts, burned area for a significant number of months could not be retrieved due to frequent cloud cover. It is therefore likely that burned areas in these regions are underestimated, although it is not expected that the general picture would be severely altered. Preliminary comparison with an alternative burned area product[1] also derived from MODIS shows that burned areas obtained with this product tend to be higher than those of the "official" MODIS burned area product.

Not all tasks mentioned in the TOR could be fulfilled due to missing or inadequate GIS base data. It was not possible to determine fire affected areas in individual forest reserves since forest reserves could not be identified by name in most cases. Neither were names available for game controlled areas, and for most plantation areas neither names nor map data (geometries) were available. It was also not possible to compare burned areas against land use (e.g. pasture, agriculture), since no digital data on land use were available. Consequently, we recommend that the GIS base data be revised, updated and completed in order to achieve a clearer picture on spatial and temporal distribution of fire in other land use systems as well as REDD+ readiness, and complete the results of this study.

The data analysed and the intersections performed allow for more exhaustive analysis, and together with the required ecological and management information and knowledge can provide highly useful material for in depth analysis and support decisions in land management and fire management.

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The data analysed and the intersections performed allow for more exhaustive analysis, and together with the required ecological and management information and knowledge can provide highly useful material for in depth analysis and support decisions in land management and fire management.

4.4.3 Annual Burned Area

For Tanzania the annual area burned detected by MODIS is summarized in ***Table 9***.

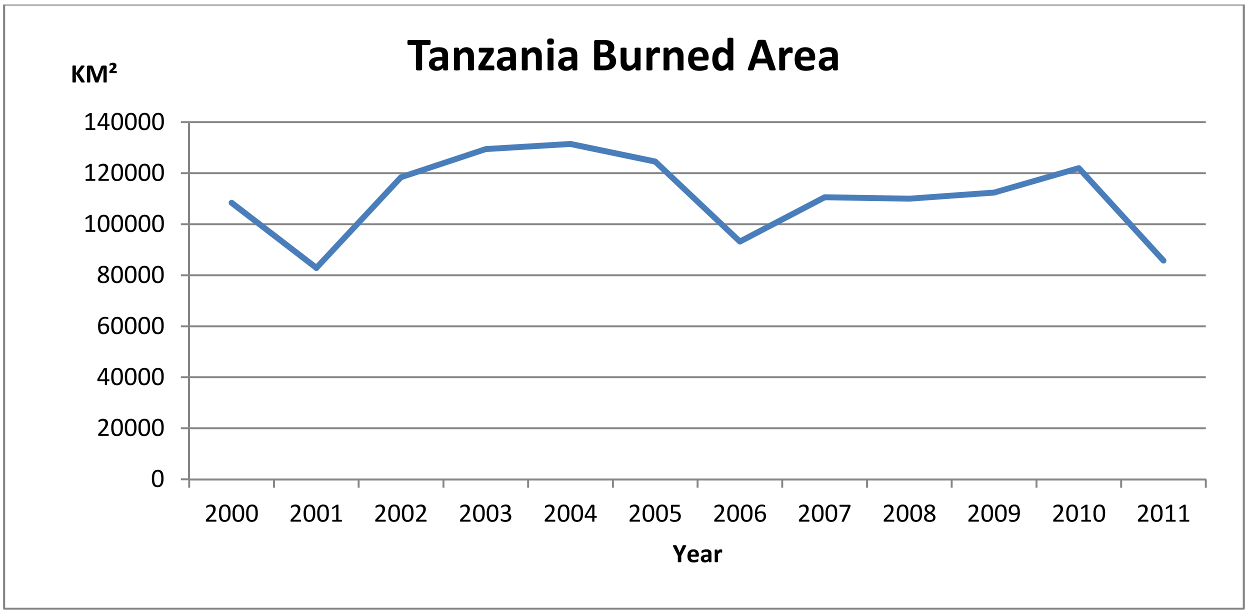
Table 9: Annual Burned Area for Tanzania

Burn Year	Km^2	Hectares
2000	108386.7398	10,838,674
2001	82870.3400	8,287,034
2002	118402.1751	11,840,218
2003	129433.3809	12,943,338
2004	131462.6155	13,146,262
2005	124544.5890	12,454,459
2006	93190.5645	9,319,056
2007	110603.8416	11,060,384
2008	110012.1536	11,001,215
2009	112396.8095	11,239,681
2010	122008.7712	12,200,877
2011	85709.5926	8,570,959
Total		**132,902,157**
Average		**11,075,180**

Notes and Questions

1. The burned area demonstrates the same sort of variation as the active fire pixel data. This suggests that the number of fires and the area burnt are correlated. Perhaps the distribution of fire sizes may not have extremes or outliers
2. 2006 was a year when less area burnt and it will be useful to assess the possible reasons for this difference of nearly 2 million hectares in area burnt.
3. IF the data sets are full year and can be compared then there is a decrease in area burnt in 2001, 2006 and 2011. It looks cyclic or regular with four years in between that are closer to the average. An evaluation of the possible explanations is a logical next step, including an assessment of the influence of El Nino.

Figure 7: Graph of Annual Area Burned for Tanzania



Graphically these figures are presented in Figure **Figure 7**. While there is variation the overall area burnt each year remains a large area.

4.4.4 Burned Area by Region

The initial jurisdiction below national in Tanzania are the Regions and a set of figures on the area burned by Regions provides and initial separation to identify the range between regions. The results can be used to identify the most fire affected regions by area and contribute to a process of prioritizing further analysis and potential planning and activities.

The regions are listed in **Error! Reference source not found.** in alphabetical order the way they are often listed in various official and other publications. In **Error! Reference source not found.** the Regions are in the order of most area burnt to least area burnt. The area burned was not evaluated as a percentage of area for each Region and this should be done to allow comparison. A large Region with a large area burnt may not have a high fire impact since the area burned as a percentage may be small, while conversely a small Region with a high percentage of its area burnt may be experiencing very high impacts from fires in the Region though the area burned is small in absolute terms. The tables enable some initial investigation of area burnt by Region.

Notes and Questions

1. The regions with high numbers of active fire pixels detected tend to also have high area burned recorded.
2. Five regions; Rukwa, Mbeya, Tabora, Kigoma and Lindi average more than 1 million hectares per year average area burnt per year.
3. 14 of 22 regions have an annual average burned area exceeding more than 100,000 hectares.

