Report of the GOFC-GOLD Workshop on Requirements for Fire Early Warning Systems in Africa

University of Ghana

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Edited by

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Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) is a coordinated international effort to ensure a continuous program of space-based and in situ forest and other land cover observations to better understand global change, to support international assessments and environmental treaties and to contribute to natural resources management.

GOFC-GOLD encourages countries to increase their ability to measure and track forest and land cover dynamics by promoting and supporting participation on implementation teams and in Regional Networks. Through these forums, data users and providers share information to improve understanding of user requirements and product quality.

GOFC-GOLD is a Panel of the Global Terrestrial Observing System (GTOS), sponsored by FAO, UNESCO, WMO, ICSU and UNEP. The GOFC-GOLD Secretariat is hosted by Canada and supported by the Canadian Space Agency and Natural Resources Canada. Other contributing agencies include NASA, ESA, START and JRC. Further information can be obtained at http://www.fao.org/gtos/gofc-gold

Summary

The purpose of the workshop was to define the local criteria needed to complete the design of an operational prototype early warning system for wildland fire (Fire-EWS) in Africa. This included identifying decision-support tools specific to fire management activities of African countries, and system data requirements. To reach that end, the workshop proceeded through 3 progressive phases (or components): describing the African fire environment, summarizing fire management policy and programs in Africa, and defining the Fire-EWS outputs needed to support African fire management decision-making. Each workshop component started with several presentations on the topic, which were followed by group discussions (breakout and/or plenary). After completing the final component, the workshop delegates met in plenary to discuss the workshop results and the next steps needed to develop the Fire-EWS for Africa.

Following is a list of recommendations by the workshop delegates.

1. There is a need to establish regional algorithms for fire danger rating and remote sensing products for West Africa. This should be done as an initial project under the newly formed West Africa Regional Network (WARN) and will be submitted to the WARN secretariat as a proposed activity.
2. Development of the prototype Fire-EWS for Africa will continue based on the workshop results. The system will be comprised of 3 components: a fire danger rating system, a fire risk assessment, and a fuels assessment. The prototype will operate at the sub-Saharan Africa, and West Africa regional levels.
3. The Canadian Forest Service (CFS) will continue to design the prototype Fire-EWS for Africa. The next step is to complete an operational coarse resolution fire danger rating system (FDRS) for Africa. Similar to the Eurasian FDRS prototype, the Africa FDRS will be operationally run by the Northern Forestry Centre of CFS and posted on the Global Fire Monitoring Centre website.
4. It was proposed to the WARN secretariat to conduct a fire risk assessment for West Africa, as part of the Fire-EWS for West Africa. The WARN secretariat will discuss this proposed activity.
5. It was also proposed that WARN conduct a fuels assessment for West Africa, as part of the Fire-EWS for West Africa. The WARN secretariat will discuss this proposed activity.
6. The prototype Fire-EWS will utilize existing fire management decision-aids from South Africa for fire suppression and prescribed burning. Because grass is the fuel type of greatest concern in Africa (including grassland, savannah, and mixed shrub-grasslands), the Fire-EWS will be run with 3 existing fire danger indices applicable to cured grass: the Fine Fuel Moisture Code (FFMC) of the Canadian Forest Fire Weather Index (FWI) System, the Lowveld Fire Danger Index (FDI) used in several countries of Southern Africa, and the Grassland Fire Danger Index (GFDI) used in Australia. Classification categories (ie, low, moderate, high, extreme) for the 3 fire danger indices will follow those used by the Lowveld FDI. This will allow initial testing and comparison of the fire danger indices.
7. After the operational Fire-EWS prototype is completed, a review of the current decision-support tools, and potential decision-support tools supporting other fire management activities (ie, prevention, detection, pre-suppression planning) will be done.

8. Funding to develop and eventually operationally run the Fire-EWS for Africa is still an issue. Further funding support will continue to be sought.
9. WARN needs to find a facility to eventually host the operational regional system, but a university association with WARN may be the best option. AFRIFIRENET indicated it would consider hosting the sub-Saharan Fire-EWS, depending on requirements and funding.
10. There is a need to develop a communications plan so early warning information gets to the local community level. Several options were discussed, including GEO Netcast. Internet service is not reliable or accessible across Africa, but it is improving.

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1. INTRODUCTION

There has been recent concern about the impacts of large fires, particularly those burning out of control and endangering human lives, property, and natural resources. Fire's influence on and in response to the changing global climate and, on a smaller scale, fire's effects on regional and local air quality have become international issues. Particularly as countries have sought to improve the public health and safeguard environmental resources, wildland and agricultural burning have attracted increasing attention as sources of concern and have become the target of regulatory attention.

To aid in determining the potential of fires starting in forests or grasslands, meteorologists have developed fire danger indices that use weather conditions and other information to determine the state of vegetative fuels on the ground. Meteorological data are also critical to forecasting behavior of fires once started. A third area of meteorological information needed relates to predicting smoke trajectories and dispersion using complex high-resolution numerical weather models. The World Meteorological Organization (WMO) has addressed this issue over the years by developing tools to evaluate and predict the effects of weather and climate on fires and their potential. A key WMO performance target includes the production of operational guidelines for fire weather agrometeorology by 2009.

Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) is a coordinated international effort to ensure a continuous program of space-based and in situ forest and land cover observations to better understand global change, to support international assessments and environmental treaties and to contribute to natural resources management. GOFC-GOLD encourages countries to increase their ability to measure and track forest and land cover dynamics by promoting and supporting participation on implementation teams and in regional networks. Through these forums, data users and providers share information to improve understanding of user requirements and product quality. As a panel of the Global Terrestrial Observing System (GTOS), GOFC-GOLD interacts with several United Nations bodies and numerous international and national scientific and technical organizations. It develops contributory products at regional and global scales in two thematic areas: fire monitoring and mapping and land cover characteristics and change.

GOFC-GOLD is implemented through implementation teams that work closely with a series of regional networks, in partnership with the UNISDR Global Wildland Fire Network and its 13 Regional Wildland Fire Networks in all continents, which provide a forum for regional scientists, data providers, and operational users to articulate their information requirements and improve access to and use of the observations. The regional networks also provide a mechanism for calibrating, validating, and improving methods and algorithms and a place to test integration of in-situ and remote sensing observations. The regional networks provide a forum for users and researchers operating in (or with an interest in) a common geographic area, and represent a link between national agencies and user groups and the global user/producer community. They provide a mechanism for sharing of resources and expertise, and perform an essential cross-cutting role in the implementation and integration of GOFC-GOLD's thematic components.

By promoting and supporting participation on implementation teams and in regional networks, GOFC-GOLD provides the international coordination to articulate user needs, specify requirements for products, assess algorithms and data assimilation procedures, and develop harmonization protocols and standards. It also provides information to support international assessments. Capacity is strengthened by working with regional networks, which provide

guidance on regional needs and promote the transfer of technology and experience in South East Asia, Central, Southern and West Africa, Northern Eurasia, Latin America, and East Asia. The four Regional Networks in Africa include:

The Miombo network was founded in 1995 under the auspices of the IGBP, LUCC and START. More than 40 scientists and natural resources managers are involved. Miombo's focus is on land cover activities in the Miombo Basin region of central Africa.

The Southern Africa Fire Network (SAFNet) was initiated in 2000 during a GOFC-GOLD regional network meeting. More than 60 members from 12 southern African countries participate in SAFNet's activities on fire.

The Central Africa OSFAC network was initiated at the GOFC-GOLD regional workshop in 2000. This network is linked to the GIS/RS lab at the University of Kinshasa, and is focused on land cover with some fire activities.

The Western Africa Regional Network (WARN) was initiated at Dakar in 2005. The frequency, extent and intensity of wildland fire were identified as important factors in land cover change and degradation of the West African landscape. Researchers and land managers require applications using in situ and remotely sensed earth observations to monitor map and understand wildfire and its effects on the regional landscape. The WARN was consolidated during the 2nd network meeting at Accra in November 2007 and intends to focus on four thematic areas of EO, including fire. Building on the results of the 2005 Dakar workshop, GOFC-GOLD and the West African scientists have decided to cooperate in the areas of wildland fire monitoring and mapping and land cover characterization and change.

The 2007-2009 Work plan of the Group on Earth Observation (GEO) includes activities concerning land cover / land cover change and a specific task concerning the progressive setup of a Wildland Fire Warning System at Global Level. Significant progress on its implementation is considered as one of the achievements to be shown at the GEO Ministerial Summit, scheduled for the 30 November 2007 in Cape Town, South Africa. It is therefore a GEO priority to support all actions aiming at the activation of the African component of such a global system.

With this broad view the aim is to develop an integrated approach to address the most pressing issues related to the consequences of vegetation cover degradation by fire and related land-use practices on the environment, including disaster risk reduction associated with extreme fire and extreme weather events. This is why a close partnership is required with the user community represented by the UNISDR Global Wildland Fire Network, and in particular with the Regional Subsahara Wildland Fire Network / AfriFireNet.

It is with this background that GOFC-GOLD and the Department of Geography and Resource Development, University of Ghana (Legon) organized, jointly with several co-sponsors, an International Workshop on Requirements for Fire Early Warning Systems in Africa. The workshop was held from 14-16 November 2007 at Accra, Ghana. The meeting was held in conjunction with the 2nd meeting of the West Africa Regional Network, 12-14 November 2007, also at University of Ghana.

The meeting was opened by Paul Yankson, Head of the Geography Department of the Universwity of Ghana, and Michael Brady, Executive Director GOFC-GOLD. The speakers gratefully acknowledged the support for the workshop provided by the University of Ghana; Natural Resources Canada-Canadian Forest Service; Canadian Space Agency; Global change SysTem for Analysis, Research and Training (START)/US National Aeronautical and Space

Administration (NASA); EC-Joint Research Centre; World Meteorological Organization; Group on Earth Observation (GEO) Secretariat; and the United Nations University (UNU).

Each of the participants introduced themselves (listed in Appendix 1). Bill de Groot, the workshop Chair, reviewed the agenda of the meeting. Following a brief discussion, the agenda was approved (Appendix 2).

Workshop Objectives

The objectives of the fire workshop were to provide an assessment of the African requirements for such systems. The workshop included a state of the art review of operational fire weather and early warning concepts, systems (EWS) and tools. Presentations addressed Africa fire conditions, fire management needs and requirements for decision support tools. Results, among others, included recommended activities for regional networks and other international partners. In particular, the workshop contributes to the GEO work plan task (DI-06-13) to initiate a globally coordinated warning system for fire, including the development of improved prediction capabilities, analysis tools and response support through sensors, information products and risk assessment models. Topics discussed include:

- Identification of current fire early warning systems and procedures including those currently implemented in Africa.
- Identification of information needs for African fire early warning systems, including information content, spatial and temporal characteristics and delivery systems.
- Evaluation of a prototype Africa fire weather index.
- Identification of potential prototyping activities.
- Preparation of a short workshop report on African requirements of a Fire Early Warning System for the GEO Ministerial Summit, November 30th 2007 in Cape Town, South Africa.

Bill de Groot reviewed the goals, objectives and outline of the workshop in Presentation 1 (a complete list of presentations is in Appendix 3). This Workshop marks the first step of a concept to support greater integration of the global wildland fire community, so the fire community can work more closely together. Each member can benefit from the experience and assistance of the others. Hallmarks of this concept are to promote the open exchange of information and resource-sharing.

The purpose of EWS is to:

- provide rapid exchange of fire information for better fire mgt decision-making
- provide a mechanism (metric) to make fire mgt decisions

A key activity to improve fire management is strategizing. Fire management decisions will be improved with better information or fire intelligence. For example, if you know what the burning conditions or fire danger is for the next two weeks, better decisions can be made about when and where to apply fire to the landscape: when is it beneficial for your land management purpose, when is it dangerous to use fire?

EWS provides advanced knowledge of fire danger. The EWS concept is global in scope, however it is something that needs to be built into the foundation. Africa is the first global region to form the foundation of the overall system. EWS is a global concept that provides benefits down to the local level, which is where fire operations happen

How to develop a Fire EWS for Africa?

- define information needs to manage fires in Africa
- determine how to coordinate data acquisition, processing and distribution of fire information

Two purposes for EWS in fire management:

- to enhance the proper use of fire to manage land resources
- to mitigate or prevent the negative impacts of uncontrolled wildfire (i.e. escaped prescribed fire)

GOFC-GOLD and partner organizations recently submitted a proposal to the UNISDR to develop a global wildland fire early warning system.

