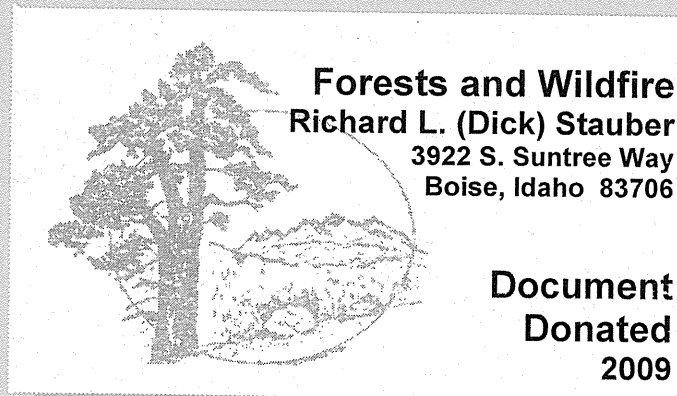


FORESTRY DEVELOPMENT IN SUDAN

**CONSULTANT REPORT ON FOREST FIRE MANAGEMENT
IN THE SUDAN**

by

Richard L. Stauber
Forestry and Wildfire Advisor



FORESTS NATIONAL CORPORATION
AND
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

June/July, 1995

TABLE OF CONTENTS

1.	Executive Summary-----	1
2.	Introduction-----	2
3.	Systematic Fire Protection Planning-----	6
4.	Present Wild Fire Situation-----	11
4.1	Fire Occurrence by Forest and Range Type-----	11
4.2	Statistics-----	12
4.3	Fire Causes-----	14
4.4	Natural Role of Fire in the Environment-----	17
4.5	Ecological Impacts of Wildfire-----	18
4.6	Present Organization & Operation-----	19
4.6.1	FNC-----	19
4.6.2	RPA-----	20
5.	Recommendations for A Systematic Fire Management Program-----	21
5.1	National Level-----	21
5.2	Prevention-----	21
5.3	Detection-----	22
5.4	Presuppression-----	22
5.5	Attack-Fire Suppression-----	23
5.6	Prescribed Fire-----	24
5.7	Cooperation-----	24

1. EXECUTIVE SUMMARY

The Terms of Reference outlined an analysis of the Fire Management Program for the Forests National Corporation (FNC). The Project Area and adjoining lands were highlighted. However, in order to provide helpful advice, the fire programs in the Darfur and Kordofan Sectors were also evaluated. Statistical data was not readily available, but a questionnaire collected sufficient information to evaluate the level of activity and the causes of the fires.

Fire is not a problem in the FNC irrigated forests or those forests located on the banks of the Blue and White Nile. Fire is a concern throughout the rainfed natural forests including the gum arabic zone. Fires reduce the production of gum arabic and kill or damage the trees. Acacia seyal is more fire resistant and replaces A. senegal in fire prone areas.

Fires originating on range and pasture lands are the greatest threat to the environment and to the adjacent Forest Reserves. The information we gathered estimates **the area burned at over 4.7 million Feddans(*) per year**. It may actually be 2 to 5 times higher than this since data was not collected from some states and in other instances only known and recorded fires were reported. Satellite imagery indicates that 55% of the area of the El Radoom National Park burns annually.

The Jebel Marra area is the most challenging fire area. The foresters and the local villagers are experienced and effective fire management people. With training, these people can support the other foresters and range managers in the Sudan. **Forest managers are doing their best without sufficient training and basic fire tools to provide for personal safety.**

Responsibility for fire suppression has been clearly assigned to the FNC for Forest Reserves. Fires set by farmers or nomads burn unchallenged in most of the natural rangelands of Sudan. The rangeland seems to be everyone's property and therefore no one's responsibility. The Range and Pasture Administration (RPA) is only able to build a limited number of firebreaks.

The future of the fire protection of the range and forest lands of the Sudan will require lengthy and persistent interest and leadership. It may take a few decades to put a nationwide Systematic Fire Management Program into operation. Advisors with fire and organizational management skills can assist in evaluating progress and encouraging the Sudanese leadership. The end result must be one that will work in the practical world of the Sudan.

*** One feddan (fd) equals 1.038 acres (ac) or 0.421 hectares (ha).**

Conduct an analysis of the wildfire situation in the project area and adjoining agricultural and range lands to determine:

- a. The magnitude of the problem, including compilation of existing forest fire statistics for the project area and determination of effects of wildfire on forest resources.
- b. Causes of wildfire.
- c. The natural role of fire in the vegetation types of the project area.

