

**LIUANA PARTIAL RESERVE, ANGOLA
&
BWABWATA NATIONAL PARK, NAMIBIA**

**INTEGRATED TRANSFRONTIER
FIRE MANAGEMENT**

A PROPOSED APPROACH

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List of Acronyms

ACADIR - Associação de Conservação do Ambiente e Desenvolvimento Integrado Rural

CBFiM - Community-Based Fire Management

CBNRM - Community-based Natural Resource Management

GHG – Greenhouse Gas

IFM – Integrated Fire Management

IRDNC Integrated Rural Development and Nature Conservation

KAZA-TFCA - Kavango Zambezi – Transfrontier Conservation Area

MET - Ministry of Environment and Tourism, Namibia

MINUA - Ministry of Urban Affairs and Environment, Angola

MODIS - Moderate Resolution Imaging Spectroradiometer

NP - National Park

NGO -Non-Government Organization

PAs - Protected Areas

PR - Partial Reserve

SADC - Southern African Development Community

TFCA - Transfrontier Conservation Area Programme

1. INTRODUCTION

In the last two decades uncontrolled fires have become a major concern in the Southern African Development Community (SADC) region. Each year uncontrolled wildfires spread throughout the region having serious consequences including environmental degradation, negatively impacting on land use and community livelihoods and increasing greenhouse gas emissions. These cross-sectoral issues highlight the importance of socio-economic factors in the management of fire and the necessity to engage public, private and civil society stakeholders.

To address these issues the SADC/GIZ “Transboundary Use and Protection of Natural Resources in the SADC Region” Project is contributing to implementing the regional Transfrontier Conservation Area Programme (TFCA). The project follows an approach which aims at enhancing possible innovations through pilot activities in TFCAs related to cross-border fire management with training and networking amongst TFCA practitioners.

In recent decades the advent of Integrated Fire Management (IFM) and Community-Based Fire Management (CBFiM) strategies in the region provides an opportunity to achieve cross-sectoral fire management objectives across international boundaries.

In the Kavango Zambezi – Transfrontier Conservation Area (KAZA-TFCA) the Project has provided support to Integrated Rural Development and Nature Conservation (IRDNC) and the Associação de Conservação do Ambiente e Desenvolvimento Integrado Rural (ACADIR) to implement a pilot Project: *Community-Based Fire Management: An Integrated Transfrontier Fire Management Strategy for Luiana Partial Reserve in Angola and Bwabwata National Park in Namibia*.

321Fire, a specialist fire management company focusing on capacity building people and governments to develop and implement IFM and CBFiM strategies, was engaged to provide technical support to CBFiM training and development of an Integrated Transfrontier Fire Management Proposal for Luiana Partial Reserve (PR) and Bwabwata National Park (NP).

This document i) provides a brief overview of the current fire regime and fire management status in Bwabwata NP and Luiana PR; ii) proposes an Integrated Transfrontier Fire Management Approach to achieve PA Management objectives, improve community livelihoods and GHG reductions; and iii) provides recommendations for implementation of the proposed Integrated Transfrontier Fire Management Approach.

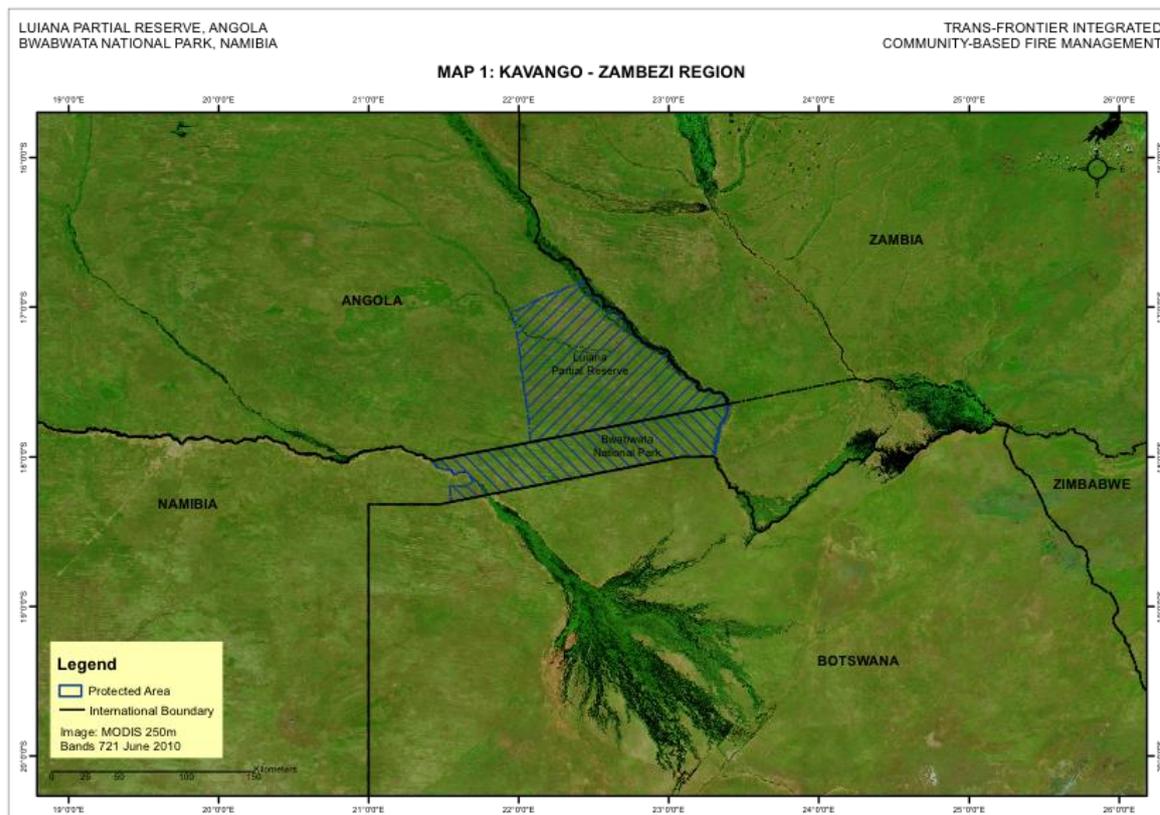
2. EXISTING SCENARIO

A brief overview of Bwabwata NP and Luiana PR and the current use of fire as a land management tool is important to understand the basic drivers and issues of the prevailing fire regime. The fire management policies, objectives and implementation strategies to address these issues, their current status and efficacy provide the foundation to build a Integrated Transfrontier Fire Management Approach upon.

