Southern Africa Fire Network of the Global Observation of Forestry Cove: A Collaborative Effort Towards Developing Capacity for Operational Fire Monitoring and Management Systems in Southern Africa

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Abstract

Fire is used in Southern Africa for management of various land use activities and it is an essential factor in the ecology of the savannas. Frequent wildland fire outbreaks due to land use activities have put fire at equal level with floods and drought as a major regional hazard, with a potential to constrain sustainable development. In most Southern Africa countries it is an offence punishable by law to cause wildland fire. But this has not protected the region from burning. Stringent fire suppression policies in some cases alienate communities that are directly affected by fire such that there is increasing reluctance to cooperate on issues of causes of fires and to volunteer to put out a fire.

Studies point to a high probability of increased frequency of hot fires in future due to climate change in the region. Current fire control systems are resource constrained and fragmented and as a result trends on wildland fire occurrence are poorly documented. Most natural resource management schemes tend to exclude fire although wildland fire is a crosscutting issue and a potential trans-boundary problem. A collective regional effort with strong community involvement at national level is required to review, design and implement a wildland fire control approach that will balance the role of fire in ecosystem functioning and land use management with the need to prevent fire hazards.

A Southern Africa Fire Network (SAFNet) was formed through the initiative of the Global Observation of Forestry Cover (GOFC) to foster regional and national collaborative efforts to address fire. The network has a range of membership representing Government, NGOs, Community Based Organizations and Research bodies. The aim in SAFNet is to achieve effective and appropriate fire management policies and practices by facilitating incorporation of remote sensing and other geo-spatial information technology tools in operational fire monitoring and management systems.

SAFNet leverages upon an emerging international network of fire managers, scientists and technicians to access expertise in spatial information technology for fires and new improved spatial data technologies and products which, when carefully evaluated could greatly improve fire monitoring and management. The network has a MODIS validation project through which officials from Forestry, National Parks, NGOs and Universities in six Southern African countries are developing capacity to use Landsat ETM and MODIS satellite data in a GIS environment to identify and map fires to meet fire management needs in their own organizations. SAFNet has proposed a three-tier capacity building program to be carried out in collaboration with the Environmental Information Systems Education and Training Sub-Program (SETES) based in Southern Africa. The program will target Community Based

Organizations and NGOs at a lower level, mid-level officers and researchers at a higher-level. The SAFNet forum therefore facilitates participation by national fire management organizations in regional and international fire issues, establishment of connections between fire data providers and fire information users and allows for collective evaluation of new technologies and sharing of experience on issues of wildland fire in the region.

Introduction

About 17 % of sub-equatorial Africa burn annually (Scholes et al. 1996). However, there is very little capacity for fire monitoring and management in Africa. Existing fire management approaches are ineffective and spatially limited. Trends in fire occurrence are poorly documented and this makes it difficult to assess changes in fire regimes and relate this to natural resource productivity in the region. Fires are known to have a significant impact on ecological and environmental processes in general and this is important for Southern Africa where there is heavy reliance on natural resources. An effective regional fire management system is critical now given the increasing land use pressure on natural resources and projected changes in climate patterns in the region. Incorporating remote sensing products in operational fire control schemes will greatly improve fire monitoring and ultimately its management in the region (Ahern et al. 2000).

Fire in Southern Africa

The fire season in Southern Africa extend from April when vegetation begins to senescence to October when fuel loads are low. The fire season general ends in November when the wet season begins. There is no information on characteristics of fires in southern Africa but general observations show that both surface and canopy fires occur but certain areas such as the Okavango Delta also experience underground peat fires (Ellery et al. 1989). Fires have implications on carbon stocks, soil fertility, vegetation type and cover resulting in feed backs into the hydrological cycle and climate processes. There has been growing interest in the role of fire in emissions of greenhouse gases and contribution of aerosols into the atmosphere (Scholes 1995). Information on emissions is needed for preparing National Communications to the UN Framework Convention for Climate Change (UNFCCC). However, of immediate concern at a local level is the realization that the frequency of fires has increased to the extent that the effect of annual burns has a negative impact on the supply of key natural resources required for sustaining livelihoods in rural areas (Fig. 1.) (Frost 1998).