Outline an integrated forest fire management programme which, as a minimum, addresses the following components:

- a. Wildfire prevention through increased public awareness.
- b. Fuels management in intensively managed plantations and natural forests.
- c. Presuppression planning activities.
- d. Wildfire suppression.

Provide training in wildfire suppression.

Recommend appropriate fire suppression tools.

Prepare a report including findings and recommendations which should be discussed and cleared with the Government authorities concerned before departure from the country; the consultant will then present the report to FA/HQ including a diskette in WP 5/1 (within one month of leaving the country), and will amend it in the light of comments received.

Duration: One and a half months (June 4 to July 18, 1995)

E.O.D.: June, 1995

Duty Station: Khartoum with local travel

Language: English

Note: Following consultation with Rome, the area of analysis for the forest fire situation was extended to include Darfur and Kordofan. This amendment is documented in an exchange of letters between Mr. Leontiades, Project Manager, Forest Development in the Sudan and Peter R. Post, Counsellor, Royal Netherlands Embassy.

2.4 Acknowledgements

My personal thanks to the many individuals who shared their time and information. Tribe and rural council leaders, FNC and RPA officials and staff at all levels, and particularly the nomad family at the El Rawashda Range were helpful and hospitable.

My visit was officially supported and facilitated by:

- Professor Hassan Osman Abdel Nour, General Manager of the Forests National Corporation
- Mr. El Sadig Yousif, Director of the Range and Pasture Administration, Sudan Ministry of Agriculture, Director of the Range and Pasture Administration.
- Mr. Leontios Leontiades, Chief Technical Adviser of FAO Project, Sudan.

3.2.3 Limited Protection

This designates areas where fire activity is desirable, or resource values do not warrant suppression expenditures. Fires are allowed to burn unimpeded. Terrain with natural barriers such as rock outcrops or lack of natural fuels determines the potential fire perimeter. There may be villages or work sites within the larger "Limited" protection area that will need "Full" or "Critical" protection. This passive fire protection can require monitoring to assure that the natural barriers will not be breached by the fire.

3.2.4 Modified Option

In these areas initial attack on all new fires will occur during the severe burning portion of the fire season. Fires which escape initial attack are evaluated by the suppression organization and the affected land manager to determine the appropriate control strategies. Strategies are employed that consider the trade off in acres burned versus suppression expenditures. The modified option is designed to provide opportunities during the low risk periods of the fire season for fire to complement the objectives of management in maintaining the natural role of fire in the ecosystem.

3.3 Fire Management Implementation Alternatives

The next logical step is to select an appropriate Fire Management Alternative. To simplify the discussion we will assume that all lands under the management authority of FNC are designated for the Full Protection Option. (See 3.2.2 for a definition).

Managers must now decide, probably with the help of budget allocation information, what fire management option to implement. There are computer programs for displaying various budget levels and the resources protected or lost due to changes in the budget level. However, personal judgment and the practical limitations of funding seem sufficient for present day Sudan.

The following assumptions apply to each of the alternatives:

- 1. The responsible agency (RPA, FNC, Rural Council) and the area of responsibility are both known.**
- 2. The fire management responsibility has been assigned organizationally at appropriate levels.**
- 3. A standard record keeping system for minimum (major fires) statistical information is implemented.**

3.3.2 Small Scale Suppression Alternative

REQUIREMENTS (IN ADDITION TO THOSE IN ITEM 1:)

- Communication:** Acquire base and portable radios and/or telephones.
- Presuppression:** Inventory and map facilities.
- Prescribed Fire:** Maintain record of accomplishments.
- Prevention:** Develop and maintain a complete (all fires) record keeping system for fire cause and location.
- Detection:** Establish a wildfire reporting system. Provide a duty officer for 24 hour fire notification during the active fire season.
- Attack:** Respond to fires with trained and properly equipped fire fighters.
- Cooperation:** Establish operational and communication procedures to connect all responsible fire fighting agencies.

ADVANTAGES

- + Reduces damage from wildfires.
- + Provides for limited initial attack.
- + Requires limited additional personnel and equipment.

DISADVANTAGES

- Some fires will still exceed the limited suppression capabilities.
- No planned and organized back-up suppression force is available.