Table 10: Region Area Burned in Alphabetic Order

Region	TOTAL	Average
Arusha	2,691,195	224,266
Dar es salaam	10,674	890
Dodoma	1,080,341	90,028
Iringa	6,568,506	547,376
Kagera	5,358,626	446,552
Kaskazini Pemba	36	3
Kigoma	12,867,291	1,072,274
Kilimanjaro	42,695	3,558
Kusini Pemba	24	2
Lindi	12,264,649	1,022,054
Mara	6,638,678	553,223
Mbeya	17,457,477	1,454,790
Morogoro	2,361,409	196,784
Mtwara	1,310,954	109,246
Mwanza	314,073	26,173
Pwani	821,167	68,431
Rukwa	24,088,053	2,007,338
Ruvuma	4,917,678	409,807
Shinyanga	6,670,328	555,861

Singida	11,422,556	951,880
Tabora	15,880,873	1,323,406
Tanga	134,874	11,239
TOTAL	132,902,157	11,075,180

Table 11: Regions in Order of Area Burned

Rank	Region	TOTAL	Average
1	**Rukwa**	24,088,053	2,007,338
2	**Mbeya**	17,457,477	1,454,790
3	**Tabora**	15,880,873	1,323,406
4	**Kigoma**	12,867,291	1,072,274
5	**Lindi**	12,264,649	1,022,054
6	**Singida**	11,422,556	951,880
7	**Shinyanga**	6,670,328	555,861
8	**Mara**	6,638,678	553,223
9	**Iringa**	6,568,506	547,376
10	**Kagera**	5,358,626	446,552
11	**Ruvuma**	4,917,678	409,807
12	**Arusha**	2,691,195	224,266
13	**Morogoro**	2,361,409	196,784
14	**Mtwara**	1,310,954	109,246
15	**Dodoma**	1,080,341	90,028
16	**Pwani**	821,167	68,431
17	**Mwanza**	314,073	26,173
18	**Tanga**	134,874	11,239
19	**Kilimanjaro**	42,695	3,558
20	**Dar es salaam**	10,674	890
21	**Kaskazini Pemba**	36	3
22	**Kusini Pemba**	24	2
	TOTAL	132,902,157	11,075,180

4.4.5 Burned Area by District

The area burnt by District allows an initial assessment of the impacts of fires on them. As with Regions the area burned was not evaluated as a percentage of area for each District and this should be done to allow comparison of districts. A large District with a large area burnt may not have a high fire impact, while conversely a small District with a high percentage of its area burnt that is a smaller area may be experiencing very high impacts from fires in the District.

The Districts are presented in **Error! Reference source not found.** in decreasing order of area burnt, most area burnt to least area burnt. A listing of the Districts in Alphabetical order, where it is simpler to find a particular District is contained in **Error! Reference source not found.**.

Table 12: Districts in decreasing order of area burnt

Table 12: Districts in decreasing order of area burnt

Rank	District	Total	Average
1	Mpanda	19,380,711	1,615,059
2	Manyoni	10,812,300	901,025
3	Chunya	10,676,822	889,735
4	Sikonge	10,553,928	879,494
5	Liwale	7,934,503	661,209
6	Kibondo	7,408,206	617,350
7	Serengeti	5,412,164	451,014
8	Mbarali	4,516,810	376,401
9	Urambo	4,414,426	367,869
10	Iringa	4,310,641	359,220
11	Kigoma	3,450,168	287,514
12	Nkansi	2,491,336	207,611
13	Songea	2,369,365	197,447
14	Kilwa	2,341,153	195,096
15	Bariadi	2,296,378	191,365
16	Sumbawanga	2,216,005	184,667
17	Biharamulo	2,213,342	184,445
18	Bukombe	2,130,549	177,546
19	Tunduru	2,028,776	169,065
20	Meatu	2,016,474	168,039
21	Kasulu	2,008,918	167,410
22	Mbozi	1,608,023	134,002
23	Nachingwea	1,488,478	124,040
24	Karagwe	1,271,782	105,982
25	Ulanga	1,269,470	105,789
26	Ngara	1,253,649	104,471
27	Masasi	1,242,218	103,518
28	Ngorongoro	860,007	71,667
29	Makete	775,581	64,632
30	Mufindi	751,436	62,620
31	Rufiji	669,537	55,795
32	Tabora	668,179	55,682
33	Bunda	647,371	53,948
34	Mbeya	587,589	48,966
35	Mbinga	519,537	43,295
36	Bukoba	518,542	43,212
37	Simanjiro	515,650	42,971
38	Monduli	493,076	41,090
39	Kondoa	459,208	38,267
40	Kilombero	418,240	34,853
41	Morogoro	381,302	31,775
42	Tarime	377,277	31,440
43	Dodoma	376,176	31,348
44	Njombe	367,308	30,609
45	Ludewa	363,540	30,295
46	Singida	350,538	29,211
47	Kiteto	347,117	28,926
48	Ruangwa	338,186	28,182
49	Kilosa	292,397	24,366
50	Iramba	259,718	21,643
51	Musoma	201,865	16,822
52	Nzega	168,614	14,051
53	Lindi	162,328	13,527
54	Kahama	161,068	13,422
55	Babati	154,771	12,898
56	Magu	154,336	12,861
57	Mpwapwa	144,901	12,075
58	Hanang	124,643	10,387

59	Karatu	103,117	8,593
60	Muleba	101,312	8,443
61	Kongwa	100,056	8,338
62	Geita	86,790	7,232
63	Mbulu	85,680	7,140
64	Igunga	75,726	6,311
65	Pangani	75,129	6,261
66	Bagamoyo	67,131	5,594
67	Kisarawe	65,818	5,485
68	Shinyanga	63,216	5,268
69	Sengerema	44,398	3,700
70	Kyela	33,544	2,795
71	Mtwara	27,252	2,271
72	Newala	24,313	2,026
73	Misungwi	21,559	1,797
74	Hai	20,951	1,746
75	Handeni	20,891	1,741
76	Rungwe	19,307	1,609
77	Tandahimba	17,171	1,431
78	Mkulanga	17,020	1,418
79	Lushoto	15,898	1,325
80	Ileje	15,382	1,282
81	Same	12,370	1,031
82	Korogwe	11,525	960
83	Temeke	10,650	887
84	Muheza	10,505	875
85	Arumeru	6,393	533
86	Kwimba	5,394	449
87	Moshi	3,753	313
88	Rombo	3,146	262
89	Maswa	2,644	220
90	Mwanga	2,475	206
91	Ukerewe	1,072	89
92	Kibaha	954	79
93	Tanga	926	77
94	Arusha	743	62
95	Mafia	707	59
96	Mwanza	523	44
97	Wete	36	3
98	Chakechake	24	2
99	Kinondoni	24	2

Table 13: Districts Area Burnt in Alphabetical Order

District	Total	Average

Arumeru	6,393	533
Arusha	743	62
Babati	154,771	12,898
Bagamoyo	67,131	5,594
Bariadi	2,296,378	191,365
Biharamulo	2,213,342	184,445
Bukoba	518,542	43,212
Bukombe	2,130,549	177,546
Bunda	647,371	53,948
Chakechake	24	2
Chunya	10,676,822	889,735
Dodoma	376,176	31,348
Geita	86,790	7,232
Hai	20,951	1,746
Hanang	124,643	10,387
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Ileje	15,382	1,282
Iramba	259,718	21,643
Iringa	4,310,641	359,220
Kahama	161,068	13,422
Karagwe	1,271,782	105,982
Karatu	103,117	8,593
Kasulu	2,008,918	167,410
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Kilwa	2,341,153	195,096
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Liwale	7,934,503	661,209
Ludewa	363,540	30,295
Lushoto	15,898	1,325
Mafia	707	59
Magu	154,336	12,861
Makete	775,581	64,632
Manyoni	10,812,300	901,025
Masasi	1,242,218	103,518
Maswa	2,644	220
Mbarali	4,516,810	376,401
Mbeya	587,589	48,966
Mbinga	519,537	43,295
Mbozi	1,608,023	134,002