International Fire Programmes

GOFC-GOLD Fire Theme

Michael Brady, Executive Director of GOFC-GOLD and Head of the Canadian Wildland Fire Information System Group, Natural Resources Canada, provided an overview of GOFC-GOLD fire theme (Presentation 2).

Current Assessment on Earth Observations

We have never had so many satellite systems for earth observation and so much data as we have now, the quality of the data is also improving. The ground based networks appear to be in serious decline and there is little indication that things are likely improve, as budgets are shrinking. The demand for reliable and timely information is growing, for both science and natural resource management. The internet is making data access and exchange easier; however, the culture of data sharing is not wide spread. Currently, there is little international coordination or cooperation on observations, although there is broad agreement that better observations are needed.

Types of Fire Information Needed:

- Fire Danger/Susceptibility (Weather and Satellite data)
    - Fuel type, fuel load and condition, fire weather, ignitions
- Fire Behavior related information
    - Weather, topography, fuel load and condition
- Fire Occurrence / Location
    - Tactical (within 15 minutes, local)
    - Strategic (daily briefings, regional coverage)
- Fire Emissions related information
    - Fuel load and condition, combustion completeness
    - Distributions of emissions products (trace gases, particulates) – air quality, atmospheric composition
- Fire Characterization (fire intensity)
- Burned Area (near real time, monthly, annual)
- Fire Severity
- Immediate Post Fire Assessment
    - Fire severity > ecosystem damage – remedial actions
    - Fire recovery – longer term
- Long-term trends in fire regimes

Examples of Current and Planned Sensing Systems Relevant to Fire Monitoring:

- Active Fire Detection and Characterization (mid-IR)
  - AVHRR (METOP), GOES, DMSP, MSG (operational)
  - TRMM, MODIS (AM/PM), A(A)TSR, ASTER, MERIS (experimental)
- Burned Area, Fire Danger, Post Fire Assessments (vis, NIR)
  - Coarse/moderate Resolution
    - AVHRR, MODIS, ATSR, VEGETATION, METOP
  - High Resolution
    - Landsat 5,7, SPOT, IRS, CBERS , ALI
    - ASTER – high resolution optical and thermal
    - Radarsat
  - Hyperspectral data – EO 1 Hyperion
  - Hyperspatial Resolution – Ikonos, QuickBird, Rapideye, DMC Surrey

Examples of Planned Systems:

- NPP/NPOESS VIIRS (2009) – active fire and burned area / intensity
- Vegetation Lidar – vegetation structure ?
- LDCM (2011)
- Sentinel 2 / 3
- CBERS 2b/3/4
- FY 3

Challenges for GOFC-GOLD Fire

Space Agencies focus on national space programs and largely work independently. Fire observations are not recognized as a priority, however fire is an Essential Climate Variable. Fire has special sensor design and data acquisition requirements. There is a commitment needed for operational (fire) data continuity to ensure that there is a high resolution global acquisition strategy and inter-calibration.

As data producers develop similar products from different systems, there needs to be systematic product accuracy assessments, international standards and protocols, and the integration of multi-source data, from different systems at different resolutions.

Operational users do not traditionally use Remote Sensing data. Producers need a better understanding of user needs. Obstacles to data use need to be reduced by having user-friendly data policies (ease of access, 'free' data), and tools for analysis.

GOFC-GOLD Fire promotes the interaction between numerous communities including:

- Remote Sensing and Operations
- Research and Development
- Fire Observation Systems (Experimental and Operational)
- Fire and Global Change Research
- Operational Fire and Resource Management and Policy

GOFC-GOLD Regional Networks include:

- SAFNET- Southern Africa (http://safnet.umd.edu/)
- SEARRIN - South East Asia (http://www.eoc.ukm.my/searrin/)
- OSFAC - Central Africa (http://osfac.umd.edu/)
- REDLATIF - Latin America (http://mob.conae.gov.ar/redlatif/)
- NERIN – Northern Eurasia (http://www.fao.org/gtos/gofc-gold/net-NERIN.html)

GOFC-GOLD Fire goals are to:

- Increase user awareness and data use
  - develop an increased understanding of the utility of satellite fire products, and their use for global change research, resource management and policy (UN, Regional, National, Local)
- Establish a geostationary global fire network providing operational high temporal resolution standard fire products of known accuracy
- Secure *operational* polar orbiters with adequate fire monitoring capability to:
  - provide operational moderate resolution long-term global fire products to meet user requirements and serve a network of distributed ground stations
  - provide operational high resolution acquisition allowing active fire, burned area, fire characterization and post-fire assessments
  - improve access to near real-time polar orbiting active fire data and information
  - provide improved fire products (fuel moisture content/active fire/burned area/ fire characterization) in a timely fashion
- Determine product accuracies
  - operational network of fire validation sites and protocols established providing accuracy assessment for operational products and a test bed for new or enhanced products – leading to standard products of known accuracy
- Develop a set of global fire danger / early warning products
  - combine meteorological data, remote sensing, and ground based information
  - timely web based access
- Develop fire emissions product suites
  - provide annual global and regional emission estimates of known accuracy with the associated input data
- Develop consistent Long-Term fire data records
  - combine data from multiple satellite sources to identify trends and monitor changes in fire regimes
- Establish enhanced user products and improved data access
  - operational multi-source fire / GIS products, Web based data access, improved national fire reporting, fire characterization
- Promote experimental fire observation systems and related research
  - in new areas focused on meeting current information gaps

Priorities for the GOFC-GOLD Fire Meeting:

- International coordination is needed to fill the Landsat Data gap with systematic continuous global acquisition of 30m class data
- Validation of Global Burned Area products – international initiative / protocol
  - Need to share raw and interpreted validation data
  - Global representation and and regional scientist involvement
- Assess progress and directions in use of observations in emissions modeling
- Need for community best practices on use of satellite observations in fuel mapping
- Community consensus on a global Fire Early Warning systems
  - Requirements workshop for Africa (Oct. 07, Accra, Ghana)
  - State of the science and global system design and implementation planning (June 08, Edmonton, Canada)
- Need for a systematic Global Fire Assessment (2008-2009)
  - Utilizing available satellite data records and regional knowledge

  - Develop new global satellite-based indicators
  - Need for regional expertise to interpret the data and explain results (regional networks)
  - Augmenting National Fire Statistics as appropriate (TBD)
- Increased research emphasis and international 'discussion' needed on
  - Post Fire Mapping – severity (terminology)
  - Post fire vegetation recovery (35 year record?)
  - Human dimensions of fire and approaches to fire prevention
  - Microwave and Lidar integration with Optical systems

The High (moderate) Resolution Data Issue

What we have now:
- International targeted global acquisition for disasters (The Charter)
- Periodic global data sets from existing systems (5 year intervals)
  - NASA Geocover 1990/2000 > Mid Decadal Global Land Survey 2005 (MDGLS – L7/L5/EO1) – available end of 08
  - CEOS WGISS Decadal Survey (2008-2010)

What is needed:
- Coordinated global acquisition strategy using current systems to achieve regular (c. 16 days?) global coverage from existing 30m class systems (GEOSS)
- A designed international constellation providing 5 day coverage 30 m class data (GEOSS)
  - Shared resources, instruments, calibration, data quality control

Global Wildland Fire Network/International Strategy for Disaster Reduction

Johann Goldammer, Co-Chair of the GOFC-GOLD Fire Implementation Team and Head of the Global Fire Monitoring Centre (Presentation 3) presented Wildand Fire: A Global Source of Multiple Hazards.

Significant Ecosystem damage:
- Degradation in forest/grassland health due to uncontrolled burning
- Agriculture and land degradation with losses in production
- Hydrological changes resulting in desertification and flooding

Significant loss of life, including negative societal impact and economic losses:
- Losses and vulnerability at urban-rural interface increasing
- Global health impact due to smoke and emissions
- Disruption of transport due to changes in visibility
- Costly fire suppression programs

Potential impact on climate change:
- Global carbon cycle impact

UN Inter-Agency and International Coordination are facilitated by the UN International Strategy for Disaster Reduction (UN-ISDR):
- Inter-Agency Task Force for Disaster Reduction
- Working Group on Wildland Fire (2001-2003)
- UN-ISDR Wildland Fire Advisory Group (since 2004)

Objectives of the Wildland Fire Advisory Group are to serve as an advisory body to the UN, provide a global inter-agency, inter-sectoral and interdisciplinary platform for the wildland fire community, and facilitate the Global Wildland Fire Network.

The main UN Partners of the Wildland Fire Advisory Group and the Global Wildland Fire Network are:

- UN Food and Agriculture Organization (FAO)
- WHO, WMO, UNESCO, UNEP / OCHA
- UN Forum on Forests (UNFF)
- UN Conventions
    - Convention on Biodiversity (CBD) (since2003)
    - Convention on Combat on Desertification (CCD) (since 2004)
    - Framework Convention on Climate Change (FCCC)
    - (expression of interest, since 2004)
- United Nations University

The Global Wildland Fire Network

Objective I: Establish and support of Regional Wildland Fire Networks, aimed at promoting formal agreements on cooperation in wildland fire management between countries (bilateral, multilateral), and sharing of wildland fire management resources (e.g., costly equipment such as aerial assets).

Objectives II: Share regional and global systems for wildland fire early warning and monitoring to develop standards, conduct joint fire management training, and develop an international voluntary and finally legally binding instrument.

Coordinate with existing and upcoming systems for wildland fire early warning and monitoring (http://www.fire.uni-freiburg.de/fwf/fwf.htm).

UN FAO Fire Programme

Andre Bassole, member of the Global Land Cover Network, Environment Information Systems-Africa, and the Food and Agriculture Organization of the United Nations (Presentation 4), presented The Global Forest Resources Assessment 2010.

Since 1946, FAO has conducted global forest resource assessments at 5 to 10 year intervals. Each assessment has had a slightly different focus reflecting the concerns of its time. The scope of these assessments has increased over time and they now provide a comprehensive picture of the extent of forests and other wooded land, their condition, management and uses. The latest assessment was completed in 2005. Copies of the Key Findings, the main report and the CD-ROM are available from fra@fao.org.

Countries are involved in both the design and implementation of the programme. There are currently 172 national correspondents, 229 country reports, and more than 800 contributors.

Guidance is provided by the FAO Committee on Forestry (COFO) through a series of Expert Consultations; including, Kotka meetings, an external Advisory Group composed of forest resources assessment experts, and with representatives from key forest-related organizations.

Guidance from Kotka V for FRA 2010:

1. FRA 2010 should cover all the 7 thematic elements of Sustainable forest management
2. The FRA 2010 process should provide the forest-related information needed to assess progress towards the Biodiversity Target of the Convention on Biological Diversity

3. A global remote sensing survey should be carried out to complement country reporting
4. We should continue to strengthen the network of national correspondents
5. We should continue to harmonize reporting on forests with other organizations.

These recommendations were endorsed by the FAO Committee on Forestry (COFO) in March. COFO also requested us to take the Global Objectives on Forests agreed under the United Nations Forum on Forests into full account.

Country reports will continue to form the backbone of the assessment and most of the information needs identified will be met through the country reporting process. Other aspects such as trends in forest types or biomes are better suited to a remote sensing survey. Some topics, particularly those with limited quantitative information or with no commonly agreed methodology for assessment will be dealt with through special studies. Finally, data from external partners (threatened species, ratification of international agreements etc) will be included.

The FRA 2010 Remote Sensing Survey is a new and ambitious initiative. The primary goals of the global survey are to obtain information on the distribution and extent of forests and on changes in forest area over time at regional, biome and global levels. The survey is designed to complement the national reports and to give us a better picture of land use dynamics such as rates of deforestation, afforestation and natural expansion of forests. It will provide information which is consistent over time and space, something which is difficult to obtain from a compilation of national reports. Very importantly, we wish to ensure a very close link with existing and planned national forest assessment and monitoring systems – to build on and complement the information already available in countries.

In addition to updating the forest map in the last slide, the FRA is particularly interested in knowing how forests are distributed among and within different biomes – or large ecological zones.

South Dakota State University (SDSU) has developed a methodology for generating maps of tree cover based on MODIS imagery at a resolution of 500 and 250 m. This will result in tree cover maps, which can be varied according to the percentage canopy cover, and updated annually (back to year 2000). FRA is working closely with SDSU on this project, and to facilitate links with national efforts in order to use auxiliary information for the continued improvement of the product.