ACTIONS NECESSARY TO IMPLEMENT

Suggested Training Subjects

- o Basic fire fighting, safety, and fire behavior.
- o Fire behavior indicators and fire weather.
- o Fire cause investigation (determination of cause and point of origin).
- o Fire suppression organization.
- o Crew boss training.
- o Fire logistical support.
- o Use of water in fire suppression.

4. PRESENT WILDFIRE SITUATION

4.1 Fire Occurrence by Forest and Range Type

Few fire problems exist on the FNC irrigated forests and those in riparian (riverain) forests such as the Gash River Delta. The Acacia nilotica stands on the banks of the Blue and White Nile and other wadi or lowland locations are not a problem. The accepted practices of cleaning up thinning slash or residues from management activities are enough to prevent any damaging fires.

In the Eastern and Central Sectors, the dryer forest reserves such as El Rawashda, Shuaib and Dali Muzmum can experience significant fire problems that warrant management attention. In the western part of the country similar conditions are found. For example, in the North Kodofan State at El Ain a 9,000 feddan fire occurred last year.

The most difficult fire problems on FNC forests occur in Jebel Marra. The steep terrain and valuable forest combine to present a challenge to the local foresters and the villagers. Fortunately, or as a result of the problems, this location has the most active and experienced fire suppression personnel.

The Range and Pasture Administration has the most flammable lands to manage. Fires burn up to 60% of some ranges on an annual basis. In the South Darfur State in the EL Radoom National Park, fires have consumed 56% of the area as recorded by satellite imagery. The remote sensing specialist for the Western Savannah Development Corp. (WSDC) has imagery for several years showing similar burned areas. (See Annex 2, Field Notes for Niyala for additional information.) A historical report dated 1962 mapped a similar burn pattern. (See Annex 3, Maps and Satellite Imagery.) Fires that threaten the Forest Reserves, for the most part, originate on the RPA lands or farm land near the forest. The Field Notes more fully describe the local fire experiences.

Firebreaks are usually built with motor patrol or tractor and disk. Camels dragging tree branches is another technique. Firebreaks to be effective must be clear of flammable materials. More discuss of this subject can be found in the Field Notes.

Our interviews with Nazirs for the local tribes and the Rural Council leadership independently confirmed that the numbers and damage from fires have increased since 1972. Agency managers agreed. A major change in the administration of the rural areas began at that time. Nazirs and local Sheikhs lost the legal administrative authority to direct the activities of the local tribe members. Initially, the state assumed the authority, but due to the scattered nature of the people, little if any influence exists. Everyone's problem has become no one's problem, and the result is more fires on the RPA supervised lands with no fire suppression organization. A firebreak system originally maintained by local people became the responsibility of the state, and with the shrinking budget of the RPA, firebreaks are not completed in a timely manner.

**Range and Pasture Administration
National Summary of Sudan Fire Statistic Report**

State	Number of Fires	Feddans Burned	% of Feddans		
			Forests & Woodland	Range	Farm
<u>Eastern Sector</u>					
Kassala	3.4	6,900	9%	90%	1%
Gedaref	4.6	23,400	3%	97%	
<u>Central Sector</u>					
Gezira	2.9	1,280			
Sennar	No	Report			
Blue Nile	No	Report			
White Nile	Unkown	2,000		100%	
<u>Kordofan Sector</u>					
Northern K.	No	Report			
Western K.	No	Report			
Southern K.	6	2,690,000		100%	
<u>Darfur Sector</u>					
Northern D.	No	Report			
Western D.	No	Report			
Southern D.	10	70,131 ⁽¹⁾	26%	72%	2%
Totals For Reporting States	37	4,731,711			

(1) Report includes only the known fires recorded by RPA employees. Actual figure could be 700,000 - 1,400,000.

Range and Pasture Administration

Fire Causes 5 Year Totals (Not averaged)

States	Natural	Smoking	Equipment	Forest Products	Agricultural Burn	Grazing	Incendiary	Miscellaneous	Total
<u>Eastern Sector</u>									
Kassala		1	2	10		4		13	30
Gedaref		20				22			42
<u>Central Sector</u>									
Gezira	5	10		5	9	10	5	-	44
Sennar									
Blue Nile									
White Nile	(1)	(1)	(1)	(1)	(1)	(1)			
<u>Kordofan Sector</u>									
Northern K.									
Western K.									
Southern K.		4				6	8	13	31
<u>Darfur Sector</u>									
Northern D.	No	Report							
Western D.	No	Report							
Southern D.	3	6	1	9	11	12		8	50
Total For Reporting States	8	41	3	24	20	54	13	34	197

(1) No number were provided (1) indicates causes for at least one fire.