Mbulu	85,680	7,140
Meatu	2,016,474	168,039
Misungwi	21,559	1,797
Mkulanga	17,020	1,418
Monduli	493,076	41,090
Morogoro	381,302	31,775
Moshi	3,753	313
Mpanda	19,380,711	1,615,059
Mpwapwa	144,901	12,075
Mtwara	27,252	2,271
Mufindi	751,436	62,620
Muheza	10,505	875
Muleba	101,312	8,443
Musoma	201,865	16,822
Mwanga	2,475	206
Mwanza	523	44
Nachingwea	1,488,478	124,040
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Ngorongoro	860,007	71,667
Njombe	367,308	30,609
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Pangani	75,129	6,261
Rombo	3,146	262
Ruangwa	338,186	28,182
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Same	12,370	1,031
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Tanga	926	77
Tarime	377,277	31,440
Temeke	10,650	887
Tunduru	2,028,776	169,065
Ukerewe	1,072	89
Ulanga	1,269,470	105,789
Urambo	4,414,426	367,869
Wete	36	3

Notes and Questions

1. 27 of 99 Districts have an average area burnt per year of more than 100,000 hectares, suggesting they may be an initial focus for fire management activities, though that should be confirmed with additional complementary analysis of the circumstances of the Districts with respect to economics, ecology, social and cultural aspects, the land use(s) and land cover and the recent history of the District.
2. There are towns and municipal areas also listed in the table. Many of them include area that is not built up or developed and hence it can be burned.

4.4.6 Burned Area by Tenure

Importantly the laws in Tanzania create mandates and provide some enabling conditions and authority for government agencies to have a role in fire management. The importance for government engagement will in part be influenced by the extent to which gazette land is being burned. Additional factors include the impacts of any burning, the sources of ignitions, the damage caused to gazetted land and any assets or values it holds and the losses and costs incurred by government from fires.

Using tenure GIS layers it was determined that most burning occurs in gazetted land, with an annual average totaling close to 8.5 million ha or 77 % of the annual average burned area of Tanzania. The data available was not coherent and there were considerable spatial overlaps between the available boundaries and locations of forest reserves, game reserves and national parks and game controlled areas. An important first step would be to confirm the boundaries of the land tenures to enable accurate attribution of burned area to gazetted lands. Additionally this would allow the calculation from GIS layers of the total area of gazetted lands by tenure as a contribution to prioritisation of the focus by agencies for fire management.

Considering these aspects it was still clear the vast majority of burned areas in Tanzania were recorded on these lands.

Notes and Questions

1. The first seven Forest Reserves have significantly higher average burned area at >160,000 hectares and each more than 2 million hectares burned over the period 2000 to 2011, than the remaining Forest Reserves, which have less than 71,000 hectares per year as an average area burned. This provides a strong reason for focusing fire management on those seven reserves initially.
2. Seventeen Forest Reserves have average burned area per year less than 1,000 hectares. There may be physical reasons, such as forest reserve size, but also lessons that can be learnt from these low figures
3. In total Forest Reserves have incurred over 44 million hectares burned with ~3,700,000 per year burned across all Forest Reserves. This suggests the management of fire needs strengthening.
4. The reduction in area burnt in 2001, 2006 and 2011 seems to express itself in the data for Forest Reserves.

Forest Reserves

Table 14: Forest Reserves by Area Burned, ranked from highest to least

Rank	Forest Reserves	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL	Average
1	**Ugalla**	1,082,570	711,399	980,133	1,102,162	1,073,499	1,052,080	713,252	828,918	945,777	905,160	890,044	911,406	11,196,400	933,033
2	**Kabungu**	843,872	537,676	661,829	739,672	842,059	808,565	661,825	655,815	663,615	609,465	659,402	682,918	8,366,714	697,226
3	**Msaginia**	725,570	456,511	559,425	620,378	778,286	741,215	592,816	557,151	592,407	580,329	566,035	590,160	7,360,283	613,357
4	**Mramba F_R_**	550,987	228,995	348,823	397,919	545,676	454,531	398,716	303,300	411,656	365,634	325,136	369,596	4,700,969	391,747
5	**Matogoro**	411,249	263,268	370,994	367,123	452,275	432,672	391,426	336,380	331,285	367,474	361,897	306,688	4,392,730	366,061
6	**Mwienzi F_R_**	427,809	221,956	365,501	410,900	446,545	389,939	296,425	382,015	364,720	394,106	354,121	318,396	4,372,433	364,369
7	**Ngogwa**	219,839	130,413	169,520	196,703	244,315	197,413	133,580	142,212	162,847	131,779	148,490	159,414	2,036,526	169,711
8	**Chomme F_R_**	92,216	41,444	51,008	68,997	94,975	68,793	60,579	63,727	70,903	76,422	79,601	84,144	852,809	71,067
9	**Ikwamba F_R_**	27,735	5,890	43,998	41,575	33,571	48,179	32,353	28,053	27,459	29,349	23,819	13,605	355,586	29,632
10	**Ruande F_R_**	20,215	6,943	1,793	31,788	20,891	13,409	877	22,895	28,905	72,753	80,949	39,357	340,776	28,398
11	**Kungwe**	16,900	8,642	23,248	21,708	24,567	20,733	22,590	18,673	26,306	20,046	17,591	18,562	239,568	19,964
12	**Mwalugulu F_R_**	23,178	8,537	8,299	8,443	15,671	12,009	5,149	7,521	9,981	8,854	8,854	6,326	122,823	10,235
13	**Mamboto F_R_**	9,907	3,848	1,421	727	3,734	5,410	3,139	4,168	5,395	2,756	7,869	1,342	49,714	4,143
14	**Kikongoloi F_R_**	273	660	862	3,028	1,168	717	471	15,504	267	7,642	5,443	182	36,218	3,018
15	**Liteho F_R_**	4,031	649	2,154	3,128	2,567	1,656	2,305	2,286	3,513	2,666	2,651	1,667	29,273	2,439
16	**Kahama Dam F_R_**	439	2,101	799	2,429	1,463	1,820	885	1,092	1,723	838	4,011	367	17,967	1,497
17	**Mtunguru F_R_**	-	14	-	97	259	1	-	6,287	-	676	335	24	7,693	641
18	**Ngongwa-Busangi F_R_**	670	2,183	392	1,287	10	98	201	609	52	119	223	24	5,868	489
19	**Unknown**	795	322	2,297	637	146	128	293	23	313	25	97	49	5,124	427
20	**Kwasumba F_R_**	-	909	-	1,019	-	463	-	15	516	-	289	-	3,212	268
21	**Sisu F_R_**	-	-	1	1,964	-	49	187	338	-	388	162	-	3,088	257
22	**Kome Island F_R_**	-	37	114	12	-	2	-	395	49	-	1,867	-	2,477	206
23	**Manka F_R_**	771	346	-	35	153	32	134	615	24	4	29	-	2,143	179
24	**Jasini F_R_**	-	-	-	24	66	-	-	342	-	98	-	-	530	44
25	**Baga ll F_R_**	-	-	-	49	-	73	-	-	142	-	146	24	435	36
26	**Kihuhwi Sigi F_R_**	-	-	-	195	-	13	-	33	-	14	1	-	256	21