Fire is an important part of the evolution of the savanna ecosystem (Ellery et al. 1989) and (Trollope et al. 1996). Numerous studies have shown that the structural and species composition of savannas is linked to fire activity (Gill, 1999). However, of equally importance and often ignored is the fact that several land use systems of Southern Africa have also evolved with fire (Frost 1998).

- Fires have been used in hunting. Patterns of fires in Botswana show that fire is still used in hunting as indicated by the increased frequency of fires over the hunting season. SAFARI companies are also known to light fires to remove vegetation and increase visibility of wildlife for tourists.

- It has also been observed that fishermen in the Okavango Delta use fire. Communities set fires just before the onset of the Delta floods apparently to stimulate growth of phytoplankton and increase fish catch (Personal communication, Budzanani Tacheba). This activity also adds nutrients for floodplain cultivation activity after the floods have subsided.

Figure 1. A burn scar during the hunting season - August 2002 in Botswana.

- Fires are part of slash and burn cultivation activity practiced in Malawi, Zambia, Angola and other Southern Africa countries. Here too fire is used to increase fertility but also to clear vegetation for planting crops. It is common for outbreaks of Wildland fires to occur from these localized uses of fire.

- Pastoralists too are known to use fire to reduce litter and stimulate growth of new and more palatable shoots, usually towards the end of the dry season.

Fire, therefore is a significant factor in land use management as is the case in ecological process in the region. However, population growth coupled with the breakdown of traditional land use management systems has lead to an increase in un-coordinated burning practices in terms of timing, location and frequency of burns as well as measures to put out fires. For example, burning for hunting purposes may occur early in the season and this is against the needs of veld product gatherers such as those harvesting thatching grass. Fires are light for hunting purposes usually with no measures in place to control the spread of the fire beyond the areas of interest. As a result other land uses such as livestock grazing areas are usually affected and in some cases these fires cross boundaries into other countries. Fires light in the early part of the dry season result in shortage of fodder over most of the dry season for pastoralists, which has implications on livestock productivity. A combination of fires from fire-based land uses and fires due to carelessness (for instance most fires along major communication lines result from dumping light cigarette stumps) explain the rise in the frequency of fires in the region (Frost 1998).

Fire suppression policies

Widespread wildland fires are now considered a threat to sustainable development in the Southern Africa region where nearly 70% of the estimated 140 million people live in rural areas and are directly depended on natural resources (SADC, 1996). For semi-arid areas with variable rainfall, the risk of uncontrolled fires increases further uncertainty in the supply of natural resources. The majority of Southern Africa countries have responded to the increased risk of fire hazard by establishing legislation, which prohibits burning. For instance, it is an offence punishable by law to cause wildfires in Botswana and those who wish to use fires for localized land use management such as in clearing fields have to apply for a permit. Under such restrictions land use systems where large scale burning was applied such as in pastoral farming, fire is totally prohibited with exception to private farms which are expected to have fire breaks. The fire suppression policy therefore does not consider the role of fire in the ecology of the savannas.

However, the large incidents of fire shows that attempts to control burning through laws designed to prevent uncontrolled use of fire have failed (Frost 1999). One of the well-documented consequences of fire suppression policies is an increased risk of fierce fires due to accumulation of fuel loads. This is evident in protected areas with limited land use pressure such as Game Reserves and National Parks in Southern Africa. For livestock production total exclusion of fires is one of the factors responsible for the development of bush encroachment and this further ultimately affect livestock productivity (Dube and Kwerepe 2000).