2.1. Location

Bwabwata National Park in Namibia and Luiana Partial Reserve in Angola are situated in the Kavango – Zambezi river basins of southern Africa and represent large protected areas central to the Kavango Zambezi – Transfrontier Conservation Area (KAZA-TFCA). KAZA is the world's largest transfrontier conservation area spanning approximately 520,000 km² where the borders of Angola, Botswana, Namibia, Zambia and Zimbabwe converge. Supporting large herds of elephant and buffalo, plus rare and endangered species such as roan and sable antelope, Bwabwata and Luiana, constitute important corridors for animal movement within the greater region.

Map 1 – KAZA Region



Bwabwata National Park covers approximately 6,274km² of the Zambezi and Kavango Regions of northeast Namibia. It encompasses the area formerly known as the Caprivi Strip, which extends 200km between the Kavango and Kwando Rivers and is bordered by Angola to the north and Botswana to the south. The Park is comprised of three Core Areas designated for special protection and controlled tourism – Kwando (1,345km²), Buffalo (629km²), and Mahango (245km²). A Multiple Use Area (4,055km²) is zoned for community-based tourism, trophy hunting and resident communities.

Luiana Partial Reserve covers approximately 10,000km² of the Kuando-Kubango Province of southeast Angola. It encompasses the lower catchment of the Luiana River and its confluence with the Kwando River that forms the border with Zambia to the east. Bwabwata NP in Namibia neighbours the Reserve to the south.

Kalahari woodlands of remnant sand dunes interspersed by fossil drainage lines, called omurumba, dominate the savanna ecosystem of Bwabwata. Luiana comprises a complex mosaic of seasonally inundated depressions associated with the drainage of the Luiana and Kwando Rivers in the north. Remnant sand dunes and fossil drainage lines become more consolidated in the south. The rivers support a diverse array of habitats including riparian woodlands and extensive floodplains. The semi-arid tropical climate provides a variable and highly seasonal (October - April) annual rainfall of 550mm with average maximum temperatures between 27 and 35°C.

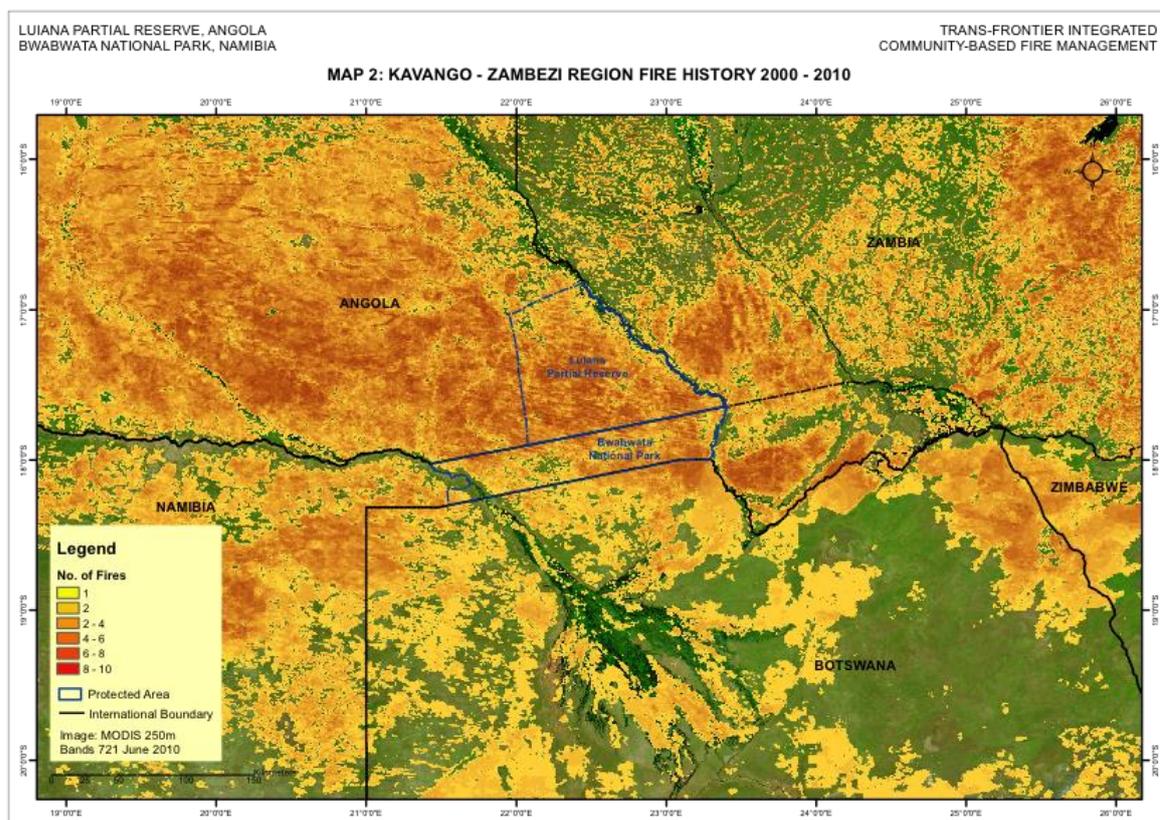
Both protected areas have resident communities (Bwabwata ~ 6,500 and Luiana ~ 1,500) whose livelihoods comprise predominantly of subsistence agriculture and natural resource harvesting and, in Namibia, an increasing wildlife-based economy. Natural resources include grazing for livestock, building materials (timber and thatching grass), firewood, medicinal plants, wild fruits and honey.