27	**Bombo East ll F_R_**	-	-	-	-	-	67	-	-	181	-	-	-	248	21
28	**Kwani F_R_**	-	-	-	19	-	72	-	-	-	118	-	-	209	17
29	**Bondo F_R_**	-	-	-	68	-	-	-	-	22	-	-	-	90	7
30	**Kitivo North F_R_**	-	24	-	-	-	-	-	-	-	49	-	-	73	6
31	**Changandu F_R_**	-	-	-	-	-	17	-	40	-	-	-	-	57	5
32	**Kwembogo F_R_**	-	-	-	14	-	24	-	-	-	-	6	-	44	4
33	**Kisima Gonja F_R_**	-	-	-	-	-	-	-	17	-	-	-	-	17	1
34	**Mgambo F_R_**	-	-	-	-	-	-	-	12	-	-	-	-	12	1
35	**Bombo West F_R_**	-	-	-	-	-	-	-	-	6	-	-	-	6	1
	TOTAL	4,459,024	2,632,768	3,592,612	4,022,104	4,581,894	4,250,180	3,317,202	3,378,436	3,648,064	3,576,764	3,539,070	3,504,253	44,502,372	3,708,531

Game Reserves

The area burnt by years, including an overall total and averages are provided in ***Table 15***.

Notes and Questions

1. The reduction in area burnt in 2001, 2006 and 2011 seems to be reflected in the data for Game Reserves.
2. Over 39 million hectares of Game Reserves was burned between 2000 and 2011 at an average of slightly more than 3,300,000 hectares per year. These figures are similar to those for Forest Reserves suggesting the two tenures may be subjected to the same influences and impacts. This further implies that there may be significant synergies in having consistent approaches to fire management for both tenures.
3. Eleven of 23 Game Reserves average more than 100,000 hectares burned per year with the remainder having less than half that area burned on average. This clear point of difference should be investigated to assess the context for the large areas and the contributing factors as compared to the lesser average burned areas in Game Reserves.

Table 15: Area Burned in Game Reserves, ranked from highest to least

Rank	Game Reserves	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	Average
1	**Moyowosi Game Reserve**	744,119	348,532	576,644	631,179	739,126	730,720	598,174	490,329	579,302	608,346	506,128	627,694	7,180,293	598,358
2	**Rungwe Game Reserve**	593,656	363,404	656,820	637,429	597,065	638,841	328,852	527,337	528,023	514,641	447,049	637,056	6,470,174	539,181
3	**Selous Game Reserve**	329,183	214,192	30,291	878,073	329,117	451,213	35,278	604,758	614,497	848,055	1,161,437	469,781	5,965,874	497,156
4	**Ugalla River Gamer Reserve**	398,877	303,873	340,658	387,074	413,815	394,082	325,014	300,895	334,230	286,137	356,156	378,456	4,219,268	351,606
5	**Kisigo Game Reserve**	127,931	133,811	292,862	239,196	293,232	235,852	120,303	211,716	269,241	245,399	187,470	206,270	2,563,283	213,607
6	**Rukwa Game Reserve**	210,448	178,258	222,452	211,704	195,562	208,364	206,646	199,760	169,765	204,773	204,520	194,432	2,406,684	200,557
7	**Kigosi Game Reserve**	351,556	105,952	154,045	161,799	310,578	334,000	251,273	157,073	174,355	131,926	102,717	143,062	2,378,336	198,195
8	**Maswa Game Reserve**	160,893	64,036	240,594	225,868	202,952	173,301	183,282	230,155	176,895	113,704	175,817	28,355	1,975,852	164,654
9	**Burigi Game Reserve**	128,439	40,102	191,192	145,297	170,796	195,490	109,863	166,448	82,767	151,042	136,839	98,773	1,617,048	134,754
10	**Usangu Game Reserve**	98,419	106,340	145,667	94,589	127,411	113,303	83,756	125,602	162,401	165,493	216,804	155,465	1,595,250	132,938
11	**Muhesi Game Reserve**	40,850	42,327	129,675	89,204	184,442	140,472	99,562	129,371	125,460	124,268	84,996	88,153	1,278,780	106,565
12	**Lukwati Game Reserve**	54,400	69,542	73,524	62,268	67,812	60,860	57,519	55,216	49,059	47,660	47,950	39,797	685,606	57,134
13	**Ikorongo Game Reserve**	11,158	6,769	40,859	55,665	38,471	46,665	17,080	46,850	25,340	34,795	41,777	8,035	373,465	31,122
14	**Grumeti Game Reserve**	19,196	5,901	32,889	28,223	21,692	27,247	28,391	31,339	14,649	23,192	25,171	7,246	265,135	22,095
15	**Biharamulo Game Reserve**	19,202	1,091	26,846	27,080	21,455	32,453	25,035	17,297	16,196	20,573	15,205	6,820	229,253	19,104
16	**Ibanda Game Reserve**	20,377	2,418	21,417	17,318	24,329	16,621	23,042	17,580	15,725	20,872	20,758	17,629	218,087	18,174
17	**Swaga Swaga Game Reserve**	7,710	31,561	14,981	3,387	7,898	8,484	5,441	22,374	12,706	5,471	2,765	2,136	124,916	10,410
18	**Lukwika Lumesure Game Reserve**	4,796	5,612	4,925	12,333	13,182	13,549	6,711	5,657	10,762	8,888	8,652	11,148	106,216	8,851
19	**Manjesi Game Reserve**	10,680	10,248	3,926	6,753	4,738	3,110	518	4,818	4,364	4,008	3,883	4,146	61,192	5,099
20	**Saadani Game Reserve**	1,555	2,369	2,908	7,186	6,310	9,308	6,552	7,755	4,538	6,885	2,251	1,396	59,015	4,918
21	**Rumanyika Game Reserve**	1,937	-	4,652	834	5,875	2,596	3,814	1,534	1,319	6,532	4,208	145	33,446	2,787
22	**Mkomazi Game Reserve**	-	341	24	7,952	2,185	2,219	-	7,533	707	-	2,131	1,016	24,109	2,009
23	**Kilimanjaro Game Reserve**	-	146	954	86	24	453	-	19	-	24	-	9	1,716	143
	Total	3,335,382	2,036,827	3,208,807	3,930,498	3,778,068	3,839,202	2,516,104	3,361,417	3,372,302	3,572,684	3,754,686	3,127,021	39,832,999	3,319,417