For trend Analysis, the resolution of the MODIS imagery is not good enough to obtain valid statistics on forest area and forest area change. To obtain statistically valid information at regional, biome and global levels, a sampling approach will be used. This part of the survey will cover the whole land surface of the Earth sampled through a systematic grid with a sample site of 10 x 10 km at each latitude and longitude degree intersection. This results in a sampling intensity of about 1 percent. Freely available Landsat imagery will be used as the primary source for the trend statistics. Efforts will begin by looking at 1990 and 2000, but will try to use the Landsat imagery from 1975 to include information from the mid-decadal dataset. This will provide a 30 year time span to help establish comparable historical rates of deforestation and forest expansion.

Implementation will be done through a framework and a fairly simple classification system will be used for all sites, but with a high degree of flexibility to suit the needs of different countries and regions. Countries are encouraged to actively participate in this initiative so that the interpretation and validation can take full advantage of the local knowledge of national teams. There will be various options for the level of participation according to the interest of the country and the number of the sample units. Support will be provided to countries in terms of pre-processing of the data and through a number of regional training and validation workshops as well

as some financial support for the interpretation work. The data will then be compiled by FAO and analysed at the regional, biome and global levels.

Pre-processing will be carried out by working closely with the EU Joint Research Centre, the South Dakota State University, the Natural Resources Department of FAO and others. All images will be clipped, normalised and made available through the internet. Detailed guidelines and training will be provided for the actual interpretation.

Where countries wish to use the same framework and methodology to establish a national level monitoring system, this will be supported by the FAO programme on support to national Forest Assessments – to the extent that our resources allow.

There are a number of positive spin-offs of this project:
- Capacity building where needed
- Potential Pilot Phase for the establishment of national monitoring systems, where these are not yet in place
- Link with United Nations Framework Convention on Climate Change - in particular the current discussions on a possible mechanism to provide incentives for Reduced Emissions from Deforestation and forest Degradation
- Map overlays and regional applications

Next Steps:
- Finalize preparations for the remote sensing survey
- Secure the remaining funds
- Launch FRA 2010 (3-7 March 2008)
- Hold regional workshops
- 2008-2009: Bulk of work
- 2010: Report preparation

EC Fire Research and Monitoring Programme

Jean Marie Gregiore, Joint Research Council (Presentation 5), presented Space-based observations of fire for park management purposes in West Africa.

There are nearly 100 terrestrial protected areas in 14 countries (from Senegal to Nigeria). Fire management is both a necessity and an issue for a large majority of West African protected areas.

A set of common requirements need to be developed:
- What sort of fire data is available and where? How to access them?
- How to analyse the data and derive information for the park managers?
- How to include an Early Warning component into the controlled fire management process ?

Two regional initiatives for fire monitoring in protected areas of West Africa:
- SUN project (Benin, Burkina, Danemark, Germany, Niger, Senegal, JRC) http://www.sunproject.dk/index.asp
- ACP Observatory for Sust. Dev. (African nations, African Union, EC) http://lunar.jrc.it/AfObs/

Fire is a land management tool and an indicator of environmental dynamics. The fire related information is available as:
- a fire bulletin (pdf & html format)
- a set of shape files

- fire events (weekly synthesis)
- burnt area (~ 2 per month)
- to be downloaded from the JRC FTP site

The next step is to develop a regional partnership for the use of space-based observations of fire for park management in West Africa (and Central Africa); focused on, sharing experience and tools for collecting and analyzing existing fire information, sharing resources for training, and sharing resources and expertise for research and development activities in the region.

AfriFireNet

Alex Held explained the fire early warning activities within AfriFireNet (Presentation 6-not available)

Review of Fire Early Warning Systems and Global Approach

Bill de Groot, a fire scientist with Natural Resources Canada-Canadian Forest Service provided an overview of fire early warning systems, (Presentation 7)

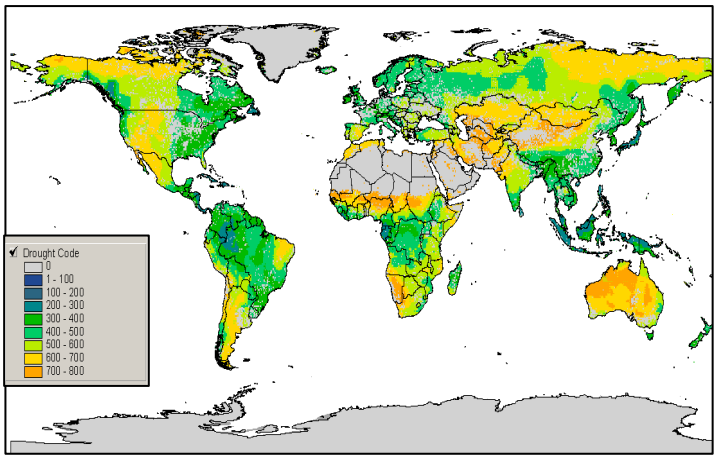
Earth observation data is important to forest and land (or wildland) fire management through fire monitoring and early warning programs. Several hundred million hectares of vegetation burn every year on the global landscape, and many regions have reported increasing trends in fire activity. Wildland fires occur annually in all global vegetation zones and most fire is unmonitored and undocumented. Wildland fires can have many serious negative impacts on human safety, health, regional economies, and global climate change. Many fire-related problems can be avoided, or at least mitigated, if forest and land management agencies (including land owners and communities) are provided with advanced warning of critical periods of extreme fire danger. Early warning allows fire managers to implement fire prevention, detection, and pre-suppression plans before fire problems begin.

The goal of a global early warning system for wildland fire is to provide a scientifically supported, systematic procedure for predicting and assessing international fire danger that can be applied from local to global scales. The system will support existing national fire management programs by providing longer term predictions of fire danger based on advanced numerical weather models, and it will provide a common international metric for implementing international resource sharing agreements during times of fire disaster. It will also provide early warning for countries where national systems do not exist. Because the system can be used at the local level, it can support local capacity-building by providing a foundation for community-based fire management programs.

Early warning of wildland fire is based on fire danger rating, which originates from ground-based weather information and forecast models. Early warning is enhanced with satellite data, such as hot spots for early fire detection, and with spectral data on land cover and fuel conditions. The proposed global early warning system will provide both current and forecasted fire danger information, because both are important for fire management decision-making. For example, current and forecasted fire danger products will use actual and forecasted weather data to calculate component values (Figure 1a). Overlaying current fire danger maps with hot spot data (e.g., AVHRR, MODIS) indicates areas where ongoing fires combine with high fire danger to create the greatest current priority (Figure 1b, 1c). Combining forecasted fire danger maps with hot spot data will indicate critical areas where serious fire problems will occur if current fire activity persists. Such maps of potential future fire threat can be used for advanced planning of suppression resource acquisition and deployment.

Hot spot databases are also very valuable for calibrating early warning products to different global regions. For example, hot spot data has demonstrated robust capacity to calibrate a general fire danger code as a regional indicator of ignition potential in Southeast Asia, which is used to plan daily fire prevention and detection activities. Hot spot data is ideal for calibrating fire danger codes for large-scale early warning purposes because of its frequent global coverage and rapid availability.

a)



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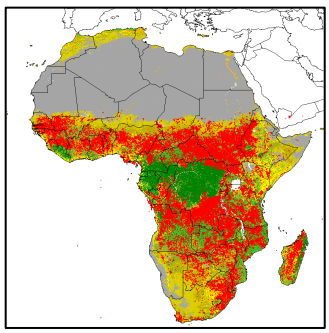

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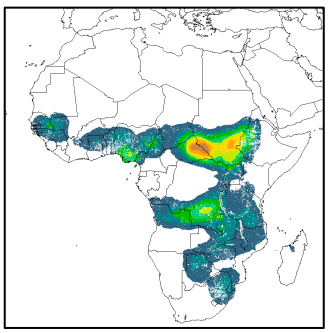


Figure 1. Examples of potential early warning products, including a) global fire danger using the Drought Code (DC) component of the Canadian Forest Fire Weather Index System (van Wagner 1987); b) DC overlaid by hot spot data (red); and c) spatial fire threat as assessed by DC and hot spot density.

2. OVERVIEW OF CURRENT AFRICAN FIRE PROGRAMMES

Six presenters provided an overview of current African national and regional fire programs and early warning systems.

Fire monitoring in West Africa

Cheikh Mbow of UCAD, Senegal described the (Presentation 8) opportunities for fire monitoring in West Africa.

In Senegal, the Centre for Ecological Monitoring uses "NOAA" for daily monitoring. This monitoring is done on an ongoing basis and has not been used extensively. The essence is for future purposes.

There are several methods used for validation. The MODIS data, which has a higher resolution, is compared with ground data and Landsat data, then passed on to institutions. Product development for an integrated fire base is a mandate for the Centre for Ecological Monitoring and UCAD. An integrated approach depends largely on the sector Minister. The Ecological Monitoring Committee has been developing monitoring systems since 1982. More sophisticated methods were employed as backups to meet data gaps.

At the local level, committees for combating fire are in place with community representatives. Fire breaks of about 3 -15km wide are made to prevent fire from spreading. The committee is in charge of fire outbreaks, and is equipped to handle outbreaks. There are about 6000 committees actively in place and about 400 are formed each year.

Plans are in place to determine the economic loss of fire in Senegal.

Data Sources:
- MODIS: 250 m (A/T, 2)
- NOAA-18: 1 km (1)
- MSG: 3 km (15')

Active fires and fire scars are detected with MODIS fire products. The imager channel 3b supports the fire detection community.

MSG-SEVIRI (LERG) :
- 12-channel imager,
- observes the full disk of the Earth
- 15 minute repeat cycle in 12 spectral wavelength regions or channels
- 3 km resolution

Spinning enhanced visible and infrared imager (SEVIRI):
- Visible band centred on 0.6μm Visible band centred on 0.8μm
- Near-infrared band centred on 1.6μm -
- Infrared band centred on 3.9μm –

SEVIRI Channels (IR3.9 μm):
- Emissivity more variable near 3.9 μm
- Sandy areas appear 5-10 K cooler at IR3.9 than at IR10.8 (at night, dry atmosphere)
- Different appearance of land surfaces during daytime, depending on surface type

During the night, channel 04 has only the emitted thermal contribution. There is very strong reflection of solar radiation at 3.9 μm. This cause's sun glint to be very bright in the 3.9 μm imagery and, at low solar angles, the sensor (and thus the image) becomes saturated. This could be applied to wind speed and direction, oil spills and other.

Interpretation of pixel values:
- Burn date (2 bytes) - Approximate Julian day of burning from eight days before the beginning of the month to eight days after the end of the month, or a code indicating unburned areas, snow, water, or lack of data.
  - 0 - unburned
  - 1-366 - approximate Julian day of burning
  - 900 - snow
  - 9998 - water bodies (seas and oceans)
  - 9999 - water bodies (internal)
  - 10000 - not enough data to perform inversion throughout the period

Gaps and bridges:
- Fire scar products for impact studies
- Development of the use of existing fire products at national levels: regional initiative on capacity building
- Bring the fire monitoring technology at National Forest commissions with direct 'operational' applications
- Data are free but, need of basic investment (internet, EUMCAST, receiving antenna HOTBIRD, Servers-FTP, etc.)
- Good products are generated in other places, but are not accessible (e.g. MSG Fire from Spain)

New developments (LERG):
- A distributed model for assessment of fire prone areas (Under progress)

Conclusion :
- Various data exist: but validation and scale of the data may not be suitable for fire management
- Use of data to orient decision making (which format?)
- Need for training to make models operational
- Existing data must be made accessible (hub, web, pipelines)

Activities of SAFNet

Mduduzi Gamedze, Swaziland SAFNet National Committee member, provided an overview of current African National and Regional Fire Programmes and Early Warning Systems (Presentation 9).

A Major contribution of GOFC-GOLD in data access and capacity building in SAFNet was the validation of MODIS Fire products in different land use and landscape system forms. The validation work was conducted from 2000-2004 in:
- Malawi: Forestry Reserve
- Namibia: Etosha National Park and communal land uses
- Botswana: Game Reserve and communal areas
- Zimbabwe: Forest and communal land uses
- Mozambique: Forest Reserve
- South Africa: Krugar National Park and communal land uses – Trans-boundary wildlife management

The programme had a strong in-built training component, and was focused on increasing access and use of satellite data and integrating satellite information with field observations.