2.2. Prevailing Fire Regime

Savannas are characterized as fire-dependent ecosystems with their ecological processes, structure and species composition having evolved with, and inextricably linked to, fire activity (Hardesty, *et al* 2005). Fire regimes maintain their characteristic form and function, and the species they contain are highly adapted to regular fire events (Bond, 1997; Wilgen, 2005) and the human use of fire has been instrumental in developing savanna ecosystems.

The use of fire to manage or access natural resources is prevalent in Bwabwata, Luiana and throughout the KAZA region in general. ‘Traditional Burning’ is maintained for subsistence livelihoods including slash-and-burn agriculture, livestock grazing, natural product harvesting (ie fruits, timber), hunting, honey gathering, charcoal production and pest control. Almost all fires are caused by anthropogenic activity and over the past decades the influence of burning on the savanna ecosystem has increased alongside population growth, fire management policy changes and civil war. The uncoordinated use and management of fire results in uncontrolled wildfires crossing borders and spreading throughout much of throughout much of the KAZA region having serious consequences on community livelihoods, loss of biodiversity and increased greenhouse gas emissions (Map 2).

Map 2: KAZA Region Fire History 2000 – 2010



Currently, the KAZA region is dominated by a repetitive late dry season fire regime of intense and extensive uncontrolled wildfires. A fire regime is the general pattern in which fires occur in a particular landscape over a period of time and is commonly described by fire frequency, intensity and timing. The timing of fires throughout the year provides an approximation of fire intensity that offers insight into the biophysical and social drivers of fire regimes in determining savannah landscape form and function (see Box 1).

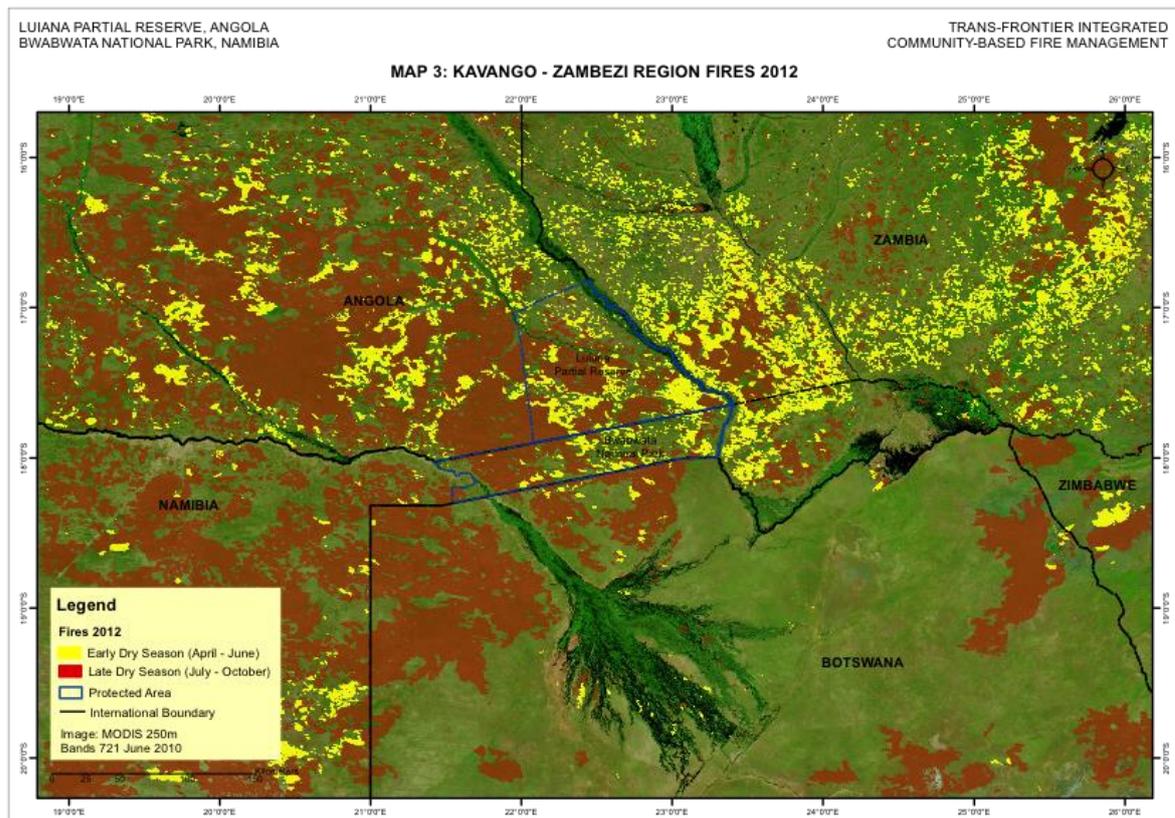
Box 1. The Seasonality of Savanna Fires

The distinct wet and dry seasons of savannah ecosystems typically determine fire conditions, behaviour and effects upon the ecosystem. The majority of fires occur in the dry season and are generally differentiated as *Early* or *Late Dry Season* fires, largely determined by the prevailing weather conditions and fuel characteristics:

- *Early Dry Season* (May – July) fires are characterized by low intensity, high degree of patchiness and a tendency to extinguish spontaneously overnight. Light winds, cool temperatures and partially dried fuel (grass, litter etc) limit the extent of these fires.
- *Late Dry Season* (August - October) fires are characterized by high intensity, low levels of patchiness and a tendency to spread due to the hot, dry and windy conditions and fully cured fuel. Fires at this time continue to burn, potentially for weeks, until they reach an area of no fuel (river, burnt area etc) or are manually extinguished.

The dominant fire regime in the KAZA region can be observed with the occurrence and extent of fires in 2012, where the majority of fires and area burnt occurs in the Late Dry Season between August and October (Map 3).

Map 3: KAZA Region Fire History 2012



Comparable to many protected areas in the KAZA region Bwabwata and Luiana have an average of approximately 50% burnt annually (Map 4, Table 1). With prevailing easterly dry season winds fires typically cross international borders between Botswana, Namibia and Angola. A single ignition has the potential to propagate several hundred kilometres in the late dry season burning vast areas.