Game Controlled Areas

Table 16: Game Controlled Areas Burnt by Decreasing Area Burned

Rank	Game Controlled Area (No)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL	Average
1	7	370,674	305,950	242,144	318,357	437,181	354,367	319,773	294,907	270,781	269,679	289,204	286,115	3,759,132	313,261
2	8	393,208	234,050	290,912	282,609	393,974	331,383	322,066	291,295	304,598	279,939	244,623	239,640	3,608,297	300,691
3	15	294,620	171,689	268,498	272,226	282,382	278,269	251,131	272,253	267,992	266,274	248,820	267,526	3,141,679	261,807
4	11	269,062	219,505	204,145	172,677	281,749	257,122	231,843	187,648	153,520	194,472	199,993	144,390	2,516,126	209,677
5	6	211,336	113,368	134,200	160,706	212,364	156,221	126,805	153,422	158,823	133,745	151,504	170,571	1,883,065	156,922
6	2	171,717	73,377	162,935	173,859	182,477	167,236	158,737	145,845	148,508	137,080	119,175	96,414	1,737,362	144,780
7	60	87,768	100,963	12,138	142,640	138,821	132,028	48,240	149,192	179,636	184,032	189,844	174,678	1,539,980	128,332
8	5	197,305	79,765	117,680	147,971	192,702	141,807	95,383	87,047	101,393	75,786	83,382	87,914	1,408,133	117,344
9	19	187,048	56,481	138,550	118,354	197,582	109,376	111,324	82,849	122,772	88,005	63,205	72,650	1,348,197	112,350
10	18	130,402	93,037	93,065	72,215	188,381	109,601	127,618	57,812	80,843	64,137	40,284	73,563	1,130,958	94,247
11	62	75,701	56,105	7,605	118,325	104,804	80,874	28,160	108,790	104,390	115,931	129,028	103,364	1,033,078	86,090
12	10	104,159	42,024	78,312	73,969	101,594	104,231	110,114	85,814	77,129	84,943	65,176	71,271	998,735	83,228
13	21	44,881	80,694	131,935	90,702	90,625	79,534	21,833	64,571	55,301	74,514	50,259	15,224	800,074	66,673
14	14	78,783	50,658	63,189	64,439	95,191	66,019	69,099	50,270	52,114	69,604	60,481	67,388	787,234	65,603
15	4	83,316	46,579	32,324	36,286	100,470	87,281	43,797	20,865	50,258	43,623	37,941	56,159	638,900	53,242
16	69	23,782	19,876	46,079	39,627	52,014	44,141	40,825	42,704	41,225	86,959	85,941	68,259	591,433	49,286
17	64	24,643	16,413	16,367	44,123	34,676	45,611	11,138	64,183	64,351	56,624	79,988	55,148	513,266	42,772
18	16	60,944	19,804	44,410	36,155	50,508	47,889	52,737	39,371	35,553	30,042	27,319	33,210	477,942	39,828
19	12	56,002	20,651	46,498	33,408	63,853	50,266	43,908	33,052	33,751	32,564	24,300	34,382	472,635	39,386
20	68	23,712	32,276	15,892	41,298	32,014	63,961	45,681	33,747	40,653	43,564	40,375	43,137	456,311	38,026
21	1	62,135	26,618	34,391	47,188	53,549	53,946	42,642	21,039	29,927	33,758	22,684	22,778	450,657	37,555
22	13	45,447	19,424	39,522	35,756	49,108	33,405	45,024	30,318	29,087	29,971	31,957	23,781	412,800	34,400
23	61	27,802	9,289	10,387	35,691	40,486	38,974	4,073	51,903	39,663	45,788	48,365	41,786	394,207	32,851
24	20	31,851	34,959	60,312	47,053	58,110	29,181	15,329	18,680	25,872	18,968	25,142	11,860	377,317	31,443
25	22	16,988	37,418	47,915	24,342	20,056	40,623	33,115	56,261	36,095	9,617	28,136	850	351,415	29,285
26	23	2,744	43,684	76,671	85,486	7,177	19,113	13,095	54,930	11,830	49	1,560	49	316,386	26,366

27	65	22,432	14,843	2,040	26,178	5,644	36,144	23,516	10,048	38,179	49,039	45,895	3,955	277,913	23,159
28	66	6,745	17,832	3,208	28,123	9,645	13,801	27,126	7,894	17,844	26,914	73,281	7,597	240,011	20,001
29	63	2,055	9,478	3,534	27,304	12,413	25,537	4,649	27,988	26,291	26,891	37,838	24,381	228,359	19,030
30	44	1	51,410	37,818	15,317	32,508	25,372	989	13,776	10,909	23	23,739	2,350	214,212	17,851
31	3	43,015	8,874	16,093	12,854	33,534	33,503	30,339	7,482	10,889	4,856	3,067	4,214	208,719	17,393
32	34	-	18,264	27,016	38,871	30,243	27,347	16,876	4,187	16,041	3,320	24,911	909	207,986	17,332
33	43	-	52,712	20,571	2,714	14,938	9,776	16,039	4,839	6,068	415	18,272	3,109	149,453	12,454
34	33	-	19,645	21,737	13,983	25,368	7,717	13,074	3,155	7,329	97	18,280	770	131,156	10,930
35	48	560	30,584	26,027	2,839	18,709	4,108	268	14,669	19,222	975	926	536	119,424	9,952
36	25	2,133	30,716	16,419	20,935	5,377	1,606	926	22,210	4,073	935	9,371	389	115,090	9,591
37	67	6,742	5,291	-	10,556	2,223	11,778	4,380	1,815	24,197	15,124	28,878	2,253	113,237	9,436
38	9	11,265	4,538	11,507	6,130	10,929	7,785	11,655	11,982	9,916	9,691	4,222	6,735	106,355	8,863
39	26	24	41,725	10,291	26,161	1,535	3,056	466	19,791	245	1,034	703	543	105,575	8,798
40	24	134	21,684	10,878	23,684	2,437	2,961	600	10,410	6,320	5,279	9,612	251	94,248	7,854
41	53	24	5,729	561	18,273	10,350	5,701	695	2,127	6,322	13,076	17,301	735	80,894	6,741
42	54	49	5,730	73	27,417	3,063	2,170	146	2,350	7,369	14,162	14,048	45	76,621	6,385
43	42	-	14,013	2,588	4,539	7,662	1,402	4,327	1,292	19,053	921	6,688	975	63,461	5,288
44	57	8,031	926	49	2,360	2,042	6,310	-	18,598	5,829	6,641	4,900	2,494	58,179	4,848
45	41	-	12,767	24	3,649	2,709	3,821	835	5,527	23,296	54	4,411	24	57,118	4,760
46	17	8,148	2,136	4,842	4,252	5,808	5,136	3,589	3,730	3,788	3,938	2,158	3,091	50,616	4,218
47	58	3,996	253	-	7,071	3,205	2,766	-	10,273	5,369	7,136	3,484	4,638	48,191	4,016
48	37	-	5,127	938	5,899	15,242	1,007	6,862	1,292	2,623	24	4,342	24	43,381	3,615
49	27	743	6,345	6,777	2,083	122	4,338	4,813	3,078	3,961	-	1,751	-	34,011	2,834
50	35	-	18,410	4,137	4,045	219	609	2,948	1,330	317	49	356	-	32,419	2,702
51	56	37	-	24	527	2,664	2,021	-	7,576	3,321	7,984	4,874	-	29,029	2,419
52	52	253	24	-	1,452	73	1,937	-	24	1,879	15,170	6,374	-	27,187	2,266
53	59	239	4,159	-	3,333	-	733	279	-	1,455	5,694	8,173	2,135	26,201	2,183
54	45	-	8,547	4,014	907	1,874	2,185	550	2,919	1,071	24	1,483	1,442	25,016	2,085
55	47	268	9,320	5,512	602	726	248	146	3,078	2,523	73	24	24	22,544	1,879
56	55	463	24	-	49	915	-	-	15,327	876	1,287	1,088	-	20,029	1,669
57	28	1,531	1,827	2,789	2,224	2,518	586	46	1,711	2,003	1,755	1,558	867	19,414	1,618