There are numerous categories of causes that could be used. For example: cooking fires, travelers, bee keepers, poachers. The proposed list is a compromise that can be adjusted by agreement with the various users.

Definitions

1. Natural Causes (lightning, rolling rocks, spontaneous combustion).
2. Smoking.
3. Equipment Use (tractor, truck, chainsaw, railroads, and combine-harvester).
4. Forest Product Gathering (hunting, timber harvesting, charcoal making, gathering honey, berries and etc). *Note: Do not include smoking.*
5. Agricultural Burning (field burning, ditch bank and land clearing).
6. Grazing (nomad and agro-silviculture). *Note: Do not include smoking.*
7. Incendiary (Fires set for illegal and improper purpose, arson. Fires set for thrills, fun, or to damage a neighbor. Do not include fire set by farmers and nomads unless the clear purpose was to damage the forest or a neighbor).
8. Miscellaneous (Fires of unknown causes or that do not fit above definitions).

4.4 The Natural Role of Fire in the Environment

Natural fires seldom occur in the Sudan. Lightning usually is accompanied by rain and rarely starts fires. People cause essentially all of the fires in the Sudan.

One report suggested that sunlight through silica crystals on grass blades may cause fires. If so, it is an insignificant number.

Man has historically used fire in the savannah. Vegetation that is now present is the result of burning and other land uses. The change in the amount and severity of the fires is difficult to determine without concentrated research. However, the opinion of local experts and of Nazirs interviewed suggests that the amount of burning has increased significantly in the last two decades. One senior official in South Darfur estimated that the number of feddans burned has increased tenfold in recent years. The burning pattern when viewed from the air appears to be removing trees and small shrubs from the landscape. Land protected by natural barriers contains more shrubs and trees than observed on the unprotected landscapes. The impact of intensive land use is evident around villages and towns where most vegetation has disappeared.

Acacia senegal is the tree most affected by fire. An occasional fire does not kill this gum arabic producer but may kill part or all of the top. Production can be seriously reduced by fire. Repeated fires will remove A. senegal which will be replaced by the more fire tolerant A. seyal. Studies of the seasonal changes in the moisture content of woody species have not been made. From my experience, I would judge that in March and April the moisture in the trees would be at its lowest level and, therefore, a very susceptible time for serious damage from fire. In the absence of scientific data, increased protection in March and April and documented observations of the effects of fire are suggested.

4.6 Present Organization and Operation

The Sudan has recently created 26 states. There were formerly nine (9) regions. New ministries and organizations have appeared in the new state capitals. The organization of the state governments may vary as the details are worked out. South Darfur, for example, has created a Department of Natural Resources.

The Forests National Corporation retained the status as a nationwide "National" organization. To provide for efficiency and continuity of leadership, FNC has maintained the previous Deputy General Manager position in a "Sector" organizational structure. This combines the new states into mutually supporting "Sectors".

The RPA is organized on a statewide basis under the new state governments. It will function as a state agency. There remains a national level RPA office with coordination and some financial assistance responsibilities.

4.6.1 Forests National Corporation (FNC)

The local manager of the Forest Reserve, "Assistant Conservator of the Forest," assumes full responsibility for fire management activities on the reserve. With the key exception of Jebel Marra, the conservators have limited experience in fire suppression and no formal training. Extension people at the local level were very interested and wanted suggestions on how to be helpful in explaining the fire prevention message.

I asked several managers how the forces were organized and supervised to assure safe and efficient fire suppression. There seemed to be no standard organization to accomplish this sometimes hazardous job. Jebel Marra effectively utilizes the villagers' tribal organizational system on the fire line. The "overseers" are experienced crew bosses for the fire activity.