Currently SAFNet (2006 meeting) is focused on these areas, which include science themes:
- Fire Management for
    - Community Based Fire Management
    - Operational fire management
- Institutional/policy issues of fire
- National to Regional Fire monitoring
- Satellite-based fire Information products
- Capacity building and training

Progress on Programmes:
- The 7th SAFNet Meeting in 2008 will serve as a forum for:
    - Reporting back on progress made
    - Discussing challenges and constraints
    - Determining the way forward
- Review of SAFNet activities over the past 5-years

SAFNet Fire Early Warning System is aimed at providing information needed to alert people on the risk of fire, or the event of a fire. The system ensures that channels of communication are in place to alert relevant people of this information, and that the community has the capacity to act on this information.

Fire Information for Resource Management System integrates remote sensing and GIS technology. The system is used to deliver MODIS hotspot/fire locations through: email, cell phone text messages, and interactive WebGIS. The advanced Fire Information System (AFIS) is a satellite based FDI, which uses:
- MSG, MODIS, SRTM, Landsat
- AFIS II is planned to cover Southern Africa
- AFIS and Fire Weather Index (FWI)
    - Developed by CSIR and Still at infancy stage
    - FW Index to provide alerts to dangerous atmospheric conditions which might result in disastrous fires
- Media Fire Warning Coverage
    - South African Broadcasting Corporation in June 2006 decided to broadcast MODIS active fire maps as a part of weather reports
- An Operational Fire Information System for Botswana
    - Fire information, fire prevention and fire suppression/operation

Early warning systems were seen to function at four time scales:

Time scale	Primary Information needed	Secondary information needed	Reasons
Seasonal	Fire season	Long term weather forecasts (SARCOF, FUSENET is it not FEWSNET)	Fire fighting teams must be prepared during the fire season. Seasonal weather forecasts allow managers to decide whether to suppress burns or not (preserve grazing).

2 weeks future	Fire Danger Index		So that it is possible to mobilize scarce fire-fighting resources to the areas that are at risk
Daily	Fire Danger Index		So that land owners know whether it is safe to burn and fire fighters can be prepared.
Sub-daily	MODIS active fire detection product	FDI, location of sensitive areas	So that potentially dangerous fires can be controlled quickly and effectively.

FDI requires predicted:
- Relative Humidity
- Maximum daily temperature
- Wind speed and direction
- Precipitation

Fire Sensitive areas, where it would be important to reduce fire risk:
- Plantations
- National Parks
- Wetlands
- Utilities
- Residential areas
- Forest reserves
- Fire-sensitive vegetation (e.g. fynbos)

Is the necessary information available to all countries?
- AWS quite rare in the Sub-Continent
- All countries have weather forecasting systems
- Different countries use different algorithms to calculate FDI
- The MODIS active fire product is easily available
- SARCOF and FUSENET information is easily accessible

Channels of communication are poorly developed in the region. Efforts should be made to learn from the experiences in Mozambique regarding flood risks and flood early warning systems. Put the decision making and action in the hands of the affected people in the affected areas (fire alert simulations).

Wildfire Management Project in the Transitional Zone of Ghana

Oheneba Agyemang, Resource Management Support Centre – Kumasi-Ghana, provided an overview of a Wildfire Management Project in the Transitional Zone of Ghana (Presentation 10).

Before 1983, wildfires were not a problem in the high forest zone of Ghana. The long drought that occurred in 1982/83 culminated in serious wildfires, which burnt almost all vegetation in Forest Reserves and Farmlands. After 1983, the vegetation of Ghana became more prone to wildfires, and wildfires have become an annual affair. Wildfires have resulted in a loss of: natural resources, revenue, property, lives and famine.

The goal of the Wildfire Management Project is to rehabilitate fire degraded forest in the transitional zone and to recover economic, social and environmental benefits. The purpose of the project is to involve local communities to implement effective methods of preventing and controlling wildfires in the semi-deciduous forest type (Transition Zone).

Components include:
- Implementation of public awareness, knowledge and warning systems for fire risks and hazards.
- Understanding the role of fire in traditional farming systems and developing improved ones.
- Establishment of sustainable incentives for reduction of fire incidence.
- Establishment of firebreaks and fuel treatment.
- Implementation of effective fire detection and communication systems.
- Increasing capacity for interagency support and active fire suppression in forest fringe communities.

The project period is ten years and it is being implemented in three phases. The two year initiation phase commenced in March 2002 ended in March 2004. The project is in the second phase, which is a four year acceleration phase. The third phase will be a four year institutionalization phase.

The following forest reserves were selected for the first (initiation) phase:
- Brong Ahafo Region: Mpameso (Dormaa District) and Bosomkese (Bechem District) in
- Ashanti Region: Afram Headwaters and Mankrang (all in Offinso District) Bandai Hills (Juaso District) and Bomfobiri Wildlife Sanctuary (Kumawu)
- Eastern Region: Worobong South -Kwahu and Akim Portions (Mpraeso and Begoro)

In the Second phase, the following reserves have been added:
- Brong Ahafo: Apirapi in Bechem District, Bosomoa in Kintampo District and Digya National Park in Atebubu District
- Ashanti Region: Anumso North and South in Kumawu District, Asufu East and West, Afrensu Brohuma in Offinso District and Pompo in Bekwai District
- Eastern Region: Volta blocks 1&2 Forest Reserves. Afram plains.
- Volta region: Nkwanta area.

The project is supported by financial contribution of the Royal Netherlands Government and the Government of Ghana. The Forestry Commission is the implementing agency and collaborators include:
- Ministry of Lands and Forestry (MLF)
- Ministry of Food and Agriculture (MOFA)
- Ministry of Environment and Science
- Ministry of Local Government and Rural Development (MLGRD)
- Environmental Protection Agency (EPA)
- Meteorological Services Department
- Resource Management Support Centre (RMSC)
- Information Services Department
- Forestry Research Institute of Ghana (FORIG)
- The College of Renewable Natural Resources (CRNR)
- Institute of Renewable Natural Resources (IRNR)
- Ghana National Fire Service
- Fire Volunteer Squads (FVS)
- District Assemblies (DA)
- Ghana Air Force (GAF)
- Traditional Councils

Responsibility of collaborators:
- MOFA – Research into fire and farming systems, extension services
- DA – Legislation and local policy making
- FORIG – Research into fire management
- GTA and GTMO – Fire suppression resources
- EPA – Environmental Guidelines, monitoring and evaluation
- GNFS - FVS training, FSD & WD territorial staff support
- GAF – Aerial fire monitoring and suppression resources
- CRNR – Training and education

Update of achievement:

Output 1	Wildfire Prevention Education Package has been developed for dissemination in communities, second cycle institutions and the wider public. Wildfire management Policy has been developed.
Output 2	Appropriate Fire use in farming systems being developed.
Output 3	Sustainable incentive scheme for forest fringe communities developed.
Output 4	70% of external boundaries of all pilot reserves have been covered by green fire break.
Output 5	Appropriate wildfire detection and communication system developed.
Output 6	Regional interagency groups for management of wildfire issues have been established in pilot regions. Plans are far advanced to establish District and Community groups as well. Representatives of all forest fringe communities in and around pilot reserves have been trained in fire suppression. Fire Volunteer Squad concept has been institutionalised in these communities.

Fire-Weather Network in the Transitional Zone of Ghana

V. Antwi of the Ghana Meteorological Service explained the fire-weather network in the transitional zone in Ghana (Presentation 11).

Fire-weather network is used to assess risk or the likelihood of bushfire event occurring. This happens during the dry season (December-March). The indicators of dry season are cloudless sky, poor visibility during the day, increase rate of fall of leaves, drying up of streams, vegetation turning brown etc. The risk assessment can be done by measuring meteorological parameters such as rainfall, temperature, relative humidity and wind speed and direction.

Ten sites near close to forest reserves have been selected for the setting up of meteorological stations to monitor environmental conditions during the dry season.

Equipment used:
- Standard instruments for the manned stations – Rain gauge, maximum and minimum thermometers, ordinary thermometers, anemometers and wind vanes and psychrometers.
- Automatic stations with the above sensors
- Calibration necessary
- Remote sensing, Geostationary (Meteo New Generations), Orbital (NOAA/MODIS)

Communication Network:

- Transmission of data (manned stations) by radio telephone (HF Single size band) and text messages (mobile phone)
- Transmission of data from automatic stations via satellite

Training:
- Technical staff to take care of the stations
- Meteorologist to forecast fire-weather risk

Wildfire Management in Ghana

A. B. Gaizie of the Ghana Fire Service (GNFS) explained the agency's involvement in wildfire management in Ghana, including strategies and the way forward (Presentation 12).

Ghana recorded an unprecedented increase in bushfires in 1983. The drought caused severe economic losses, which compelled the Government to enact several laws; including, the Prevention and Control of Bushfire Law 229 in 1990. The law mandated the local government structures to form an Anti-Bush Fire Committee and mandates the GNFS to form and train community fire volunteers throughout the country. A department, Rural Fire Directorate (RFD), was created for the implementation of policies on Bushfire in Ghana with support and collaboration from Stakeholders. Since 1983, 85 000 Ghanaian volunteers have been trained.

The main objective of the RFD is to improve prevention and suppression of Bushfires to reduce hazardous fuels. Fuel reduction is the major avenue of influencing fire behaviour and reducing the severity of bushfires.

The RFD of the GNFS Headquarters is currently headed by a Deputy Chief Fire Officer, with ten Regional Co-ordinators, and is further supported by District Co-ordinators.

The GNFS is responsible for strategically planning for the launch of Annual Bushfire Campaigns at National, Regional and District levels. Planning is done in close collaboration with stakeholders; including: the Forestry Commission, National Disaster Management Organization (NADMO), Ghana Meteorological Agency, Environmental Protection Agency, and the Food and Agriculture Ministry.

Community members and various partner agencies are involved and educated to understand, prevent and reduce the risk of bushfires, since these strategies require some basic or fundamental technical know-how.

The Directorate conducts membership drives at the community level and train citizens on Bushfire Prevention and Control techniques. Membership in the Community Fire Volunteer Squad is open to all citizens who are not below six years of age. There are two levels of participation: Fire Volunteers Club for the ages 6-17 years and Fire Volunteer Association for 18 years and above. A code of conduct has been designed for the two Fire Volunteer Groups to encourage compliance with the ethics, principles and conditions enshrined in the Code of Practice/Conduct book (National Bushfire Volunteer Association). A training curriculum has been designed for an eight-week intensive course. Training is followed by interviews and assessment prior to passing out community fire volunteer memberships.

Training involves the following:
- Prescribed burning/creating fire belts
- Fire behaviour
- Techniques/tactics for bushfire suppression (eg. Fuel breaks, vegetation management)
- Fire safety

- First aid
- Command and control
- Strategies for community fire education (eg. Community protection zones for vetting)
- Fire laws/policies
- Risk assessment/hazard mapping
- Community leadership
- Foot drills (Physical/regimental exercises)

The absence of comprehensive and corroborated effort at the local government structure levels are major failures of bushfire planning, prevention, protection and mitigation. The inability to develop a comprehensive local incentive/welfare package/support for Fire Volunteers poses a major set-back in achieving social and economic dependency considering poverty levels in Africa.

The way forward:
- The GNFS will, in collaboration with stakeholders, develop a Bushfire Risk Assessment and Mitigation Plan
- GNFS, in collaboration with NADMO and UNDP, are developing National Wilfire Hazard Mapping Scheme
- Comprehensive data on the Fire Volunteers in the country will be added to the database
- GNFS, in collaboration with METEO AGENCY, will develop Early Warning System based on:
    - Ecological/vegetation management information
    - Ecological community alertness/preparedness
    - Emergency response plan

Awards and incentives have been a major challenge, as far as volunteer membership sustainability is concerned. The various local government structures are being tasked with supporting the scheme. Community award schemes are to be introduced to assist volunteer groups in the communities. Mechanisms have been worked out to introduce free insurance schemes for fire volunteers. A health insurance scheme for fire volunteers is also been considered. Corporate institutions have also been lobbied to provide basic logistical support to volunteer groups. Selected communities in various regions are awarded at Annual National Anti-Bush Fire Campaign launching ceremonies. Stakeholders have been supportive.

The national anti-bushfire planning committee is multi-sectoral and multi-functional. The committee has identified that until recently, bushfires have been given low importance relative to other hazards. Hazards have been treated on a case to case, or project by project basis, instead of a holistic national approach. Although there may be some policies or laws on bushfire prevention and control, there is the need to urge for increased legislative attention and funding for bush fire mitigation planning.