58	46	24	8,179	2,940	97	1,609	2,987	634	1,164	881	49	49	49	18,663	1,555
59	36	-	2,174	382	945	719	-	9,703	390	171	24	180	-	14,688	1,224
60	49	24	97	-	7,627	244	246	-	1,954	439	97	4	-	10,732	894
61	39	-	840	298	-	1,364	-	4,397	609	49	-	1,267	-	8,825	735
62	51	-	-	-	504	49	366	-	-	338	2,229	3,849	-	7,334	611
63	40	-	231	-	24	2,412	-	1,950	24	30	-	2,656	-	7,327	611
64	38	-	73	49	49	737	24	3,761	76	-	24	171	24	4,988	416
65	29	-	891	2,705	49	219	-	-	536	42	219	247	-	4,908	409
66	50	-	223	24	24	285	5	115	78	2,364	24	463	24	3,630	302
67	31	-	1,671	-	73	49	146	69	155	366	-	195	133	2,857	238
68	32	-	414	744	-	309	521	244	274	-	-	-	-	2,506	209
69	30	-	-	-	-	24	-	19	43	24	-	-	-	111	9
	TOTAL	3,194,969	2,442,385	2,662,682	3,069,185	3,734,568	3,178,216	2,610,521	2,744,551	2,809,346	2,694,916	2,779,774	2,336,823	34,257,935	2,854,828

Notes and Questions

1. Eleven of the 69 Game Controlled Areas had more than 1 million hectares burned in the 12 years since 2000. As with other gazetted lands there appears to be areas where the impacts of fires are most widespread, suggesting an initial focus for further analysis and potential application of fire management integrated with land use and the landscape context.

National Parks

Table 17: Area Burned National Parks in Decreasing Order of Area Burnt

Rank	National_Park	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL	Average
1	**Serengeti National Park**	194,844	311,148	824,873	1,012,789	640,826	675,483	487,524	821,516	556,717	615,229	711,897	170,666	7,023,514	585,293
2	**Ruaha National Park**	448,493	470,322	661,135	446,777	532,747	466,573	228,559	602,921	566,033	491,166	571,508	471,420	5,957,653	496,471
3	**Katavi National Park**	331,667	172,445	333,168	288,706	314,149	338,650	315,337	288,262	274,551	297,458	312,072	301,647	3,568,112	297,343
4	**Mahale Mts National Park**	44,949	12,847	58,805	43,333	66,708	40,781	57,062	39,763	35,220	36,702	58,959	25,588	520,717	43,393
5	**Tarangire National Park**	110	34,557	40,511	2,025	23,061	13,998	22,212	42,709	7,591	4,403	39,373	42,876	273,426	22,786
6	**Mikumi National Park**	149	97	567	6,169	4,377	6,263	1,072	21,403	10,531	38,166	32,009	4,913	125,717	10,476
7	**Udzungwa Mountains National Park**	219	517	361	8,304	49	9,068	-	605	5,905	19,550	17,286	317	62,180	5,182
8	**Gombe National Park**	-	-	187	299	863	598	5	-	2	-	-	14	1,968	164
9	**Kilimanjaro National Park**	-	-	1,020	-	73	-	-	6	24	-	-	-	1,124	94
10	**Arusha National Park**	-	-	-	-	-	122	-	-	146	24	97	317	707	59
11	**Lake Manyara National Park**	-	49	3	-	70	-	-	42	-	-	-	-	165	14
	TOTAL	1,020,433	1,001,982	1,920,630	1,808,403	1,582,923	1,551,536	1,111,773	1,817,226	1,456,720	1,502,697	1,743,201	1,017,758	17,535,283	1,461,274

Notes and Questions

1. Three National Parks; Serengeti, Ruaha and Katavi, incurred approximately 16.5 million hectares area burnt. The remaining eight National Parks had approximately 1 million hectares between them. The area burnt in the three suggest a need for further investigation to confirm the context and influences on fires and the area burnt to inform a balanced and integrated planned approach to fire management.

4.4.7 Burned Area by Landcover Type

The analysis of land cover (vegetation) included an aggregation, following the Land Cover Classification Scheme of Africover, of the original landcover classes of the Africover dataset to improve interpretation and allow for faster processing. The annual, national figures for Area Burnt and average of the total area burnt for each land cover category for Tanzania at the national level are set out in the table below.

Table 18: Area Burned by Landcover type in Order of Decreasing Area Burned

Landcover	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL	Average
Open to very open trees	5,068,297	3,665,170	4,595,143	5,471,352	5,926,863	5,586,603	4,286,770	4,644,371	4,858,167	5,057,464	5,480,081	4,144,120	58,784,401	4,898,700
Shrubs (sparse to closed)	2,459,294	1,907,396	3,216,249	3,293,869	3,195,020	2,997,042	2,177,049	2,977,349	2,773,365	2,715,101	2,954,776	2,012,897	32,679,407	2,723,284
Rainfed shrub crops with natural vegetation	893,644	1,003,084	1,330,970	1,206,497	1,205,893	1,034,068	815,472	830,804	848,190	841,595	988,196	432,375	11,430,788	952,566
Open to closed herbaceous vegetation temporarily flooded land	998,678	576,142	1,109,425	1,044,414	1,107,388	1,065,664	753,014	993,145	930,717	970,568	902,033	772,705	11,223,892	935,324
Trees and shrubs on temporarily flooded land	677,907	407,174	615,740	698,082	733,983	677,707	491,697	645,280	614,905	573,225	625,324	550,189	7,311,211	609,268
Closed herbaceous vegetation permanently flooded land	318,997	171,755	290,858	332,675	338,633	335,577	304,753	288,079	291,888	272,401	275,373	266,810	3,487,800	290,650
Open to closed herbaceous vegetation	185,707	185,618	379,188	424,950	316,638	336,566	223,045	357,842	285,121	307,278	351,793	126,011	3,479,757	289,980
Closed trees	134,756	171,420	141,719	231,291	158,772	217,911	145,626	157,861	215,117	283,960	352,195	149,839	2,360,467	196,706
Rainfed tree crops with natural vegetation	46,207	152,369	107,061	153,624	92,296	118,994	51,408	105,525	125,322	145,330	176,169	69,603	1,343,908	111,992
Post flooding herbaceous crops with natural vegetation	36,035	22,348	25,657	44,982	40,143	33,170	23,898	28,604	27,221	31,175	37,052	25,803	376,088	31,341
Waterbodies	5,313	5,305	4,349	11,477	11,352	22,517	21,320	6,889	7,909	10,909	15,040	6,121	128,500	10,708
Rice Fields	4,485	8,465	13,188	13,826	8,518	9,825	17,004	10,202	11,036	10,174	14,578	6,630	127,932	10,661
Multilayered trees (broadleaved evergreen)	3,896	3,164	2,641	6,661	2,622	9,708	2,359	6,710	5,532	15,418	17,417	3,610	79,737	6,645
Unvegetated areas (urban and bare)	3,186	5,101	4,862	4,599	4,795	4,947	3,073	5,318	4,142	3,269	4,885	2,689	50,867	4,239
Forest plantation - undifferentiated	406	1,240	1,132	3,063	1,523	1,956	373	1,262	525	505	3,215	521	15,721	1,310
Irrigated herbaceous crops	1,438	311	1,430	1,361	1,126	1,328	1,264	346	1,170	604	1,747	189	12,314	1,026
Mangrove	150	246	114	155	140	182	160	197	218	272	231	92	2,160	180
TOTAL	10,838,397	8,286,310	11,839,725	12,942,878	13,145,705	12,453,766	9,318,285	11,059,782	11,000,547	11,239,247	12,200,107	8,570,204	132,894,952	11,074,579