Map 4: Bwabwata - Luiana Fire History 2012

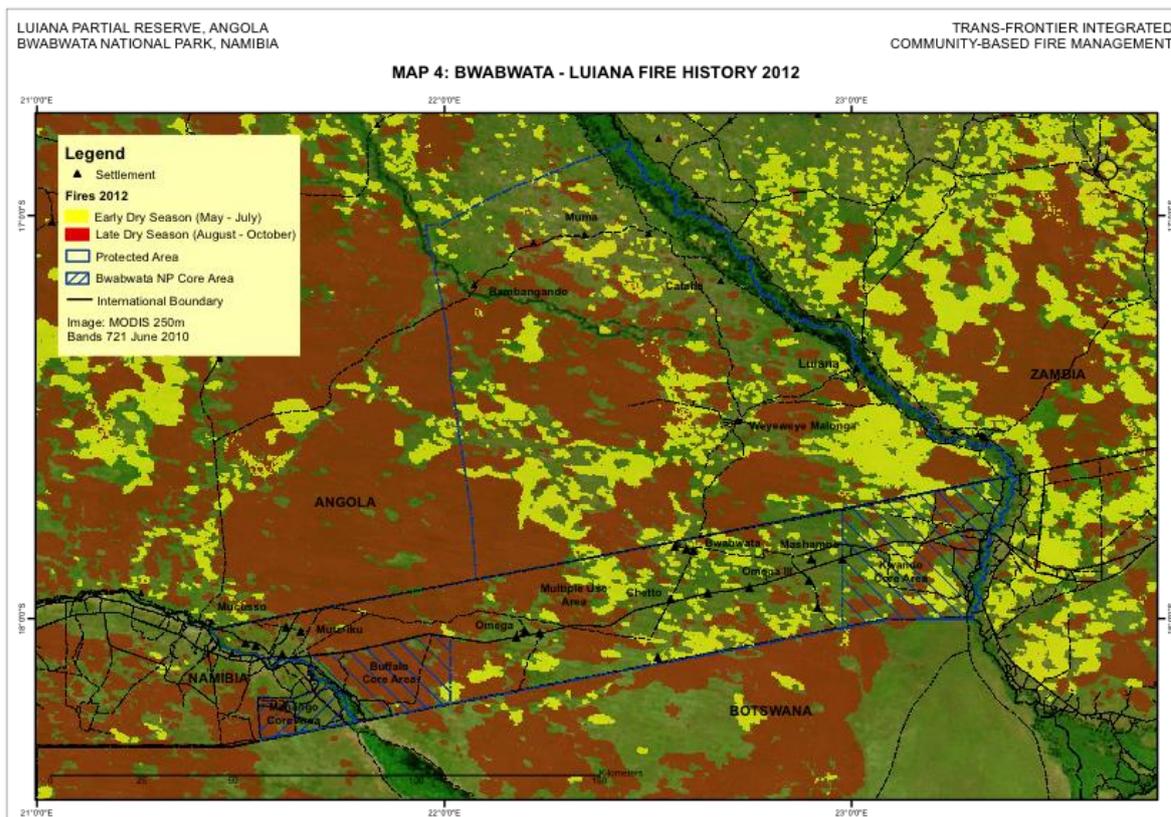


Table 1 – Bwabwata NP and Luiana PR Fires 2012

FIRE SEASON	Bwabwata NP		Luiana PR	
	Area (km ²)	% of PA	Area (km ²)	% of PA
Early Dry Season	970	15	1957	20
Late Dry Season	2412	38	3912	39
Total	3382	53	5869	59

Derived from MODIS Burned Area Product 500m (MCD64A1).

The prevailing intense late dry season fire regime has a variety of direct and indirect effects upon the savanna ecosystem of Bwabwata and Luiana that can be beneficial or negative.

Repetition of this fire regime in extensive areas of Bwabwata and Luiana over the past decades has contributed to the degradation of the PA ecosystems and management objectives. This is evident as a reduction of tree density and canopy cover; threatened high value and vulnerable habitats and fire sensitive species of fauna and flora; reduced long-term nutrient status and productivity; increased soil exposure to wind and water erosion and evaporation; reduced ecosystem function through disruption of the energy, carbon and water fluxes between the soil, plants and atmosphere. Importantly, the extensive high intensity fires cause a distinct lack of habitat heterogeneity by reducing spatial and temporal variability (ie large areas burnt by end of dry season) at landscape scales.

Infertile soils and human wildlife conflicts prevalent in the two PAs determine that traditional subsistence farming methods (small-scale, labour intensive, rain-fed crops) and livestock production are limited and the low economy communities in the region are inherently vulnerable to natural disasters, such as drought and wildfires. These communities experience the greatest

impact of uncontrolled wildfires and livelihoods are at risk of deterioration leading to increased poverty and pressure on natural resources. Impacts include loss of life and infrastructure (houses, food stores and fences); reduced natural product availability and sustainability that provide for basic everyday needs (construction materials, medicinal plants, wild foods and firewood); and reducing subsistence agriculture productivity through the general reduction of ecosystem soil fertility and moisture content.

The prevailing late dry season fire regime contributes significantly to the region's land-use-related GHG emissions by i) reducing the total standing above and below-ground biomass and carbon storage, ii) releasing GHG from biomass burning, and iii) reducing ecosystem function, productivity and the storage capacity of biomass and organic soil carbon.

2.3. Management of Fire

Historically, fire in the KAZA region has been regulated, with a few exceptions, by prevention- and suppression- oriented fire management legislation and policies, maintained since colonial administrations revoked local burning practices and control (Frost 1998; FAO 2006). Fire management implementation strategies commonly comprise of programs for prevention, control and monitoring of fires with effort and resources focused on:

- i) Prevention and Regulation of the Use of Fire;
- ii) Firebreak Networks; and
- iii) Fire Suppression.

Typically, insufficient and inconsistent land and fire management legislation, administered by centralized governments with limited capacity, inadequately addresses the appropriate use or management of fire. The absence of clearly defined processes, roles and responsibilities for decision-making, combined with limited local-level governance and community capacity, results in the uncoordinated use of fire and uncontrolled fires dominate the fire regime.