South Africa Based Working on Fire Organization

Chris DeBruno-Austin presented a video of the South Africa based Working on Fire organization.

3. WILDLAND FIRE IN AFRICA

Two discussion sessions were held to identify similarities and differences in the following areas of wildland fire across Africa, 1) the African fire environment and 2) African fire management policy and programmes.

The African Fire Environment

Three break out groups discussed and synthesized aspects and key questions about the wildland fire environment across Africa.

a) People, culture and fire

- What are the major causes of fires?
- Why/how do people use fire? eg, Cooking, heat, pastoralism, land clearing?
- Do fires often get out of control? How large do they become?
- Is uncontrolled fire a problem? Why? What does it threaten?
- How can you reduce human fire problems?

Anja A. Hoffmann discussed community participation in integrated forest fire management: some experiences from Africa and Asia (Presentation 13).

Community participation in integrated forest fire management is important as fire is a spatially and temporally disperse phenomenon, which is difficult to control centrally. The responsibility for control must be brought closer to those who benefit both from the use of fire and from efficient prevention and control of wildfires. The objective of community participation in forest fire management is to ensure: rational, ecologically compatible, sustainable and safe use of fire. With few exceptions, no plans are being made for the complete cessation of fire use.

Currently there are difficulties arising from the definition of responsibility ("the community"). There is a need for complementary policy and legislative change. Communities need definitions and the supply of technical and other support to enable them to assume a central role in fire management. Definitions of mechanisms, methods or policies are needed to encourage communities to assume control.

The Global Fire Monitoring Centre provides support for the development of national integrated Forest Fire Management programmes starting from local to national "Round Tables on Fire Management". This effort has been done in cooperation with the German agency for Technical Cooperation (GTZ) and other international partners.

Examples of:

- The Namibia-Finland Forestry Programme (NFFP), supported by the GFMC, convened the "National Round Table on Fire Management" in 1999 in response to the escalating fire situation.
- Ethiopia – After the successful international response to assist Ethiopia in handling the fire emergency between February and April 2000, the government, supported by the GTZ and the GFMC, called for the "Ethiopia Round Table on Fire Management" and developed a strategic fire management plan (September 2000).
- In Mongolia a sociological study was carried out to investigate the underlying causes of increased occurrence of wildfires in the steppe and forest ecosystems (GFMC/GTZ).
- In Guatemala a local forum on IFFM was convened in August 2001 to define the community involvement in the lowland rainforests on Petén (GFMC/GTZ). Experience gained from the Guatemala forum was communicated to the national level in 2001 (National Round Table).

In Namibia, support is provided for public relations and extension activities for forest fire prevention within the Government and the training and mobilizing of local communities into fire management units, and fire awareness and public education campaign in schools and local

organizations in the area, involving all stakeholders. This includes the production of written material, posters, bill boards, theatre plays, radio programmes and videos.

In Cote d'Ivoire the National Committee of Forest Protection and Bush Fire Control was formed in 1986. Personnel of the Forest Service fill the positions of the General Secretariat and the Presidency of the National Committee. These bodies coordinate the participation of 14 ministries involved in national programmes. The task of this committee is to raise awareness of the population about the damage caused by fires, the need for fire prevention and techniques for extinguishing fires. On the administrative level, 1500 Village Committees, 57 Local Committees and 32 Regional Committees were created to decentralize the task of fire control.

In South Africa the Ukuvuka Operation Firestop Campaign was developed to bring together representatives of government, private enterprise and the media in an unprecedented partnership, which includes public sector members and private sector sponsorship.

The first key target area was land and plants, where the aim is to control invading alien plants, and rehabilitate fire-damaged areas. The second key target area is assisting communities and individuals to:
- create employment, training and poverty relief for disadvantaged people,
- protect the most vulnerable communities from fire, and
- promote cooperation and social cohesion between communities.

Ukuvuka was followed by "Working on Fire" (WoF), which is focused on:
- involving unemployed and otherwise socially disadvantaged people, especially young people
- capacity building in fire management
- developing public information and education materials
- participatory planning
- identifying participants, planning area and expectations of participants
- identifying zones, changes, contrasts, conditions and physical features in the village environment (Transect walk)
- presenting and analysing information on land use, forests, water and other resources and risk zones (participatory mapping)

A transect walks is a walk taken with villagers during which problems and opportunities related to the physical geography and topography of a community are documented, producing a type of map. Transects help identify risk zones, changes in land use, conditions, and physical features such as soils, vegetation, and water resources in the village, because they establish the villagers as the experts on living conditions in the planning area.

The Integrated Forest Fire Management (IFFM) is a joint Indonesian-German (GTZ/KfW) project in East Kalimantan, 1994-2004. The project is located in Samarinda (headquarters) and District Fire Management Centres, including National Parks.

GIS data for fire risk mapping include:
- Burn scars
- Roads and settlements
- Annual rainfall data
- Vegetation type

b) Fire climate

Anja Hoffmann described the fire climate in Botswana (Presentation 14). She presented the Fire Management efforts of the Department of Forestry and Range Resources in Botswana. In particular she presented the existing Fire Information System using near-real time fire data from Aqua-Terra-MODIS and the determination of fire preparedness levels based on the development of a Fire Danger Index derived from the South African Lowveld Fire Danger Index.

Botswana Country Profile:
- Land-locked country, Nambia, South-Africa, Sambia, Zimbabwe
- 585.370 km2 ~ France, 10 Districts with ~ 1.7 million citizens (Tswana, Kalanga and Basarwa)
- African Savannah biome, grass/woodland
- Subtropical – (Semi) arid climate, hot summers, mild-warm winters, Mean annual rainfall 650 – 250mm.
- ~ 75% is covered by Kalahari desert; World largest inland delta Okvango ~1.700.000 ha
- Major pillars of economy: Diamonds, Beef exporting industry, Tourism
- Overgrazing, desertification, bush encroachment and limited fresh water

c) Vegetation (fuels, ecology) and fire

Ahmed Balogun described the Shifts and Changes in Ecozones of Nigeria over 42 years period (Presentation 15).

The Issues
Fire is a natural and beneficial disturbance of vegetation structure and composition, and in nutrient recycling and distribution. However, substantial uncontrolled burning does occur across Nigeria with destructive consequences. Effective actions to limit these are necessary to protect life and property, as well as to reduce the current burden of emissions on the atmosphere and subsequent adverse effects on the global climate system. A major handicap to fire management in Nigeria is the lack of accurate fire records, detailing the extent of the problem.

An inter-comparison of TRMM/VIRS-based Fire Counts with Observed Fire Occurrence Data over Nigeria was conducted for the Forest Zone and the Sahel Zone in West Africa. There were discrepancies between both VIRS Datasets. The smaller number of fire pixels in the Ji and Stocker dataset may be a consequence of several factors, including:
- Comparatively high (320 K day; 315 K night) minimum 3.75 micron brightness temperatures require for fire pixels. Smaller and/or cooler fire will be missed
- Ji and Stocker employ a single threshold test to eliminate cloud contamination: 10.8 micron brightness temperature must exceed 285 K. This works over oceans but not less effective over land. Giglio et al. use a multi-tiered approach in their fire detection algorithm

Mohamed Elgamri A. Ibrahim explained the use of remote sensing in defining and assessing the wildland fire regime and its impacts on range and forest management in the Sudan (Presentation 16).

Research objectives:
- Help determine and recommend measures to minimize the adverse impacts of wildland fire on the environment of Sudan and particularly in Albaja.
- Use remote sensing in studying the wildland fire regime in the area (extent, recurrence, intensity and seasonality of burns), wildfire mapping, fuel and fire management planning and wildfire impacts assessment.
- Measure the effects of wildfire events on the biodiversity and ecosystems in the area.

- Investigate the causes and incidents of wildland fires.
- Investigate the impacts of the wildland fire on the socio-economic activities.

The hypothesis was that wildland fires are largely extending and have negative impacts on the biodiversity, the ecosystem and the socioeconomic activities of Albaja; and that, existing wildland fire management practices are not protecting the area.

Burned area mapping Methodology:

- No historical data is available for Albaja region to document the wildland fire regime (extent, recurrence, intensity and seasonality of burns). Therefore, this research used a time series of satellite data to generate a historical background of the wildland fire regime. The interpretation of historical fires in the image time series was aided by using the coordinates of wildland fire incidence located using GPS for the fire season of the years 2003, 2004 and 2005.
- Burned areas were detected for the years 2000-2005 based on MODIS surface reflectance image data; this data was downloaded from LP DAAC (Land Processing Distributed Active Archive Centre). To facilitate the analysis, cloud and gap free images were first selected for a region of interest containing Albaja area.
- NDVI was calculated to provide a basis for detecting burned areas; since burning removes vegetation, it also reduces NDVI; this makes it possible to burned vegetation as pixels where NDVI has reduced significantly between dates.
- Then all burned areas detected between each two successive images were summed together to obtain one image containing all burned areas of the year.

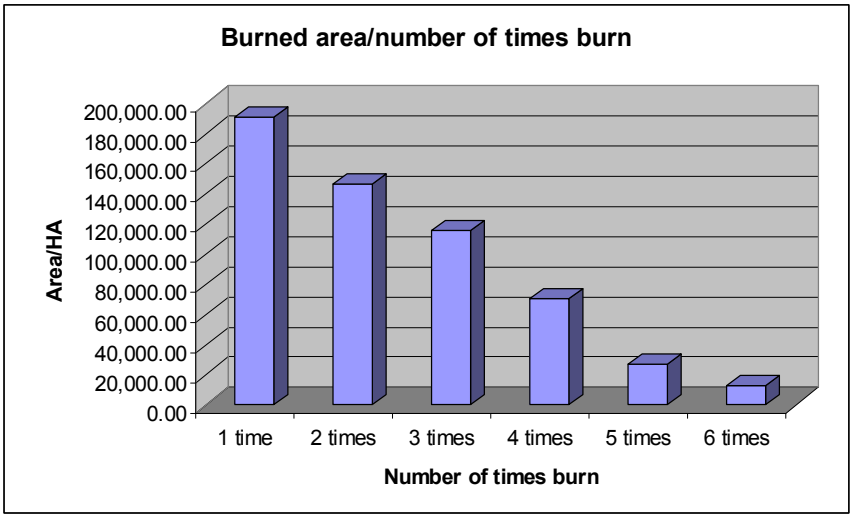
Firebreaks currently built by the Range and Pasture Administration (RPA) in Albaja do not control wildland fire effectively; instead the spread of fire is controlled mainly by the availability of combustible fuel. Due the lack of budget available for firebreak construction, only narrow single strips of 5 m width are built annually. Fires observed by satellite images are irregular in shape because they follow the availability of combustible fuel clearly indicating that the firebreaks built annually in the area are too narrow to control wildland fires.

Fire Season:

Year	Beginning of Fire Season	End of Fire Season
2000	September 30	December 12
2001	September 24	November 3
2002	September 22	December 14
2003	September 21	December 8
2004	September 9	December 5
2005	September 8	December 31

The burning peak is usually in October because the grasses become fully dry and are not yet severely grazed by the animals at that time.

Fire frequency:



Impacts of wildland fire on vegetation:

It is clear from general observation that a very few scattered number of trees exist in the area vulnerable annually to wildland fire and their number increased greatly within agricultural land because it is more protected against fires.

- The tree species found in the area are Acacia raddiana, Balanites aegyptiaca, Ziziphus spina-christi of local names Seyal, Hijlij and Sidir respectively.
- Neither Hijlij nor Sidir were found in the 41 sample plots, and Seyal was found in only two plots.

Two species of shrubs were found in Albaja these are: Leptadenia pyrotechnica and Calotropis procera (local name Marakh and Ushar respectively).

- Marakh widely spread over Albaja and found in all 41 sample plots while Ushar restricted in certain areas and found only in 12 sample plots.
- Marakh is not as good for animal as Seyal, but still provide few shade and the animals browse on it.

People living in Albaja report that the Marakh was rare prior to the drought of the early 1980's, and appeared just after drought period finished. During the drought the seed bank diminished, because the viable grasses seeds germinated and dried out before maturity, and no new seeds were produced. After the drought period there was good precipitation; however, there was no seed bank available to develop grasses in the area, thus there were no wildland fires for a period of three to four years without wildland fire in Albaja, which allowed the establishment of Marakh in the area.

Perhaps existing Marakh seeds germinated and seedling were able to survive during the drought period, or new seeds were brought to the area by animals from the south where Marakh exists abundantly.