Further stringent fire suppression policies contribute in some cases in alienating communities that are directly affected by fire from actively participating in fire management. Communities are reluctant to report fire incidents and indicate the causes in fear of being implicated. This makes it difficult to document and asses causes of fires over time and to devise appropriate measures to address fire control. In Botswana there is increasing reluctance by local communities to volunteer to put out fires. There is need to implement policies in which communities own fire control issues within their locality.

Status on fire control

Of great concern in Southern Africa is that while the role of local communities in fire control has weakened and fire has grown to be recognized as a major threat, Central Governments fire control systems are resource constrained and fragmented. Currently fire weather forecasting and condition of fuel loads is not a priority in the early warning systems of Southern Africa (http://www.sadc-fanr.org.zw/). Where fire risk assessment is made this is usually not consistent and up to date information on fire risk is rarely communicated to the communities affected. There are also inconsistencies in methods of reporting fires and most countries have no system of archiving fire data.

Fire in generally not considered in natural resource management plans of most Southern Africa countries. This is so despite evidence showing that it is a crosscutting issue, for example in Botswana the use of fire in hunting is a matter for the Department of Wildlife and National Parks and this is in contrast to its use in livestock production which is a case for the Ministry of Agriculture. While the socio-economic impact of frequent fires, a subject rarely considered at sufficient depth, needs to be assessed under the Ministries of Finance and the Ministry of local Government and Lands. In addition, both national and regional NGOs in Southern Africa have a limited role in issues of fire despite the fact that some of these organizations deal with for instance, marketing veld products such as medicinal plants, which are threatened by annual burning.

Nearly all countries operates a reactive approach to fire, which is a major concern given the limited resources usually deployed to put out a fire. The lack of a pro-active approach to fire control is a feature that can also be noted with respect to other disasters such as floods and droughts in Southern Africa and this partly explain the severe impact of such disasters when they strike. Initial climate change assessments point to a high probability of increased frequency of hot fires in future in the region (IPCC 2001). A pro-active approach needs to be developed to minimize vulnerability to new fire regimes in future.

A link with climate process is enough proof that fire is a regional issue, more so that trans-boundary fires have been recorded. The development of the Trans-Boundary Wildlife Management Areas (TBNRMAs) such as the Gaza-Kruger-Goranezhou covering South Africa, Zimbabwe and Mozambique and the Limpopo TBNRMA for Botswana, Zimbabwe

and South Africa, which are significant for the tourism industry, is a clear indication that a regional approach will be most appropriate.

Needs for an effective fire management strategy

Information on the causes and impacts of fire and level of fire risk for early warning is required at different scales by fire managers, land use planners as well as policy makers. This information will help to assess outcome of different options for fire policy and management. Long-term fire data sets need to be built to assess the role of fire in ecological and climatic processes. To make estimates of emissions released during the burning season requires accurate information on burnt area, fire severity, location and fire timing (Tacheba et al 2001). Integrated fire management systems need information on vegetation types and climatic factors such as, rainfall in addition to land-use (Dube and Kwerepe, 2000).

Expertise in geographic information technology is an important component for effective monitoring of fire at different scales and integrating fire information with socio-economic activities; landscape and climatic factors to provide fire information requirement for different users. Half of Southern African countries fall in the low-income category. It will be difficult for each country, individually, to develop and maintain an integrated fire management system in the forcible future. It is against this background that the Southern Africa Fire Network (SAFNet) was established in 2000.

The Southern Africa Fire Network

SAFNet was constituted under the Global Observation of Forestry Cover Fire Project (GOFC) (http://www.safnet.net/). GOFC is part of the Global Terrestrial Observing System (GTOS). SAFNet provides, for the first time, a framework, for trans-boundary exchange on fire issues. The aim of SAFNet is to forester more effective and appropriate fire management policies and practices in Southern Africa through the use of remote sensing, GIS and other geo-spatial information technologies. Here too SAFNet provides for the first time, a regional framework to build capacity in the use of geo-spatial tools specifically for fire monitoring and management. Such tools once acquired will facilitate integration of fire in general resource management and help establish a balance between fire as an integral part of savanna ecology and land use management and as a hazard. These efforts will ultimately improve estimates of fire emissions from the region to meet UNFCCC agenda and contribute in reducing vulnerability to future climate change.