Administrations of savanna ecosystems worldwide are becoming increasingly aware that implementing conventional fire prevention and suppression policies to address the risks and consequence of damaging fires is costly, hazardous and largely ineffective. Over recent decades IFM approaches have been developed to address the issues associated with both damaging and beneficial fires within the context of the natural environment and socio-economic systems in which they occur. CBFiM has developed concurrently to re-establish fire management rights, responsibilities and decision-making to communities, in many cases specifically to permit controlled burning on communal and collaboratively managed lands.

In the KAZA region a good example of the application of these two principles has been implemented in the Caprivi (Zambezi) Region IFM Program in north-east Namibia since 2006. In the fire-dependent savanna ecosystem fire plays an important beneficial role in maintaining ecosystem function, health and services to multiple land uses. The Caprivi Program demonstrates the use of controlled fire management to provide tangible livelihood benefits to communities in this setting through improved land use productivity and sustainability, reduced hazards and impact of uncontrolled fires and improved natural resource availability (Russel-Smith, et al. 2013). Controlled burning was prescribed in the early dry season (April – July) by community brigades to improve grazing, natural product harvesting and agriculture.

The Ministry of Environment and Tourism (MET) were instrumental in supporting the Caprivi (now Zambezi) Program and many PAs, including Bwabwata NP, were central to its implementation. MET has recently institutionalized and formalized these approaches in the *Management Plan - Bwabwata National Park 2013/2014 to 2017/2018* (MET, 2013), as follows:

- *Fire has, and will continue to play an important role within the Park and the fire management objective is to use fire as a management tool for actively maintaining and rehabilitating all habitats in the Park.*

- *Park staff will work with residents and neighbours (communities, other departments and institutions, other countries) to manage burning with specific reference to the Park's position in the KAZA TFCA.*

Collaborative fire management in Bwabwata, facilitated by Kayaramacan Trust and MET, has enabled the resident community to use controlled burning at landscape scales to minimize uncontrolled wildfires, maintain ecosystem function and services and provide management benefits, which include human health and community livelihoods, biodiversity conservation, eco-tourism and climate change. For example, in the eastern half the resident community pro-actively implement controlled burning in the early dry season and are significantly reducing uncontrolled fires in the late dry season in the Multiple Use and Kwando Core Area (**Map 4**). The well-established customary rights to natural resources, well-developed community-based natural resource management (CBNRM) policy/legislation and support NGOs in Namibia continue to facilitate institutionalization of IFM and CBFiM approaches within MET and the Directorate of Forestry at the national level.

In the remote Luiana PR implementation of the prevention- and suppression- oriented fire management legislation and policies of the Ministry of Urban Affairs and Environment (MINUA) are limited and IFM, CBFiM and CBNRM are at a very early stage of development.

3. PROPOSED TRANSFRONTIER IFM APPROACH

The existing fire management framework provides an excellent foundation to build upon and develop into an Integrated Transfrontier Fire Management Approach for Bwabwata NP in Namibia and Luiana PR in Angola.

With well-established institutional IFM approaches in place, particularly in Namibia (see Section 2.3), development of an IFM Strategy should focus on incorporating the following key components:

1. ***Controlled Fire Management*** to reduce the area burnt annually and shift the seasonality of burning to the early dry season to minimize uncontrolled fires, enhance land use and the environment.
2. ***Community-Based Fire Management*** is important to improve resident community livelihoods, promote collective fire management responsibility and collaboratively achieve PA management objectives.
3. A ***Transfrontier Collaborative Fire Management Framework*** to coordinate and regulate fire management in Bwabwata in Namibia and Luiana in Angola and to integrate with national and regional fire management objectives.

The Strategy will enable cost-effective fire management to balance the risks of harmful fires with the beneficial ecological and economic role of fire on PA management objectives, community livelihood improvements and GHG emissions reductions in Bwabwata and Luiana.

A general description of these key IFM components is provided in the following sections. Valuable insights and experiences from international projects are provided in case studies from comparable settings in northern Australia and southern Africa (see Appendix 1).

3.1. Controlled Fire Management

Controlled fire management is based on the strategic implementation of controlled burning to manipulate ecosystems to enhance land use objectives. Using this approach the prevailing late dry season fire regime can be effectively modified to achieve PA management objectives, improve community livelihoods and reduce GHG emissions in Bwabwata and Luiana.

A strategic early dry season burning regime is applied to reduce the risk and extent of uncontrolled late dry season fires. Controlled burning reduces, and importantly, fragments fuel loads to create a landscape of burnt and unburnt patches. Interlinked burnt patches and corridors create an early dry season firebreak network that minimizes the occurrence and extent of late dry season fires. The

result is a reduction in the total area burnt annually and a shift to a predominantly early dry season regime of low intensity fires. This effectively dispenses the need for costly and hazardous conventional fire management practices of firebreak networks and wildfire suppression.



Reducing Area Burnt



Reducing Fire Intensity

Controlled burning is implemented by igniting fires from vehicles along roads and tracks, walking across country or from aircraft. Local landscape features, weather conditions, fire behaviour and local knowledge are used to implement safe and efficient early dry season controlled burning. The specific location, timing and method of controlled burning is determined to achieve PA management objectives, improve community livelihoods and reduce GHG emissions.

3.1.1 Protected Area Management Objectives

A reduction in the total area burnt annually and shift to an early dry season regime will achieve PA management objectives through reduced fire intensity and frequency as well as diversification of fire to enhance habitat and biological diversity.

Reducing the extent, intensity and frequency of fires will increase tree density and canopy cover by reduced tree mortality, increased seedling establishment and recruitment. Early dry season burning will reduce the occurrence of large late dry season fires, that are typically severe, while having little negative impact on tree productivity (Werner, 2005; Prior et al., 2006). Strategic controlled burning will enable tailored fire regimes to protect, maintain and enhance high value and vulnerable habitats and flora and fauna species in PAs.