Grasses and herbs:

- Many species of grasses and herbs are found during the sampling survey
- The following table shows average vegetation cover and frequency of each species

Umm Assabi is a very good fodder for animals and the local people prefer it because it contains grains of high nutritional value to their animals and also it can be eaten by the people especially during the period of famine. It is clear from the above charts that the vegetation cover, frequency and the dominancy of Umm Assabi are reduced with increased fire frequency.

Gaw usual get the highest value of vegetation cover, frequency and dominancy and these values can increase with fire frequency increase. Gaw has less nutritional value than Umm Assabi, but under the current situation of uncontrolled wildland fire it is dominant in Albaja because it is more fire resistant.

Spatial configuration and quantity of biomass:

- End-of-wet-season standing grass is estimated for 2005 by correlating field measurements of aboveground dry biomass with time-integrated values of vegetation index values derived from MODIS
- Three vegetation indexes are considered for estimating biomass: the Enhanced Vegetation Index (EVI), the Modified Soil Adjusted Vegetation Index 2 (MSAVI2) and the Normalized Difference Vegetation Index (NDVI).
- The NDVI is found to be best predictor of standing biomass (r2=0.69).

Wildland Fire Causes:

Cause	Percent
Careless cooking	80.8
Charcoal production	42.3
Poachers	26.9
Sheep owning nomads	11.5
Camel owning nomads	3.8
Farmers	7.7
Smokers	11.5

Damage Caused by Wildland Fires:

Damage	Percent
Consume Grasses	84.6
Burns domestic animals	61.5
Burns wild animals	38.5
Burns fuel-wood	19.2
Destroys trees	42.3
Dry out lush grasses	11.5
Burns People	3.8
Reduce seed bank	3.8

Conclusions:

- Remote sensing technology can be used to determine the extent, frequency and seasonality of wildland fires.
- Wildland fires occur annually on largely scale at Albaja.
- Fire season will probably begin between the first and third week of September.
- The majority of the area burned usually occurs in October.
- Firebreaks construction generally begins too late in mid October, when wildland fires have already burned large areas.
- Firebreaks are too narrow (5m in width) to help wildland fire management.

- Wildland fires play a large role in causing extinction or extreme reduction in the numbers of some valuable fire sensitive plant species.
- Wildland fires are caused by humans, and not by natural factors.
- Wildland fire damage plays large role in increasing poverty of the local people, and the nomads coming seasonally to Albaja.
- If range lands continue to be squeezed between wildland fires and agriculture encroachment, the future of animal resources will be threatened.

Recommendations:

- As there is no available information on the wildland fire regime in Sudan, further research needed in all areas affected by wildland fires.
- The work on firebreak construction must start at the beginning of September.
- Previous traditional procedures of building firebreaks should be implemented
    - Consist of cleaning two parallel lines (each of 5 m in width and 30 m apart from each other) by burning at the same time early in the dry season, before the grasses are fully dry and consequently less likely to burn, to create wide enough firebreaks
- The effects of agriculture encroachment on range lands must be quantified to prevent potential conflicts between nomads and farmers.

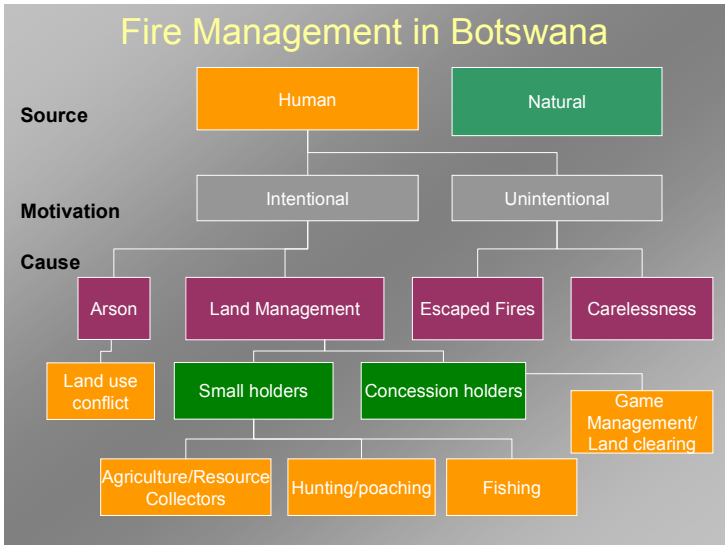
Fire Management Policy and Programmes

Facilitated discussions were held in plenary to characterize and synthesize four aspects of the fire management policy and programmes across Africa.

a) Suppression capacity

Anja Hoffmann described the fire management program in Botswana (Presentation 14).

Fire Management in Botswana:



Fire Management Section Head Quarters:

- Policy/Planning
- Fire Information
    - To compile and analyze fire relevant data for detection, monitoring and assessment

  - To assess the current and predicted fire situation (fire danger) in order to determine readiness levels and identify fire risk areas
  - To provide information necessary to make decisions to districts, political officials, agencies, other land management agencies dealing with fire management
- Fire Prevention
  - To develop Community Based Fire Management concepts through training, awareness campaigns and educational materials that enhance the capacity of villages and related stakeholders to actively participate in fire prevention and suppression activities
  - To construct and assess and maintain the fire breaks
- Fire Operations (Preparedness/suppression)
  - To assist the Districts in developing the physical and institutional capacity to perform rapid initial attack to fires that are identified as "unwanted"
  - To develop the organizational capacity and coordination mechanisms to mobilize and manage fire suppression actions on large fire events
  - To develop prescribed burning programs and carry them out

Community Based Fire Management (CBFiM):
- Create sensitivity, awareness and knowledge about fire and the use of fire to improve natural resources income
- Enable communities to manage fire for their own benefit and minimize the negative impacts of fire
- Enable communities to regulate and enforce on village fire regulations and suppress unwanted fires through village fire crews

Fire Information System (FIS):
- Regular Fire event maps based on near-real time satellite data
- Burnt area mapping
- Fire Danger Rating based on weather data
- Baseline data for fire statistics
- Daily active fire data (MODIS and EUMETSAT)
- Web Fire Mapper MODIS and DFRR have set up a web page for Botswana showing active fires for the last 48 hours online. The page is hosted at the following address;
  - http://maps.geog.umd.edu/activefire_html/checkboxes/botswana_checkbox.htm
- Web Fire Mapper provides fire email alert service to its subscribers. Individuals can subscribe in order to receive daily fire emails alerts. http://dev.geog.umd.edu/alerts/alerts
- Near Real time Satellite image with 250m ground resolution for burned area measurements

Determination of Readiness Levels following Fire Danger based on weather data:
- Using the Lowveld Index from South Africa
- Weather data/FDI export sheet for DFRR

Fire Danger Rating – Weather data Processing
- Department of Forestry & Range Resources
  - Establishment of work relationships and facilitation of cooperation between the involved parties
  - Testing and running the FDR prototype, developing prevention messages
  - Integration into GIS for visualisation
- Department of Meteorological Services
  - Provision of daily weather data and data entry in web based mask (airport unit)
  - Provision of WMO GTS data at DMS HQ

- South Africa – Winston Trollope and Canadian Forest Service – Fire Science Department
    - Provision of FDI equation
    - Development of a Perl Decoder to decode WMO weather data automatically
- Department of IT
    - Development of web-based entry mask for weather data
    - Further development of a Perl decoder for GTS automated weather data

b) Active public programs

Badanga Ahmed Lamidi Fire Disaster Prevention and Safety Awareness Association of Nigeria described the human constraints to designing of effective fire early warning system in Africa (Presentation 17).

A recent survey was conducted by an NGO to assess the level of activities on early warning system in Africa. The survey results emphasized that; although, the concept of an early warning system is not new is Africa, much work must be done in to develop a system.

The survey indicated some fundamental factors that may prevent an effective fire early warning system to be designed for Africa, these include:

- Lack of resources and capacity
- Absence of skill, due to the current low level of science and technological knowledge
- Lack of an integrated community plan for effective adaptations of EWS tools for local usage
- Lack of standardized channels of information dissemination and communication on early warning system
- Poverty
- High level of illiteracy

Lack of resources and capacity building; for example, this workshop brings stakeholders together to examine the gaps in early warning system in Africa and how to improve on them with the primary aim of developing capacity that will assist to institutionalize the concept of early warning system in Africa, especially in the area of fire. Following this Workshop, are there the resources and capacity to build upon this initiative by organizing similar workshops periodically to follow up on what has been learnt, improve on them to meet future challenges without depending on internationally generated fund is a question that we all need to critically examine?

In most parts of Africa, there is an absence of the required skills, as a result of the present low level of science and technology. A lot has been done in terms of developing the tools to help improve early warning systems, which are scientifically based tools using satellite, GIS, NASA, geostationonary systems, remote sensing, and fire danger rating science. The question is, to what extent is Africa prepared to effectively manipulate this science to meet challenges on early warning systems, particularly in regard to fire?

Currently there is no integrated community plan for effective adaptation of EWS tools for local use. Several EWS tools have been developed or are in development. The question is, does Africa have an integrated community plan to effectively adapt these tools for local use, as these tools are meant to solve problems in communities?

A standardized channel of information dissemination and communication on early warning system is needed. It is not enough to gather information, as target groups must be educated. The question is what facilities or current structures are available in Africa to disseminate information on early warning systems to meet the needs of the communities?

Poverty will limit the level of implementation on an Early Warning System. Poverty is a fundamental problem, which will hamper the effective use of these ideas especially in Africa.

Most of the tools being developed; such as, risk and vulnerability assessment, or data generated from GIS, are either in French or English. These tools will depend on intermediaries to be able to interpret and effectively communicate with local people in their various dialects. The question is, what are the present mechanisms to tackle this gap, as it relates to fire early warning system in Africa?

Recommendations:
- Develop a long term action plan on fire Early Warning System based on the existing culture and capability of technical agencies, in various regions and countries.
- Create a platform to promote political commitment to stimulate policy action and implementation on fire Early Warning System.
- Define rules and responsibility among stakeholders clearly.
- Advocate for international support and cooperation on fire early warning systems for Africa.
- Develop strategies to make fire early warning a National policy among countries in Africa.
- Enable wider participation from local communities.
- Develop a checklist to identify weak points, and how to improve on them, on the existing early warning system in Africa.
- Provide education on fire early warning systems, and promote among the local communities.
- Develop a proper channel for information technology to further enhance dissemination of information, especially to local communities.

Ahmed Balogun of the Department of Meteorology at the Federal University of Technology, Akure (FUTA), Nigeria, presented a report on wildfire inventory: Development of a National Wildland Fire Inventory and Fire Management Action Plan for Nigeria (Presentation 18).

Fire is a natural and beneficial disturbance of vegetation structure and composition, and in nutrient recycling and distribution. However, substantial uncontrolled burning does occur across Nigeria with destructive consequences. Effective actions to limit these are necessary to protect life and property, as well as to reduce the current burden of emissions on the atmosphere and subsequent adverse effects on the global climate system. A major handicap to fire management in Nigeria is the lack of accurate fire records, detailing the extent of the problem. The Summary of Global Vegetation Fire Inventory (November 2002) for example, contains no data for a majority of African countries, including Nigeria.

The aims of this project were to develop a functional national wildland fire inventory system, design a national wildland fire management action plan, identify the barriers to effective fire risk reduction strategies, and also sensitize stakeholders and decision-makers on the need for detailed and accurate fire records to effectively understand fire problems and to develop appropriate strategies for a sustainable wild fire control and risk reduction in Nigeria.

The study was implemented in 21 of the 36 states of Nigeria and the Federal capital, Abuja. State and Federal Departments of Forestry, Game Reserves, National Wildlife Parks, Local Government Headquarters and State Fire Services were surveyed and data collected on fire records/documentation, regulations concerning control and management, facilities and methods used in fire control and management, and the socio-economic and institutional barriers to the adoption of effective fire disaster and risk reduction strategies in Nigeria.

Key Findings:
- Accurate fire data detailing the extent of fire problems (i.e. What is burning? How often is it burning? What are the causes of burning, and the impacts or benefits) are presently not available in Nigeria.
- There is lack of an integrated structure for the documentation and management of fires in the country, as policy makers perceive fires as localized dispersed small events that are not sufficiently important to warrant national concern.
- A low-cost and simple fire inventory scheme is now proposed as a first step towards addressing the fire management problems in Nigeria.
- Adequate facilities for the monitoring, prevention, suppression and control of fires are lacking in both federal and state government protected forest reserves and wildlife parks, and the available ones are either broken down or obsolete.
- Inadequate staff, fire experts, regular training and a lack of community participation in the management and utilization of forest resources make it hard to plan and implement mitigation measures.
- Inadequate government funding to responsible agencies, limited budgets for mitigation, and bureaucratic barriers impede fire risk reduction.