Notes and Questions

1. Two landcover types, Open to very open trees and Shrubs (sparse to closed), account for ~91 million of ~133 million hectares over 12 years (~68%) and ~7.6 million hectares of ~11 million hectares (~69%) on average annually.
2. There may be an ecological influence involved with the presence of grasses and annual plants and their response to burning, perhaps the requirement for it.
3. The large area burned combined with people as virtually the sole source of ignitions suggests that a careful assessment of the context, economics and ecology of fire use by local communities should be undertaken as a step in evaluating the need and types of fire related interventions to improve fire management.

4.4.8 Fire Sizes and Distribution

The work to develop a data set of fire sizes from the MODIS satellite information was not completed in the timeframe of this Fire Baseline report. It will be finalised and made available. Fire size provides another indicator of the fire regime for Tanzania the frequency of very large fires, very small fires and those of intermediate size being important in characterizing the fire situation.

One further piece of analysis for Tanzania would be to obtain the data on fire sizes over the period 2000 to 2011 and generate the size distribution and numbers of fires by size that will contribute to the improved understanding of fires in Tanzania.

5

5 Summary Points

The step taken in compiling this fire baseline for Tanzania is a sound strategic one and should be something that is repeated in most countries that are working to understand and account for fires in their landscapes. In the preparation of the Fire Baseline there have been a series of aspects that have been indentified, which can provide a set of ongoing analyses to further refine and contribute to enhancing the insights and understanding of fire in Tanzania.

The information on impacts was not readily available and there is very little information able to be collected during the field work from 1960 to present. Overall information appears incomplete and it is highly likely it is and the data collected is probably indicative of the impacts only. More analysis and research work is needed to systematically assess the economic, social and ecological impacts of fires in Tanzania.

5.1 National Level

An average of 11 million hectares burn annually (ranging between 8.5 and 12.9 million hectares) in Tanzania. This corresponds to between nine and 14 % of Tanzania´s land area. Most burned area is recorded in the months from May to October, with the peak fire activity in July and August.

Fires were detected throughout the year. There have been over 900,000 fires detected in Tanzania by satellite since November 2000 with the number of fires per year in Tanzania is reasonably consistent. The 'shape' of the fires seasons is reasonably consistent with most fires detected in June to November and the fire seasons have similar peaks occurring mainly in July.

In 2006 there were over 30,000 less fires detected than the eight year average and an analysis of this difference should be undertaken to identify the causes of the reduction in the number of fires detected. Those causes may provide some insights of interest for fire management in Tanzania.

The consistency of numbers of fires may indicate a persistent set of ignition sources. This conforms to the identification that Tanzania has mainly rural population with high dependence on agriculture, forest and land use. In rural areas fire use is common, widespread and frequent for various purposes related to livelihoods and production.

The regions with high numbers of active fire pixels detected tend to also have high area burned recorded. Five regions; Rukwa, Mbeya, Tabora, Kigoma and Lindi average more than 1 million hectares per year average area burnt per year. 14 of 22 regions have an annual average burned area exceeding more than 100,000 hectares.

Six regions have a very high counts of active fire pixels, all more than 6,500 per year, also have high rural populations, a total rural population of over 12 million people. The site preparation and post harvest activities for most of the crops may involve fire at one or both stages, especially tobacco, which also uses a lot of wood as fuel for drying. There is an important, sometimes dominant, proportion of traditional farmers in these regions.

The burned area demonstrates the same sort of variation as the active fire pixel data. This suggests that the number of fires and the area burnt are correlated. 2006 was a year when less area burnt and it will be useful to assess the possible reasons for this difference of nearly 2 million hectares in area burnt. An evaluation of the possible explanations is a logical next step, including an assessment of the influence of El Nino. In 27 of 99 Districts there is an average area burnt per year of more than 100,000 hectares, suggesting they may be an initial focus for fire management activities, though that should be confirmed with additional complementary analysis of the circumstances of the Districts with respect to economics, ecology, social and cultural aspects, the land use(s) and land cover and the recent history of the District.

5.2 Land Use

Two landcover types, Open to very open trees and Shrubs (sparse to closed), account for ~91 million of ~133 million hectares over 12 years (~68%) and ~7.6 million hectares of ~11 million hectares (~69%) on average annually. There may be an ecological influence involved with the presence of grasses and annual plants and their response to burning, perhaps the requirement for it. The large area burned combined with people as virtually the sole source of ignitions suggests that a careful assessment of the context, economics and ecology of fire use by local communities should be undertaken as a step in evaluating the need and types of fire related interventions to improve fire management. An assessment of CBFiM in nine villages in Tanzania was undertaken as part of the FAO-Fin IFM TZ and provides a strong starting point for refining and targeting future work.

In croplands there is a very low number of fires detected. This may be due to the timing of land preparation being in December in many areas when it is not dry. Additionally informants suggested it is very unusual for fires to burn in cropland. People are concerned about the damage fire can do to crops and people care about fire. There are sometimes rules about using fire for land preparation, including seeking permission, assistance from neighbours and other steps along with penalties for rule breaking. In Game Reserves and National Parks fire is prescribed for renewing pastures and ecological objectives. Farmers also clear land for new crops, especially under the influence of Kilimo Kwanza, which is the "Agriculture First" programme of Tanzania and pastoralists burn for pasture on open areas and also to control pests such as tsetse fly. In Miombo woodland burning is a widespread practice. There is a question as to the ecological requirement of Miombo woodland – is fire needed to sustain or maintain it? Forests other than Miombo woodland in Tanzania are much less in area and have high population (Kilimanjaro, Arusha) and it is closed forest. Areas of these forest types do not tend to burn as most area is under some form of management, some of it for coffee, banana and other crops where fire is not used.

5.2.1 Forest Reserves

Seven Forest Reserves have significantly higher average burned area at >160,000 hectares and each more than 2 million hectares burned over the period 2000 to 2011, than the remaining Forest Reserves, which have less than 71,000 hectares per year as an average area burned. This provides a strong reason for focusing fire management on those seven reserves initially – Ugalla, Kabungu, Msaginia, Mramba, Matogoro, Mwienzi and Ngogwa. Forest Reserves. Seventeen Forest Reserves have average burned area per year less than 1,000 hectares. There may be physical reasons, such as forest reserve size, but also lessons that can be learnt from these low figures. In total Forest Reserves have incurred over 44 million hectares burned with ~3,700,000 per year burned across all Forest Reserves. This suggests the management of fire needs strengthening.