Maintaining ecosystem function and services through reducing the area burnt and the total fuel consumed will improve the long-term nutrient status and productivity of the ecosystem. Increasing plant biomass and soil surface cover, fertility and moisture content will enhance natural resource availability in PAs.

Variation in the timing, intensity and frequency of fire will increase the spatial and temporal heterogeneity of PA ecosystems. Providing conditions suitable to increase the distribution and abundance of fire sensitive flora and fauna species and maximize overall habitat diversity and biological diversity.

Strategic reduction of fuel loads around infrastructure including management and ecotourism facilities, roads and other utilities (ie electricity, water) will afford protection of these assets.

Enhancing ecosystem function and natural resource availability will improve the viability of ecotourism and reduce pressure on natural resources from resident communities and provide opportunities to develop alternate livelihoods.

3.1.2 Community Livelihoods

A reduction in the total area burnt annually and a shift to a predominantly early dry season regime will enhance resident community livelihoods by reducing the hazard and impacts of uncontrolled wildfires, enhance land use and natural resource availability.

Strategic reduction of fuel loads through controlled burning around community infrastructure including villages, fences and food stores minimizes wildfire hazard and impact on property and life. Similarly, important resources areas, such as quality farmland or grazing areas, can be protected ensuring food security.

Reducing the extent of intensive late dry season fires increases forest and woodland product availability, such as construction materials, medicinal plants, wild foods and firewood that provide for basic everyday needs. Importantly, the timing, intensity and frequency of early dry season controlled burning is prescribed to specific land use objectives. For example, controlled burning can be used to promote growth of thatching grass, medicinal and food plants including fruit, nuts and honey. Harvesting can be facilitated through improving access, visibility and removal of old or unwanted growth.

The fundamental approach is to maximize the benefits and minimize the harmful effects of fire on the immediate availability and sustainability of natural resource product harvesting.

A shift to an early dry season fire regime will increase the function, productivity and long-term nutrient status of ecosystems through increasing plant biomass and soil surface cover, fertility and moisture content. Increasing ecosystem function will provide increased natural resource availability for improved agriculture and diversified community livelihoods.

3.1.3 Greenhouse Gas Emissions

Under the prevailing fire regime and current management scenario there is considerable potential to decrease GHG emissions in Bwawata and Luiana through controlled fire management. A reduction in the total area burnt annually and a shift to a predominantly early dry season regime reduces GHG emissions by i) maintaining and increasing above and below- ground biomass; ii) reducing GHG from biomass burning; iii) and increasing ecosystem function and soil carbon sequestration.

Managed early dry season fire regimes can reduce GHG emissions and promote carbon sequestration within the savanna ecosystem. Reducing the extent, frequency and intensity of fires will increase woody plant density by reducing tree mortality and increasing regeneration. Managed early dry season fire regimes lead to very significant biomass accumulation (carbon sequestration) in woody savannah vegetation and is likely to be maximized by extensive use of strategic early dry season burning, with fires deliberately lit at times of mild fire weather, and in parts of the landscape where burnt areas are most effective as firebreaks (Murphy *et al.*, 2010). Considering the long-term degradation of the savannah ecosystems and the above and below-ground biomass carbon stock this carbon pool has the greatest potential for increasing the carbon carrying capacity.

Reducing the extent and intensity of fire can substantially decrease annual GHG emissions from biomass burning. High levels of patchiness and low total fuel consumption associated with early dry season fires releases significantly less emissions of GHG per unit area burnt.

Increasing ecosystem function will maintain and enhance the soil carbon carrying capacity by manipulating the energy, carbon and water fluxes between the soil, plants and atmosphere. Soil carbon sequestration is a long-term process and increasing ecosystem function is more relevant to increasing above and below- ground biomass in the short to medium- term.

3.2. Transfrontier Collaborative Fire Management Framework

A Transfrontier Collaborative Fire Management Framework coordinated by the MET in Namibia and the MINUA is proposed to coordinate fire management in Bwabwata in Namibia and Luiana in Angola and to integrate with national and regional fire management objectives.

An important focus is improved collaboration and cooperation among communities, government agencies, private sector, NGOs and other key stakeholders supported by the development of sound policy and legislation that promotes IFM and CBFiM approaches. Collaboration and cooperation is proposed at three levels:

1. Internationally at the appropriate national level through the KAZA-TFCA initiative and other inter-governmental structures.
2. Cross-border through knowledge / information exchange, development and implementation of joint fire management activities between Bwabwata and Luiana.
3. Locally through decentralized collaborative management with PA stakeholders including communities, public service agencies, private sector and NGOs.

To develop and implement collaborative management a decentralized fire management framework coordinated and regulated by PA Management is proposed. Building on, and integrating, existing institutions and fire management initiatives enables decentralization of fire management decision-making and implementation to stakeholders to promote ownership and collective fire management responsibility.

PA stakeholders develop fire management programs specific for zoned management areas. Stakeholder fire management brigades are established to plan and implement fire management programs to enhance land use objectives. Brigades are trained in the process of implementing a fire management program with emphasis on managing people as much as managing fire.

Structured collaboration and coordination between neighbouring fire management programs / land tenures aligns fire management objectives, sharing of resources and workloads to facilitate effective fire management throughout the PAs. The MET and MINUA regulate and coordinate the fire management programs.

This Strategy is adaptable and robust with fire management driven by land use objectives, accommodating for the diversity of environments, people and land use, whilst achieving overall fire management objectives. Additionally, PA Management can assume a regulatory role more attune with the available resources and capacity.

3.3. Community-Based Fire Management

As important stakeholders (see Section 3.2) in, and around, Bwabwata and Luiana it is proposed communities develop and implement CBFiM programs specific to identified / zoned resource management areas.

CBFiM programs are based on enhancing community land use objectives to improve livelihoods and reduce poverty using the existing capacity and resources of the community (see Section 3.1.2).

Tangible livelihood benefits to community members will promote ownership and collective fire management responsibility in the communities. Integrating existing community skills, knowledge and institutional structures into the CBFiM programs will facilitate sustainability and arbitration of fire related disputes within communities.

Community fire management brigade provide fire management services to resident communities and PA Management delivering added benefit as employment opportunities to further promote collective community fire management responsibility.