Above the forest reserve level in the organization, the fire management responsibilities seem to be informally blended into the manager positions. There is presently no "point of contact" or specific fire responsibility or reporting system. I understand that there was, at one time, a telegram reporting system for major fires. However, I was unable to find any use of this system in the field. **When compared to the "Systematic Fire Protection" model described in 3. Systematic Fire Planning, the FNC managed lands would be in the " Full Protection" option. Most of the fire prone reserves do not meet the**

5. RECOMMENDATIONS FOR A SYSTEMATIC FIRE MANAGEMENT PROGRAM

The following recommendations are primarily aimed at creating an atmosphere in which a National Systematic Fire Management Program can begin. These recommendations begin with the general and national issues and then move to the specific and local ones. Most of the suggestions apply in the Project Area. In some cases, specific suggestions will be made for the Project Area to highlight the support needed. The sponsoring project has very limited time and financing. Few acquisitions will be suggested. This seems appropriate in light of the need to first decide on a national approach to fire management.

5.1 National Level

- 5.1.1 FNC and RPA should each create a "point of contact" for fire management. This could be an independent Fire Management Officer, staff function, or as a part of the proposed Environmental Staff or an existing staff such as Protection.**
- 5.1.2 FNC and RPA should initiate a compatible fire statistical reporting system. A suggested fire report form and examples of summary forms are included in Annex 5.**
- 5.1.3 Following the creation of the Fire Management position, FNC should describe and assign the fire responsibility at the Sector, State and Forest Reserve levels. This could be an added duty to an existing position.**
- 5.1.4 The role, responsibilities, and legal authority of RPA need to be established at the national and state levels. Legislative action may be needed.**
- 5.1.5 As time permits FNC should study the fire laws and regulations used in other countries to select those authorities on fire closure and fire permit systems that could expand the ability to deal with fire risks. RPA can benefit from this work following the clarification of the agency's role.**
- 5.1.6 The area burned by fire each year and the effects on the vegetation need analysis. I believe fires are contributing to desertification in many areas. A satellite imagery study combined with field tests can confirm the changes in the plant communities and increases in soil movement. Perhaps a donor country, or the U.N. Desertification or Global Warming units could assist in the financing.**

5.2 Prevention

- 5.2.1 Develop a fire extension program based on information in this report. This could be done by a local committee, a consultant, or specialists from an experienced fire country.**

60 meter burned firebreak. The Montegello unit at Jebel Marra, as well as other locations, are familiar with the process.

5.4.3 RPA administrators will need to prioritize the firebreak system to assure that the limited money is spent on the most important firebreaks. Firebreaks that are not well built do not provide protection. Kilometers of firebreak, by itself, may not be a good target. Maximize the use of local villagers.

5.4.4 FNC should use the Foresters at Jebel Marra to advise the Conservators of other reserves on firebreak adequacy and the proper techniques for burned firelines. They could also advise managers at other locations where early burning is needed to strengthen a firebreak. I did not note locations other than Jebel Marra where early burning is needed.

5.4.5 For the Project Area at El Rawashada, Gadaref, Dali/Muzmum, and other fire prone reserves, acquire minimum fire fighting equipment to be on location at the beginning of the fire season. The equipment should be specifically marked and reserved for fire use only. Acquire a supply (fire cache) for a minimum of 20 people or more if the normal number of employees is larger. Suggested items and costs in U.S. \$ for a 20 person cache is as follows:

10 Backpack pumps (soft neoprene style) 5 gal.	@\$138ea	\$1380
20 Jerry cans 5 gal. to resupply backpack pumps (local)	@\$ 10ea	\$ 200
15 Fire beaters (fire swatters)	@\$ 36ea	\$ 540
10 Shovels (local)	@\$ 20ea	\$ 200
5 McCloed tools (to test effectiveness in Sudan)	@\$ 92ea	\$ 460
20 Drinking water canteens	@\$ 20ea	\$ 200
2 Crew first aid kits	@\$ 150ea	\$ 300
5 Drinking water containers (5 gal.)	@\$ 50ea	\$ 250
	Total (incl. McCloed tools)	\$3280
	Shipping and import costs	?

5.5 Attack-Fire Suppression

5.5.1 Obtain Basic Fire Suppression and Fire Behavior Training for key managers who are interested and who are, or may be, assigned to fire prone areas. Consultant training support from Cyprus, Canada, Australia, or the United States is recommended.

5.5.2 Assign foresters from the "Project Area" or other fire prone areas to an "on the job training assignment" with the Bel Dong early burning fire crews.