Detailed objectives of SAFNet are as follows

i. To build capacity to collect, archive and distribute regional fire related databases and associated information.

ii. To develop capability to monitor using remote sensing, fire and its effects

iii. To increase information on fire issues through research and raise public awareness as well as policy makers on issues of fire and the value of geo-spatial information in fire control.

vi. To seek resources to facilitate the applications of remote sensing products for fire control among local communities.

Networking SAFNet

SAFNet is a network with membership drawn from National Parks, Government Forest fire sectors, regional NGOs, independent consultants, University and Research bodies within the Southern Africa countries (Table 1). The network membership has a wide representation of the fire community in the region and diverse fire skills. This broad participation facilitates effective incorporation of fire information in natural resource management decision-making processes as demonstrated below.

Table 1. Countries with registered SAFNet membership as of July 2003 and affiliations of members

Country	Organization
Botswana	University, National & International NGOs, Government - Wildlife and National Parks, Agriculture, Meteorology, and Community Based Organizations (CBO)
South Africa	Government - National Parks, University, Research - CSIR and satellite data providers
Zimbabwe	University, Consultant, Government - Forestry and International NGO - WWF
Namibia	Government - National Park & Forestry and National Remote Sensing Centre
Mozambique	Government - Forestry
Malawi	University and Government - Forestry
DRC	University
Tanzania	University
Madagascar	Government - Forestry and NGOs

In addition SAFNet maintains a strong international link through GTOS/GOFC and this provides exposure to existing international data archives, new technologies and external expertise in fire issues. SAFNet has also developed links with the UN Office of Outer Space Affairs (UN OOSA) programme on Space Technology for Disaster Management in Africa (http://www.oosa.unvienna.org/). Under the UN OOSA initiative SAFNet has a role of coordinating fire disaster networking over Africa with specific reference to applications of satellite data in managing fire related hazards. This linkage also provides SAFNet with access to satellite data providers and various expertise on fire issues in Africa.

SAFNet is in the process of forging links with the Regional Subsahara Wildland Fire Network (Afrifirenet) formed under the UN International Strategy for Disaster Reduction (ISDR), (http://www.fire.uni-eiburg.de/GlobalNetworks/Africa/Afrifirenet.html). This link will provide the SAFNet geo-spatial fire expects members greater interaction with field-based fire managers. It is hoped that this will pave the way for a more holistic approach to fire management in Africa.

These linkages have positioned SAFNet strategically with respect to addressing fire monitoring in the region even when the network has no specific funding support. The SAFNet forum facilitates increased participation by national fire management organizations in regional and international fire issues, establishing connections between fire data providers and fire information users and collective evaluation of new technologies and sharing of experience. Further, SAFNet has a strong research capacity which is fundamental to

establishment of a solid foundation for long-term capacity building in Southern African fire issues.

SAFNet Strategic Activities

SAFNet has been engaged in various activities strategies applied to achieve the objectives of the network with minimum funding support.

SAFNet meetings: Since its formation SAFNet holds annual meetings and the fourth SAFNet meeting in August 2003 will be held jointly with Afrifirenet at the Kruger National Park in South Africa. The Third SAFNet meeting held in Gaborone helped to raise the profile of fire management in the country and since then consultations have been going on at various levels on how best to approach fire management in Botswana. It is expected that the Kruger National Park meeting will also generate comparable results in South Africa and also enhance collaborations between South Africa fire community with their counterpart in Southern Africa countries. The fourth meeting is also set to seal the basis for collaboration between SAFNet and Afrifirenet and this will mark the beginning of a focused approach to fire in Sub-Sahara Africa.