Recommendations for communities, forest reserves and wildlife parks:
- Start by planning and implementing the proposed low-cost and simple fire inventory scheme.
- Develop emergency plans for communities, reserve and park staff, with training for all in fire safety and management procedures.
- Establish community forestry projects and collaborations on community participation in forest resource management.

Recommendations for policy-makers:
- Streamline the approval and implementation process for the proposed integrated structure for the documentation of fires in the country.
- Allocate more funding to responsible agencies for fire mitigation work, including recruitment and training of staff, equipment and materials for implementation.
- Enact policies that encourage and promote community participation in forest resource management.

Recommendations for conservationists and researchers:
- Sensitize the major stakeholders on the need for and benefits of establishing a national fire inventory.
- Form interdisciplinary collaboration to create educational materials and training programs on the effective use of fire to meet subsistence needs.
- Develop guidelines on fire risk reduction strategies, safety and management procedures.
- Research mitigation measures to evaluate their efficiencies.

c) Information networks

Ahmed Balogun presented Wildfire Inventory: A First Step Towards Mitigating the Effects of Wilfire Disasters and Assessing the Efficiency of Fire Early Warning Systems in Nigeria (Presentation 15).

Fire early warning, detection and monitoring

Presently there are no operational fire early warning, detection and monitoring systems in Nigeria. However, Balogun et al., 2004 proposed a simple scheme that may be used as an early warning scheme, using meteorological parameter (air temperature, humidity, rainfall and wind).

The recent launch of the Nigeria Sat-1 into orbit on 27th September 2003 may encourage government to establish an agency devoted to early warning, detection and monitoring of fires using remote sensing; the Nigerian satellite is a component of the Disaster Monitoring Constellation (DMC) incorporating Britain, Algeria, China and Thailand. The satellite among others is expected to monitor water resources, soil erosion, forest fires, deforestation and desertification and environmental disasters.

Wildfire Inventory-Nigeria

The aim is to propose a low cost scheme for a functional national forest fire inventory system in Nigeria. The barriers to effective fire risk reduction strategies must be identified. The stakeholders and decision-makers must be informed on the need for detailed and accurate fire records to effectively understand fire problems. Appropriate strategies for a sustainable wild fire control and risk reduction in Nigeria must be developed.

Fire has been a useful human tool for millennia, but it also causes grave economic losses and intolerable harm to the environment. Paradoxically, despite the development of advanced techniques, particularly in fire detection and suppression, the incidence of ecosystem damage from forest fire appears to be increasing in most regions of the world, Troensegaard (1990). The Summary of Global Vegetation Fire Inventory (November 2002) for example, contains no data for a majority of African countries, including Nigeria.

The realization of the dearth of fire data in Nigeria motivated the study to develop a national wild land fire inventory and fire disaster management action plan for Nigeria (Balogun et al., 2004; and Balogun, 2007); where a national fire inventory scheme was proposed and recommendations made towards achieving more effective monitoring and fire management planning through the use of currently available remotely sensed satellite products (Balogun, 2004). The study, funded by the Prevention consortium was conducted under the umbrella of the AfriFireNet, the regional arm of the Global Fire Monitoring Centre (GFMC), Freiburg, Germany in Africa.

The study was implemented in 21 of the 36 states of Nigeria and the Federal capital, Abuja. State and Federal Departments of Forestry, Game Reserves, National Wildlife Parks, Local Government Headquarters and State Fire Services were surveyed and data was collected on fire records/documentation, regulations concerning control and management, facilities, and methods used in fire control and management. The socio-economic and institutional barriers to the adoption of effective fire disaster and risk reduction strategies in Nigeria were also investigated.

The study determined that:

- Accurate fire data detailing the extent of fire problems are not presently available in Nigeria (i.e. What is burning? How often is it burning? What are the causes of burning, and the impacts or benefits)
- There is lack of an integrated structure for the documentation and management of fires in the country, as policy makers perceive fires as localized dispersed small events that are not sufficiently important to warrant national concern.
- A low-cost and simple fire inventory scheme is now proposed as a first step towards addressing the fire management problems in Nigeria.
- Adequate facilities for the monitoring, prevention, suppression and control of fires are lacking in both federal and state government protected forest reserves and wildlife parks, and the available ones are either broken down or obsolete.

- Inadequate staff, fire experts, regular training and a lack of community participation in the management and utilization of forest resources make it hard to plan and implement mitigation measures.
- Inadequate government funding to responsible agencies, limited budgets for mitigation, and bureaucratic barriers impede fire risk reduction.

Conclusions and Recommendations

The study concluded that a simple and low cost fire inventory scheme for Nigeria is required, and barriers to the adoption of effective fire disaster management and risk reduction strategies in Nigeria need to be broken.

Recommendations for communities, forest reserves and wildlife parks:
- Start by planning and implementing the proposed low-cost and simple fire inventory scheme.
- Develop emergency plans for communities, reserve and park staff, with training for all in fire safety and management procedures.
- Establish community forestry projects and collaborations on community participation in wildfire and forest resource management.

Recommendations for policy-makers:
- Streamline the approval and implementation process for the proposed integrated structure for the documentation of fires in the country.
- Allocate more funding to responsible agencies for fire mitigation work, including recruitment and training of staff, equipment and materials for implementation.
- Enact policies that encourage and promote community participation in wildfire and forest resource management. Working with and rewarding communities is a key activity that will yield good results.

Recommendations for NGO's, conservationists and researchers:
- Sensitize the major stakeholders on the need for and benefits of establishing a national fire inventory.
- Form interdisciplinary collaboration to create educational materials and training programs on the effective use of fire to meet subsistence needs.
- Develop guidelines on fire risk reduction strategies, safety and management procedures.
- Research mitigation measures to evaluate their efficiencies.

Towards a regional partnership

Christopher DeBruno Austin described the development of a Fire Danger Rating System For Controlled Burning by *Winston S. W. Trollope* of the Department Livestock & Pasture Science, University Fort Hare, Alice, 5700, South Africa (Table 1).

Table 1: Fire Danger Rating System using Fire Danger Indices (FDI's) as a means for selecting suitable burning conditions for controlled burning. Adapted from the Fire Danger Rating System developed by Johan and Lizette Heine from the Forest Fire Association in Nelspruit, South Africa.

FIRE DANGER STAGES	FDI	FIRE DANGER	FIRE INTENSITY kJ/s/m	CONTROLLED BURNING
BLUE	0-20	LOW	<500	Too cold, humid or wet for controlled burning
GREEN	21-45	MODERATE	500-1000	Suitable for controlled burning to: Remove moribund and/or unpalatable grass material; Construct burnt firebreaks.
YELLOW	46-60	DANGEROUS	1001-2000	Suitable for controlled burning to: Remove moribund and/or unpalatable grass material up to a maximum FDI of 55.
ORANGE	61-75	VERY DANGEROUS	2000-3000	Suitable for controlled burning to: control and/or prevent the encroachment of undesirable plants e.g. bush encroachment.
RED	76-100	EXTREMELY DANGEROUS	>3000	Too dangerous and unsuitable for contolled burning.

d) Fire management programs

David Duodu-Asare, Forestry Commission, Ghana described the wildfire management planning process of the Forestry Commission at Ghana (Presentation 19).

The core responsibility of a wildfire manager is to develop and select the most cost-effective programme to ensure that policies and standards are met in the general wildfire management approaches:

- Fire Prevention
- Fire detection
- Pre-suppression
- Suppression

Planning wildfire management activities is both the organizational process of creating and maintaining a plan, and the psychological process of thinking about the activities required to create a desired future on some scale. This thought process is essential to the creation and refinement of a plan, or integration of it with other plans, that is, it combines forecasting of

developments with the preparation of scenarios of how to react to them. The term planning is also used to describe the formal procedures; such as, the creation of documents, diagrams, or meetings to discuss the important issues to be addressed, the objectives to be met, and the strategy to be followed. Intelligent fire planning involves the collection, maintenance, and analysis of vast quantities of data, much of which are best displayed on maps. Properly done Wildfire management planning is an iterative process requiring annual revision as risk and hazards change and better data are collected.

Collection of Relevant Data:
- Fire occurrence (over the past five years) coded by month, time of day, cause and size class.
- Fire history coded by area burnt, year of fire and intensity class
- Fuel types: Over-storey, under-storey: Special coding for slash areas and plantations
- Land ownership and improvements
- Contour map with watershed delineation with special coding for unstable soils
- Road map coded by width and surface

Environmental data:
- Fuels – historic rates and spread and difficulty of control of fuel types
- Weather – daily weather records for the full period of records from all weather stations
- Climate – long term averages

Economic data:
- Cost and productivity of personnel and equipment by slope, fuel type & weather severity.

Logistical data:
- Fire management personnel – ages, qualifications, training needs, etc.
- Collaborating personnel – agency, qualifications, contact point/person
- Equipment – location, specification, date of last inspection
- Supplies – amount, location, date of acquisition, source of emergency supplies
- Rental & lease agreements

Basic Contents of a wildfire management plan

Once the prerequisite data have been assembled and the planning period (fire season) and planning level (peak load) established, the fire manager is ready to prepare the actual fire plan for the year. The first decision to be made is what period of the year should be planned for intensive fire protection (identification of the fire season). Establishing a planned fire season is critical to fire management planning since the length of season dictates the kind and number of fire forces (work force) that could be reasonably considered in building the fire protection organization.

Fire plans vary widely in length and format depending on the size of fire management organization but each plan should include as a minimum a:
- Description of protection area; including, management objectives, and a brief discussion of the relationship with all neighbouring ownerships
- Statement of fire management goals and policies including an organizational chart and a concept of operation.
- Fuels management plan including expected abatement of active fuels, hazard reduction work, firebreak construction and maintenance etc.
- Fire prevention plan including all specific activities such as inspections and contacts with a timetable for each.

- Detection plan encompassing all detection activities including those of collaborating agencies by fire danger classes.
- Manning plan to govern the placement of personnel and equipment by fire danger classes.
- Initial attack plan to govern initial dispatching of personnel and equipment, including contractors and cooperators, by fire location and the fire danger classes.
- Reinforcement plan - listing procedures for obtaining backup forces if initial attack is, or predicted to be, unsuccessful.

Large fire management organizations will usually have additions or annexes to the basic plan covering such activities as:
- communication
- transportation
- training
- air operation
- fiscal control
- reports
- data management

As wildfire continues to be the most serious single threat to sustainable development of our natural resources, conscious and concerted efforts are required for the effective planning and management of it.

The following fire management activities were identified as being relevant in Africa:
- Training – fire science, fire ecology, technical fire fighting, incident management (ICS), and equipment for fire fighters
- Integrated fire management – fuel load management, awareness, prevention, protection, post-fire rehabilitation
- Prevention – breaks, fuel load reduction, public education (controlled burning, danger of fire), school curriculum (all levels), media (radio, TV, papers), focus group discussions, billboards, leaflets, sensitization (public information at the local level)
- Detection – South Africa – lookout towers, cameras in high value areas, satellite detection, public reporting, radio system in most sensitive areas
- Courses – put fire fighting in holistic forest mgt, culture, socio-economic situation
- Pre-suppression – strategic positioning of fire equipment (near hot spots) [equipment: heavy water trucks, fire tenders with pumps, small equipment]
- Communications – Policy is important to clarify who is responsible for fire, and who provides funding.
- Collaboration – training, suppression, stakeholders forum (discuss how agencies work together – an MOU),

Controlled burning – fire volunteers will help to control burn (done with permit); communities have anti-bushfire committee

4. DESIGNING EARLY WARNING SYSTEMS FOR AFRICA

Discussions focused on the current science and technology, including an example prototype produced for the workshop and identification of EWS product requirements for African fire management (decision-support tools).