4. IMPLEMENTATION RECOMMENDATIONS

Implementation recommendations are presented to develop an Integrated Transfrontier Fire Management Approach for Bwabwata NP and Luiana PR by incorporating the key components into the existing fire management framework (see Section 3).

Fire management in the region is highly seasonal and it is *critical* Pilot IFM Programs commence in the first quarter of the year, well in advance of the fire season, to ensure adequate preparation of institutional arrangements and stakeholders.

4.1 Transfrontier Collaborative Fire Management Framework

An important component is to develop a Transfrontier Collaborative Fire Management Framework coordinated by the MET in Namibia and the MINUA to coordinate fire management in Bwabwata and Luiana.

- Establish forums to develop the Framework at i) International; ii) Cross-border; and iii) Local levels through participatory approaches based on liaison and consultation with all relevant stakeholders.
- PA Management (MET and MINUA) engage a more regulatory fire management role, more attune with available resources, than operationally implement all fire management activities.
- Coordinate and regulate IFM Programs through a decentralized organizational structure to facilitate participatory fire management by PA stakeholders.
- Appoint IFM Facilitators to coordinate and regulate IFM Programs through a decentralized Permit to Burn System.
- Implement IFM Programs with local Community Fire Management Brigades through strategic and structured CBFiM Programs.
- Emphasize structured collaboration and coordination between neighbouring Stakeholder IFM Programs to align fire management objectives, sharing of resources and workloads.
- Share experiences and achievements with all institutions and key role players to facilitate policy development, extension and concrete implementation of IFM in future years.

4.2 Integrated Fire Management Facilitators

IFM Facilitators are field extension officers from key fire management institutions that represent the operational unit to coordinate and support Stakeholder IFM Programs. They provide technical assistance and support to establish Stakeholder Fire Management Brigades.

- Select a number of IFM Facilitators from the key fire management institutions to provide an overall representative cross section of the key public institutions.
- Ensure each PA has sufficient and dedicated IFM Facilitator support through institutional commitment of personnel and resources.
- Ensure participation of IFM Facilitators in Training and Skills Transfer and all other planning and implementation activities of the Pilot IFM Programs.
- Establish information sharing between the IFM Facilitators, as the primary management and information link between Stakeholder Fire Management Brigades, public administrators and other key role players.

4.3 Permit to Burn System

A Permit to Burn System is recommended as the core decentralization instrument to coordinate and regulate the Stakeholder IFM Programs.

- Permits to Burn are issued to Stakeholder Fire Management Brigades by the IFM Facilitators based on an approved Stakeholder Integrated Fire Management Plan.
- Permits to Burn are issued for the Fire Management Area registered to the Stakeholder Fire Management Brigade.
- Permits to Burn are issued for the duration of the Controlled Fire Management Season.

4.4 Community-Based Fire Management

As important stakeholders in, and around, Bwabwata and Luiana communities develop and implement CBFiM programs through the decentralization framework and Permit to Burn System.

- Develop ‘Fire Management Areas’ in, and around, PAs based on a group of villages or settlements rather than individual / family basis to facilitate collaboration and cooperation of stakeholders.
- Assist in the establishment of a (relatively small) Community Fire Brigade composed of a representative members from the each village / settlement for each Fire Management Area.
- Promote development of CBFiM programs based on integration of traditional fire management knowledge and contemporary technological approaches to fire management.
- Incorporate traditional leadership structures into the CBFiM programs to provide Brigades with local level governance support.
- Provide support to Community Fire Brigades with basic Personal Protective Equipment and Fire Equipment and, if possible, remuneration to implement the CBFiM programs.
- Provide technical support and develop collaborative implementation to share workloads and resources to achieve CBFiM and overall PA fire management objectives.
- Explore potential synergies existing savannah fire management and sustainable livelihoods projects (Russell-Smith *et al.* 2013); http://www.unutki.org/default.php?doc_id=248.

4.5 Training and Skills Transfer

The skills and knowledge required to implement the recommended key IFM components, particularly the safe and efficient use of controlled burning at landscape scales, can only be acquired only through first-hand experience, hence it is recommended:

- Training and skills transfer be delivered to the IFM Facilitators and Stakeholder Brigades as ‘*On the Job Training*’ throughout implementation of Pilot IFM Programs during the fire season.
- Deliver field-based ‘*On the Job Training*’ modules of the key IFM Program components at strategic phases throughout the fire season, as follows:
 1. Integrated Fire Management Planning (March/April)
 2. Controlled Fire Management Season Commencement (May/June)
 3. Controlled Fire Management Season Completion (July)
 4. Wildfire Management Season (September/October)

- Contract a fire management specialist with significant experience in, and understanding of, implementing landscape scale IFM Programs in tropical savannah ecosystems to deliver field-based training modules.
- Each ‘*On the Job Training*’ module will require approximately *one month* of field-based training and implementation by the fire management specialist to develop and implement the two or three Pilot IFM Programs.
- Training should incorporate one complete cycle to provide the necessary skills and knowledge in planning, implementation and monitoring of the Pilot IFM Programs

4.7 Stakeholder Integrated Fire Management Programs

Structured and strategic Stakeholder IFM Programs are developed and implemented by Stakeholder Fire Management Brigades specifically in registered Fire Management Areas of the Pilot Focal Areas. The main components of the Stakeholder IFM Programs involve:

1. ***Integrated Fire Management Planning*** - is the process to develop a Stakeholder Integrated Fire Management Plan and is central to the decentralized organizational structure of the IFM Programs. The planning process is carried out in March/April prior to the start of the fire season.
2. ***Integrated Fire Management Implementation*** - activities detailed in the Stakeholder IFM Plan are carried out by Stakeholder Fire Management Brigades. Structure fire management implementation is based on fire seasons with:
 - a. Controlled Fire Management Season (Early Dry Season, May – July)
 - b. Wildfire Management Season (Late Dry Season, July – October)
3. ***Integrated Fire Management Monitoring and Reporting*** - activities detailed in the Stakeholder IFM Plan are carried out by Stakeholder Fire Management Brigades throughout the fire season (May – October). These are supported by remotely sensed fire information.