World Summit on Sustainable Development: SAFNet was an active participant at the World Summit on Sustainable Development in Johannesburg, 26 August - 4 September, where the network shared an exhibit with the MIOMBO network, the University of Maryland (UMD) and NASA Earth Science Enterprise (ESE). The SAFNet stall included among others an Internet GIS showing Central and Southern Africa MODIS Web Fire Maps and the MODIS Rapid Response System. This demonstration showed the potential of Internet GIS technologies to provide easy access to near-real time satellite data and data archives, and to extend GIS capabilities to non-GIS users. The MODIS Web Fire Maps GIS server which showed daily active fire locations from NASA's MODIS instrument was the most popular. The SAFNet stall demonstrated the potential of Internet GIS technologies for fire monitoring and management for both scientists and decision-makers.

Accessing satellite data: SAFNet offers links to satellite data providers and therefore facilitates access to satellite data by different fire control organizations in the region. For example, through the link with GOFC, SAFNet members have had access to Landsat Enhanced Thematic Mapper Plus (ETM+) and MODIS fire products. This support facilitated SAFNet to establish links with some members of the Environmental Information Systems Education and Training Sub-Program (SETES) working on aspects of fire in Malawi.

SAFNet also provided data to the ongoing project on assessment of impacts of climate change, vulnerability and adaptation capacity in the Limpopo basin part of Botswana (http://www.start.org/Projects/projects.html). This project is part of the UNEP/GEF capacity building project in developing countries on Assessment of Impacts of and Adaptations to Climate Change in Multiple Regions and Sectors (AIACC) which is executed by the System for Analysis Research and Training (START) and the Third World Academy of Sciences (TWAS). The Limpopo project incorporates a section on impacts of climate change on fire.

Active Fire Monitoring Systems: SAFNet is exploring possibilities for establishing satellite based active fire monitoring system in Southern Africa. One such system is the MODIS Rapid Response Fire Monitoring System that is being developed by NASA and the University of Maryland (http://rapidfire.sci.gsfc.nasa.gov.). The NASA MODIS Rapid Response Fire Detection System service includes a textfile, which provides Centre co-

ordinates of burning fires and the date and time when the fire was captured (Table 2) and (Fig. 2). The latitudes and longitudes can be plotted on a map to determine the actual location of the fire on the ground. One of SAFNet's role is to make such near real time information on fire known to policy makers and fire managers for use in for instance, preparations for putting out a burning fires. The near real time system also provides information that is useful for locating fire scars.

Table 2. An example of information on fires for parts of Botswana extracted from the MODIS Rapid Response Fire data.

Latitude	Longitude	Date	Time	Place
-24.84	24.161	7/29/02	800	Southern District
-24.952	24.182	7/29/02	800	Kgalagadi/Southern District
-22.934	21.752	8/2/02	915	Ghanzi
-23.026	21.782	8/2/02	915	Ghanzi _West Ncojane