5.2.2 Game Reserves and Game Controlled Areas

The reduction in area burnt in 2001, 2006 and 2011 seems to be reflected in the data for Game Reserves. Over 39 million hectares of Game Reserves was burned between 2000 and 2011 at an average of slightly more than 3,300,000 hectares per year. These figures are similar to those for Forest Reserves suggesting the two tenures may be subjected to the same influences and impacts. This further implies that there may be significant synergies in having consistent approaches to fire management for both tenures.

Eleven of 23 Game Reserves average more than 100,000 hectares burned per year with the remainder having less than half that area burned on average. This clear point of difference should be investigated to assess the context for the large areas and the contributing factors as compared to the lesser average burned areas in Game Reserves.

Eleven of the 69 Game Controlled Areas had more than 1 million hectares burned in the 12 years since 2000. As with other gazetted lands there appears to be areas where the impacts of fires are most widespread, suggesting an initial focus for further analysis and potential application of fire management integrated with land use and the landscape context.

5.2.3 National Parks

Three National Parks; Serengeti, Ruaha and Katavi, incurred approximately 16.5 million hectares area burnt. The remaining eight National Parks had approximately 1 million hectares between them. The area burnt in the three suggests a need for further investigation to confirm the context and influences on fires and the area burnt to inform a balanced and integrated planned approach to fire management.

5.2.4 Fire Sizes and Distribution

The work to develop a data set of fire sizes from the MODIS satellite information was not completed in the timeframe of this Fire Baseline report. It will be finalised and made available. Fire size provides another indicator of the fire regime for Tanzania the frequency of very large fires, very small fires and those of intermediate size being important in characterizing the fire situation.

One further piece of analysis for Tanzania would be to obtain the data on fire sizes over the period 2000 to 2011 and generate the size distribution and numbers of fires by size that will contribute to the improved understanding of fires in Tanzania.

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6

6 Conclusions and Potential Future Actions

During the preparation of this Fire Baseline for Tanzania a series of ideas for additional work and analysis was identified or arises from this analysis. They are:

1. In 2006 there were over 30,000 less than the eight year average.
    a. NEXT STEP - An analysis of this difference should be undertaken to identify the causes of the reduction in the number of fires detected. Those causes may provide some insights of interest for fire management in Tanzania.
2. The availability of data and information on fire impacts was very limited.
    a. NEXT STEP – More analysis and research work is needed to systematically assess the economic, social and ecological impacts of fires in Tanzania.
3. Districts with high average area burnt per year, more than 100,000 hectares, could be prioritized and subject to additional analysis.
    a. NEXT STEP – Initiate complementary analysis of the circumstances of the Districts with respect to economics, ecology, social and cultural aspects, the land use(s) and land cover and the recent history of selected District(s) with high burned areas.
4. Gazetted lands account for the major proportion of burnt area, ~77%.
    a. Seven Forest Reserves have significantly higher average burned area at >160,000 hectares and each more than 2 million hectares burned over the period 2000 to 2011. Eleven of 23 Game Reserves average more than 100,000 hectares each burned per year. Eleven of the 69 Game Controlled Areas had more than 1 million hectares each burned in the 12 years since 2000. Three National Parks; Serengeti, Ruaha and Katavi, incurred approximately 16.5 million hectares area burnt.
    b. The remaining gazetted areas show much less burned area. This clear point of difference should be investigated to assess the context for the large areas burned and the contributing factors as compared to the lesser average burned areas in gazetted lands.
    c. NEXT STEP – Undertake further analysis to strengthen the understanding of the contributing causes, drivers and underlying factors that lead to this very high level of burned area.
5. Two landcover types, Open to very open trees and Shrubs (sparse to closed), account for ~91 million of ~133 million hectares over 12 years (~68%) and ~7.6 million hectares of ~11 million hectares (~69%) on average annually.
    a. There may be an ecological influence involved with the presence of grasses and annual plants and their response to burning, perhaps the requirement for it.
    b. The large area burned combined with people as virtually the sole source of ignitions suggests that a careful assessment of the context, economics and ecology of fire use by local communities should be undertaken as a step in evaluating the need and types of fire related interventions to improve fire management.
    c. NEXT STEP - Review the literature and consult expertise available to frame up the question as to the ecological requirement of this sort of landcover type, much of which is Miombo woodland – is fire needed to sustain or maintain it?
6. The work to develop a data set of fire sizes from the MODIS satellite information was not completed in the timeframe of this Fire Baseline report. It will be finalised and made available. Fire size provides another indicator of the fire regime for Tanzania the frequency of very large fires, very small fires and those of intermediate size being important in characterizing the fire situation.
    a. NEXT STEP - Obtain the data on fire sizes for Tanzania over the period 2000 to 2011 and generate the size distribution and numbers of fires by size that will contribute to the improved understanding of fires in Tanzania.

7

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8

8 Appendices

8.1 Appendix 1 Field Study Questionnaire

Fire Baseline FAO-Finland Forestry Programme TANZANIA

Questionnaire for key informant

A. General information

Questionnaire No: ……………………………………………………………………………………
Date of interview……………………………………………………………………………………
Name of institution. ………………………………………………………………………………
Post/Name of interviewee…………………………………………………………………………

B. Information on wildfires

1. Is there a wildfire problem in your area? 1. Yes 2. No
2. What are the causes of wildfires in your area?
   (1) Farm preparation (2) Honey collectors (3) Livestock keepers
   (4) Hunters (5) Arsonist
   (6) Others specify……………………………………………………………………………
3. Which group of society is most likely to cause fire?
   (1) Women (2) Men (3) Youth (4) Elders (5) Children
4. What is the wildfires peak period in your area?
   (1) June (2) July (3) August (4) September
   (5) Others specify……………………………………………………………………………
5. Do you have any responsible officer for fire data recording? (1) Yes (2) No

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……………………………………………………………………………

6. What are the impacts of wildfires in your area? (Positive and Negative)

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7. What should be done to improve records and documentation of wildfires incidents at community, local government and national wise level?

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…………………………………………………

8.2 Appendix 2 - Fire Report Format

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF NATURAL RESOURCES AND TOURISM

DEPARTMENT OF FORESTRY AND BEEKEEPING

FIRE REPORT FORMAT

1. FIRE SITE Grid ref. boundary on map..
2. WHO DETECTED ....
3. WHEN DETECTED...
4. TYPE OF FIRE...
5. FUEL TYPE..
6. VEGETATION BURNT..
7. WHO WERE INVOLVED IN FIRE FIGHTING ....
8. WHEN FIRE FIGHTING COMMENCED..
9. METHOD USED IN FIRE FIGHTING..
10. TOOLS USED ....
11. SOURCE OF FIRE ....
12. CONDITION OF THE FIRE AT PRESENT...
13. WHEN COMPLETELY EXTINGUISHED
14. TOTAL AREA BURNT ....
15. Map of wildfires (attached)