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APPENDIX 1: CASE STUDIES OF LANDSCAPE SCALE INTEGRATED FIRE MANAGEMENT PROJECTS

Valuable insights on landscape scale integrated CBFiM and carbon offset projects are provided by the Western Arnhem Land Fire Abatement, Fish River Fire, and EcoFire projects in northern Australia. Fire as Resource, a CBFiM approach in southern Africa, illustrates the decentralization of early dry season controlled burning to improve community livelihoods, reduce uncontrolled fires and enhance the environment in rural Africa.

Western Arnhem Land Fire Abatement Project

A highly successful and well-documented carbon offsets project for indigenous people in northern Australia provides a comprehensive example. The Western Arnhem Land Fire Abatement Project (WALFA) is a landscape scale (28,000km²) fire management project of comparable latitude, ecosystem function and dominance of uncontrolled wildfire scenario to the Reserve. The Project is supported through an agreement between ConocoPhillips, a major multi-national energy corporation, the local government, indigenous land council and traditional owners. Under the arrangement, traditional owners have agreed to generate 100,000 Mt CO₂-e credits per annum in return for offset payments from ConocoPhillips of A\$1 million p.a. for 17 years.

This is achieved through increasing strategic early dry season controlled burning to reduce late dry season wildfires that produce more of the potent GHGs methane and nitrous oxide. The Project has reduced the extent and severity of uncontrolled wildfires through improved fire management and substantially decreased mean annual greenhouse gas emissions. by 113,000 Mt CO₂-e annually from 2005 to 2010 (Russell-Smith, J. et al, in press). This represents a 31.4% reduction in emissions from savanna burning.

Managing fires more effectively also provided important economic, biodiversity and socio-cultural benefits to the indigenous community. The fire management has involved over one hundred part-time jobs for Indigenous Rangers and others and has allowed many different ranger groups and communities to coordinate their activities and build regional collaboration.

This project provides valuable scientific; GHG monitoring, reporting and verification (MRV) framework; financial and socio-cultural insights for developing similar schemes. Importantly, the experience demonstrates that such projects can be effectively monitored and assessed to ensure good governance and meeting the aspirations and obligations of local indigenous people.

Fish River Fire Project

The Fish River Fire Project operates in the 1,800 km² IUCN Category 2 protected area – Fish River Station. When first acquired in 2010 for conservation this defunct cattle station had an extremely deleterious fire regime with more than 74% burnt annually with more than half (38%) of this fire occurring in the late dry season (post July) when fires have higher severity and spread more rapidly. Upon acquiring the property the Indigenous Land Corporation began implementing strategic early dry season prescribed burning (pre August) and a minimal amount of strategic fire suppression aimed at reducing the total area burnt and shifting the fire regime from one dominated by large scale, high severity late season fire to one dominated by fine scale, low severity early season fire (http://www.ilc.gov.au/~link.aspx?_id=0BED7EF5EB684E35BE1A95B089B3DF3A&_z=z).

These works have been highly successful with the average total area burnt over the project period (2010 to 2013) reducing to 34% from 74% prior to acquisition and the seasonality shifting dramatically from an average of 38% of Fish River burnt late to less than 2% burnt late during the project period. This has concomitant impact upon a range of key indicator across the project area with reductions in the ‘mean distance to unburnt area’ decreasing and the proportion of longer unburnt vegetation increasing, both are thought to be key determinants for habitat suitability for native granivorous birds and small mammals.

Fish River is also a successful carbon trading enterprise with the Fish River Fire project being the first land sector project approved under the Carbon Farming Initiative. This Australian government scheme forms the frame work for the production and trading of certified Australian Carbon Credit Units (ACCU's) and allows for a variety of methodologies. Fish River implements the Savanna Burning Methodology as developed through the WALFA project and has successfully abated more than 25,884 tonnes of CO₂-e during the course of this project – this represents a 54% reduction in CO₂-e emissions from the project area. These ACCU's have been successfully traded with Caltex Australia for more than \$500,000AUD (<http://www.fishriver.com.au/>).

EcoFire Project

The EcoFire Project is a collaborative fire management project covering 51,000km² of the Kimberley Region in north Western Australia. It is a collaborative project between neighbouring landholders, government and non-government conservation agencies and various regional bodies that commenced in 2007. Incorporating 13 conservation, pastoral and Aboriginal pastoral properties (indigenous communities) and intervening Crown Land the project. The Australian government's Caring for Country Our Country Program supports the project to promote natural resource monitoring.

The prevailing fire regime of extensive, mid-to-late dry season fires reduces biodiversity, degrades soil health and cattle pasture, affects cultural sites and releases higher greenhouse gas emissions. The EcoFire project delivers a strategic controlled burning program coordinated across property boundaries and tenures to effectively shift the seasonality of burning from the late to the early dry season. Establishing annual controlled burning in 40% of the project area in 2007 – 2009 high intensity late dry season fires and increasing patchiness to benefit biodiversity, pastoral and cultural values (Legge et al. 2010).

Fire as a Resource – 'Grass Roots' CBFiM in developing Africa

Fire as a Resource is a CBFiM approach employed in southern Africa since 2006 that focuses on controlled fire management to provide tangible livelihood benefits to communities through improved land use, reduced uncontrolled fires and improved environmental management. Implementation is supported by international and local development non-government organizations and carried out in collaboration with government institutions.

Projects range from properties of 4,000ha to multi-stakeholder regions of 10,000km² in Botswana, Mozambique, Namibia, Swaziland, Zambia and Zimbabwe. Similar to the Reserve, inadequate management and uncoordinated use of fire by communities results in dominance of a late dry season fire regime of uncontrolled wildfires in these nations.

The approach demonstrates the decentralization of controlled fire management to communities, protected area management institutions and private stakeholders to reduce the area burnt annually and to shift the seasonality of burning to the early dry season in rural Africa. It provides valuable insights into effective and sustainable CBFiM programs and building the fire management skills and collective responsibility in African communities (FAO, 2011).

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