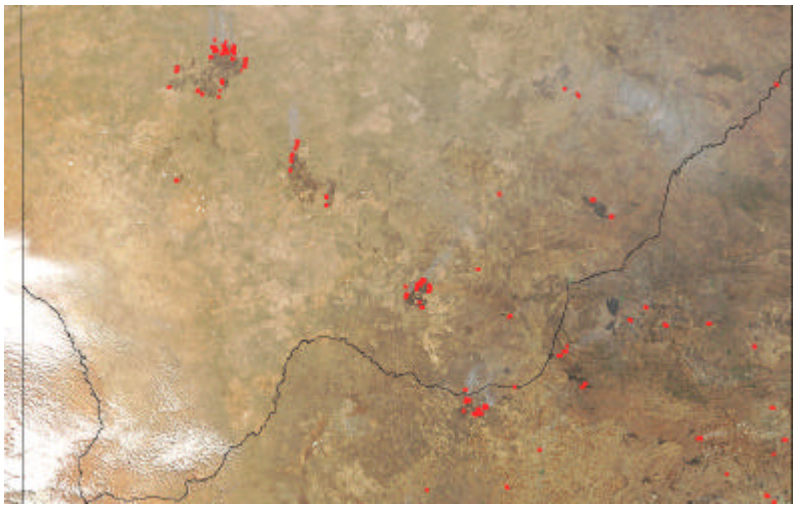

Figure 2. Fires of the 29th July 2002 over western Botswana (see Table 2 above). A MODIS satellite 1 km scale fire product (http://rapidfire.sci.gsfc.nasa.gov.).

However, there are also initiatives under the Satellite Applications Centre/CSIR in South Africa to develop the Wide Area Monitoring Information System (WAMIS). The goal of WAMIS is to provide wide area coverage and monitoring information service from low to medium resolution satellite sensors to support disaster management, early warning and environmental monitoring by delivering timely products and information to the national and regional user community on a non-profit basis. UN OOSA is exploring opportunities to fund among others SAFNet to participate in evaluating some of the fire products provided through WAMIS.

Capacity building: To effectively use space technologies in fire monitoring and management there is need to develop a critical mass of experts in these tools at various levels and in different sectors involved in fire issues. SAFNet provides a forum through which regional and international human resources can be tapped to facilitate incorporation of geo-spatial information skills in operational fire management systems and in the management of natural resource in general. An example of this is the ongoing SAFNet MODIS validation project, which is linked to GOFC at the University of Maryland. Under this project officials

from Forestry sectors, National Parks, NGOs and Universities as well as individual consultants (from Botswana, Malawi, Mozambique, Zimbabwe, Namibia and South Africa) participate in the project and develop capacity to use the new Landsat ETM+ and MODIS satellite data in a GIS environment to identify and map fires to meet fire management needs in their own organizations.

SAFNet has participated in the USAID Environmental Information for Resource Management (E-INFORM) program Clearinghouse, Metadata and Internet Mapping Workshops; particularly those run in Zambia, Botswana, and Namibia. The aim in E-INFORM is to strengthen the capacity of regional organizations, community groups, and conservation NGOs and government natural resource management authorities in Southern Africa to collect and analyze data and information about the region's natural resources. SAFNet's involvement in E-INFORM initiatives contributes towards building fire data archiving which a major missing link in the region

SAFNet is currently developing a three-tier capacity building program to be carried out in collaboration with the Environmental Information Systems Education and Training Sub-Program (SETES) based in Southern Africa. The three level program will organize as follows:

Level I: A basic operational course targeting key members of local communities, extension officers, representatives of Community Based Organization (CBO) and NGOs.

Level II: A mid-level course catering for officers in for instance, National Parks/Game Reserves, forest and rangelands, land use planners, coordinators/leaders of relevant NGOs and CBOs.

Level III: A higher-level training program involving research, on job training and trans-boundary projects.

The first is considered to be critical for establishing ways of introducing the use of satellite based information at the community level.

Conclusion

The recent IGBP congress in Canada, 19-24th June 2003 recognized the need for in-depth assessment of both the biophysical and socio-economic aspects of global fires. A collective regional effort with strong community involvement at national level is required to review, design and implement a wildland fire control approach that will balance the role of fire in ecosystem functioning and land use management with the need to prevent fire hazards in Southern Africa. SAFNet aims to contribute towards meeting this goal by providing a forum for regional to international collaboration on fire and the use of geo-spatial information technologies to improve fire monitoring and management, a process which will help to improve estimates of emissions from fires. A number of fire monitoring and management skills are transferable to other resource management issues, for instance data archiving, fire monitoring using Remote Sensing and integration of fire information with land use and climate data. In this regard SAFNet has a potential to contribute to sustainable development of Southern Africa given the large influence of fire in environmental processes.

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