Fire Weather, Fire Danger Rating and Early Warning Systems: current science and technology

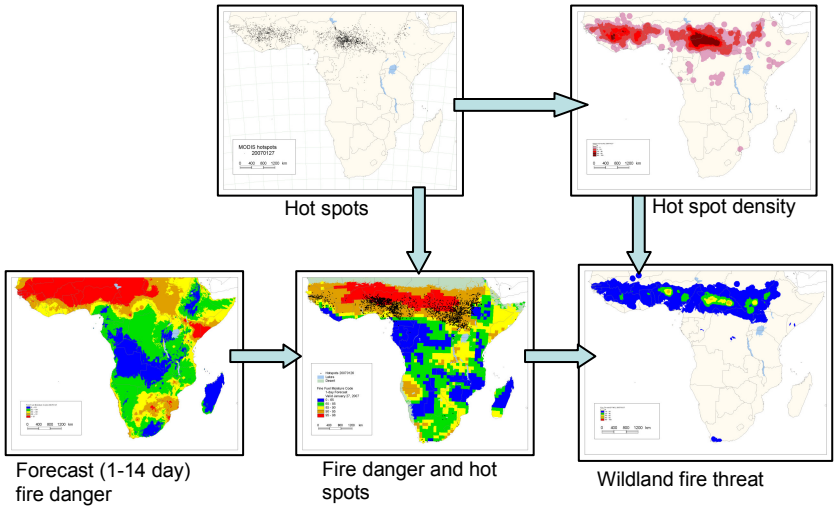
Bill de Groot, Natural Resources Canada-Canadian Forest Service provided an overview of the current science of fire weather and fire danger (Presentation 20), as well as prototype EWS-Fire for Africa.

Examples of Current Fire Danger Rating Systems:
- Mexico – Sistema de Informacion de Incendios Forestale
- EurAsian Fire Danger System
- Florida – ERC-GRID 2000
- Canada - Daily severity rating
- New Zealand Fire Weather
- Forest Fire Danger Index (FFDI), used in Australia to assess the likelihood and severity of bushfires.

Established Infrastructure:
- Existing capacity within WMO network to rapidly collect, model, and distribute early warning information
- Can provide 0-10 day ensemble forecasts of fire danger
- Examples include:
    - Global Telecommunication System (GTS)
    - Global Data-processing and Forecasting Systems (GDPFS)
    - Global Observing System (GOS)

An example of Early Warning System for Wildland Fire in Africa was presented.

EWS-Fire Data Flow and Potential Product:



Product Examples from an Asian Early Warning System

Bill de Groot, Natural Resources Canada-Canadian Forest Service provided an example of developing fire management decision-aid tools and EWS-Fire calibration in Southeast Asia (Presentation 20).

Key Problems that were identified:

- deep burning peat fires (haze)
- large areas of slow-burning fires
- small areas burning with high intensity and fuel consumption
- many different situations can cause haze problems
- grass and slash fires, shifting cultivation (haze, uncontrolled fire)
- need more than one FDRS indicator and decision-aid

The project goal was to develop an Early Warning System for fire by: identifying critical burning periods before they occur, restricting burning to reduce haze and prevent uncontrolled fires, and by promoting fire prevention and suppression preparedness

FDRS Applications for Fire Management Decision-Aids were developed for: prevention, detection, suppression, and preparedness.

Fire Management problem areas were identified: acacia plantations, primary forest, shifting cultivation, logged forests and peatlands, and grasslands. Applications training and workshops were conducted to develop fire management decision-aids.

5. WORKSHOP CONCLUSIONS AND RECOMMENDATIONS

Following is a list of recommendations by the workshop delegates.

1. There is a need to establish regional algorithms for fire danger rating and remote sensing products for West Africa. This should be done as an initial project under the newly formed West Africa Regional Network (WARN) and will be submitted to the WARN secretariat as a proposed activity.
2. Development of the prototype Fire-EWS for Africa will continue based on the workshop results. The system will be comprised of three components: a fire danger rating system, a fire risk assessment, and a fuels assessment. The prototype will operate at the sub-Saharan Africa, and West Africa regional levels.
3. The Canadian Forest Service (CFS) will continue to design the prototype Fire-EWS for Africa. The next step is to complete an operational coarse resolution fire danger rating system (FDRS) for Africa. Similar to the Eurasian FDRS prototype, the Africa FDRS will be operationally run by the Northern Forestry Centre of CFS and posted on the Global Fire Monitoring Centre website.
4. It was proposed to the WARN secretariat to conduct a fire risk assessment for West Africa, as part of the Fire-EWS for West Africa. The WARN secretariat will discuss this proposed activity.
5. It was also proposed that WARN conduct a fuels assessment for West Africa, as part of the Fire-EWS for West Africa. The WARN secretariat will discuss this proposed activity.
6. The prototype Fire-EWS will utilize existing fire management decision-aids from South Africa for fire suppression and prescribed burning. Because grass is the fuel type of greatest concern in Africa (including grassland, savannah, and mixed shrub-grasslands), the Fire-EWS will be run with 3 existing fire danger indices applicable to cured grass: the Fine Fuel Moisture Code (FFMC) of the Canadian Forest Fire Weather Index (FWI) System, the Lowveld Fire Danger Index (FDI) used in several countries of Southern Africa, and the Grassland Fire Danger Index (GFDI) used in Australia. Classification categories (i.e. low, moderate, high, and extreme) for the three fire danger indices will

follow those used by the Lowveld FDI. This will allow initial testing and comparison of the fire danger indices.

7. After the operational Fire-EWS prototype is completed, a review of the current decision-support tools, and potential decision-support tools supporting other fire management activities (ie, prevention, detection, pre-suppression planning) will be done.
8. Funding to develop and eventually operationally run the Fire-EWS for Africa is still an issue. Further funding support will continue to be sought.
9. WARN needs to find a facility to eventually host the operational regional system, but a university association with WARN may be the best option. AFRIFIRENET indicated it would consider hosting the sub-Saharan Fire-EWS, depending on requirements and funding.
10. There is a need to develop a communications plan so early warning information gets to the local community level. Several options were discussed, including GEO netcast. Internet service is not reliable or accessible across Africa, but it is improving.
11. Socialization of the existing EO data and information through setting up an "yahoo user group account (makes exchange and contribution much easier)
12. Existing EO data and fire information such as hotspots, FDRS etc. should be thoroughly introduced and advantages/disadvantages shown through ongoing workshop and network meetings.
13. GIS training should be given to selected technicians in countries's key institutions including but not limited to University members on how to use fire information in the daily routine of fire management.
14. More education and training is needed in the use of fire danger information and its application for fire management activities.
15. Technical application training for the calculation of a given Fire Danger Rating (FDR) System.
16. Enable people to use existing local WMO weather data to calculate FDR and further develop standard perl decoder for decoding WMO weather data.
17. Organization Seminars and training workshops for exchanging knowledge and experiences between the existing African fire (management) networks such as AfriFireNet , SAFNET and WARN.
18. In conjunction with the upcoming SAFNET meeting in Nambia (2008) organize a application training of MODIS data and Fire Danger Rating Calculation.

6. REFERENCES

Mbow, Cheikh, Amadou T. Diaw, Brent Simpson, David Skole, Kjeld Rasmussen 2006. Action Plan for West African Remote Sensing/GIS Network. Draft proposed by LERG (UCAD), Institut des Sciences de l'Environnement, Faculté des Sciences et Techniques, LERG, ESP, UCAD (Sénégal).

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7. APPENDICES

Appendix 1. List of Participants

West Africa national organizations:				
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Other GOFC-GOLD Africa Regional Networks				

19	Swaziland	Gamedze, Mduduzi	SAFNet	gamedze@gmail.com
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22	South Africa	Alexander C. Held	AfriFireNet	alex@wof-int.com
23	Botswana	Hoffmann, Anja	Department of Forestry & Range Resources	aahoffmann@email.de
GOFC-GOLD:				
24	Canada	Michael Brady	CFS	mbrady@nrcan.gc.ca
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International Organizations:				
29	Switzerland	Rum, Giovanni	GEO	grum@geosec.org

Appendix 2. Agenda

Date	From	To	Session	Title of Session	Chair
14/11/2007	14:00	14:40	**Session 1** Workshop Intro.	Workshop Objectives and Program Context	B.de Groot
					Speakers:
				GOFC-GOLD / WMO	M.Brady
				UNISDR, UNU, GFMC	J.Goldammer
				FAO	A.Bassole
				JRC	J.Gregoire
				AFRIFIRENET	A.Held
	14:40	15:20	**Session 2** Background Information	Review of Fire Early Warning Systems and Global Approach	Bill de Groot
	15:20	15:40		Break	
	15:40	17:30		Overview of current African National and Regional Fire Programs and Early Warning Systems	
					Speakers:
				UCAD, Senegal	C.Mbow
				AfriFirenet	A. Held
				SAFNet, Swaziland	M.Gamedze
15/11/2007	9:00	10:20	Ghana Presentations	-Overview of Wildlife Management Project in the Transitional Zone of Ghana (with video)	Oheneba A. Agyemang
				-Fire-Weather Network in Transitional zone in Ghana	V. Antwi
				-G.N.F.S: Involvement in Wildfire Management in Ghana; Strategies and Way Forward.	A. B. Gaizie
	10:20	10:40		Break	
	10:40	11:30	**Session 3** Wildland Fire in Africa	Breakout Groups 1:	Facilitators:
				The African Fire Environment.	A.Hoffman
				(i) people, culture and fire	B.de Groot
				(ii) fire climate	J-M. Gregoire
				(iii) vegetation (fuels, ecology) and fire	
	11:30	12:30		Continuation of Breakout Groups 1:	B.de Groot
				The African Fire Environment	
				Plenary – Breakout Group Reports	
	12:30	14:00		Lunch	

Date	From	To	Session	Title of Session	Chair
	14:00	15:20	**Session 4** Fire Management in Africa	Fire Management Policy and Programs (i) Suppression capacity – resource types, amounts, base locations, mobility, etc. (ii) active public programs – prevention, detection, (iii) information networks – weather and fire data collection, processing, distribution (iv) fire management programs – centralized or de-centralized, resource and information-sharing agreements/opportunities (national, regional, continental)	Facilitators: A.Hoffman B.de Groot J-M. Gregoire A. Held
	15:20	15:40		Break	
	15:40	16:30		Continuation of session 4: **Fire Management Policy and Programs**	B.de Groot
16/11/2007	9:00	9:30	**Session 5** Designing Early Warning Systems for Africa	Fire Weather, Fire Danger Rating and Early Warning Systems: current science and technology	B.de Groot
	9:30	10:00		Product Examples from a Prototype African Early Warning System	B.de Groot
	10:00	10:20		Break	
	10:30	12:30		**EWS Products for African Fire Management (decision-support tools)** − Fire prevention − Fire detection − Fire suppression and preparedness − Prescribed burning	Facilitators: A.Hoffman B.de Groot B.de Groot J.Goldammer
	12:30	14:00		Lunch	
	14:00	15:30	Workshop conclusions	Plenary Discussion: − Implementation options − Next Steps (political, technical, operational) Workshop Report and Recommendations	B.de Groot

Appendix 3. List of Presentations

No.	Title	Author(s)
1	GOFC-GOLD Workshop on Requirements for Fire Early Warning Systems in Africa	B DeGroot
2	GOFC-GOLD-Fire: An International Program for the Coordination of Fire Observations	M. Brady
3	Towards Building a Global Wildland Fire Early Warning System	J. Goldammer
4	The Global Forest Resources Assessment 2010	A. Bassole
5	Space-based observations of fire for park management purposes in West Africa	J.M. Gregoire
7	Developing a Global Early Warning System for Wildland Fire	B. de Groot
8	Opportunities for fire monitoring in West Africa	C. Mbow
9	Overview of current African National and Regional Fire Programmes and Early Warning Systems	M. Gamedze
10	Wildfire Management Project in the Transition Zone of Ghana: Overview	O.A. Agyemang
11	Fire-Weather Network for the Transitional Zone (Ghana)	V. Antwi
12	G.N.F.S Involvement in Wildfire Management in Ghana: Strategies and the Way Forward	A.B. Gaizie
13	Community Participation in Integrated Forest Fire Management: Some Experiences from Africa and Asia	A Hoffmann
14	Fire Management in Botswana	A. Hoffmann
15	Wildfire Inventory: A First Step Towards Mitigating the Effects of Wildfire Disasters and Assessing the Efficiency of Early Warning Systems in Nigeria	Balogun
16	The Use of Remote Sensing in Defining and Assessing the Wildland Fire Regime and its Impacts on Range and	Ibrahim

	Forest Management	
17	Designing fire early warning system for Africa "How do we realize this goal and what are the challenges"?	Badanga
18	Development of a National Wildland Fire Inventory and Fire Management Action Plan for Nigeria	Balogun
19	Wildfire Management Planning	Duodu-Asare
20	Current Science of Fire Weather and Fire Danger	B. DeGroot