6. TRAINING AND TECHNICAL ASSISTANCE

Recommendations for training and technical assistance have been included in the specific fire areas. The future of the protection of the range and forest lands of the Sudan will require lengthy and persistent interest and leadership. It may take a few decades to put a nationwide Systematic Fire Management Program into operation. Consultants with fire and organizational management skills can assist in evaluating progress and encouraging the Sudanese leadership. The end result must be one that will work in the practical world of the Sudan.

6.1 Schedule Training

The scheduled training provided during my visit was held on 9.7-10.7. Ten trainees were invited from both RPA and FNC. Fourteen (14) students attended. Training materials were reviewed and provided to the trainees. Slides from the United States and Jebel Marra were shown and discussed. A set of materials was provided for each trainee which included a copy of each of the following:

1. *Fire Control* presentation by Dick Stauber.
2. *Introduction to Forest Fire Management*, a U.N. publication.
3. *Look up-Look Down-Look Around*, National Wildfire Coordination Group.
4. Fire prevention materials and handouts.
5. Crew Boss training materials.
6. Fire Safety information.

6.2 Informal Training

Training materials were shared during the field trips. Examples of fire safety alerts, such as the *10 Standard Fire Fighting Orders*, were shared with interested staff. Advice and suggestions were also exchanged. Slides on fire activities were shared on a limited basis due to the lack of time and equipment.

Samples of extension programs and fire prevention materials were given to many of the people contacted. The Smokey Bear pens, balloons, and stickers were presented on behalf of the United States Forest Service and the Canadian Interagency Forest Fire Center.

El Fatih Eli Imeri
Abdalla H. Eli Basheir
El Tahir El Nour

Community Forestry Expert, FNC (Madison Wisc.)
Deputy Manager, RPA
Wildlife Officer

Singa, Gazir State and Dali Mazmum, Blue Nile State

Musa Sulieman Musa
Omer Adam Amen
Mohammed Ahmed
Khaleifa H. Humri
Fadle Ibrahim
Khalda O. Ibrahim

Dali/Mazmum, Project Officer
Singa Fire Station
Singa Fire Station
RPA Manager, Gazir State
Nazir of Kenana Tribe
Extension Officer

Jebel Marra

Abdel Salam Ismail
Yahia A. Abdalla
Moahmmed El Gamery
Abu El Gasim Abdalla
Zoel Fagar E. Omer
Hydear A. Yousif
Sieqfried Uhlig
Mrs. Uhlig

Assistant Conservator of the Forest
Golo Forest Inspector
Bal Dong Forest Inspector
Botanist
Accountant
Montagello Forest Inspector
Project Manager, GTZ Project
Herbarium curator

Niyala

Abdalla Gaffar
Edris M. El Daw
Ali H. El Karim Sidig
Mohammed H. Ahmed

Dep. Director, Darfur Sector, FNC
Asst. Dep. Director
Reg. Director, RPA, S.Darfur
Acting Dir. Gen., Western Savannah Development
Corp. (W.S.D.C)
Head of Agri. Devel. Division, W.S.D.C.
Remote Sensing, W.S.D.C.

El Obeid, Kordofan State

Ahmed El Taib
Ali M. A. Korak
Rashid A. Aziz
Hussein M. Mohammed
Mohamed E. Abdel Rahman
Fadill Alla S. Ismail

Dep. Director, FNC, Kordofan Sector
Project Manager, Gum Arabic, FNC, N. Kordofan
Project Mgr. El Ain Natural Forest Mgt. Project
Director, RPA, N. Kordofan State
Dean of Natural Res., Kordofan University
Forest Inspector

FIELD NOTES

Kassala 11.6-14.6

Mr. Fathi M. Salih was a very helpful and gracious host. He arranged for our Gash River forest tours and facilitated our visits to the other locations in the Eastern Sector. Mr. Salih explained that the conversion of forest lands to farms has dramatically reduced the forest resource and the potential for wildfire. During our field trips we observed brick manufacturing, charcoal making (illegally), and the vast areas of mesquite stands. The plantations on the east and the west banks were impressive demonstrations of the productivity of the forest land for eucalyptus as well as native tree species. The taungya (agro-silviculture) practice was very effective. The dedicated forest personnel explained that the success was the result of careful supervision of the process. Fire problems under a normal weather cycle do not exist in the forested areas. Moisture in the river bottoms and the lack of fire fuels (dry grass) under the mesquite effectively limit the fire spread. The two fires observed had gone out without attention at a "spot" (less than 1/10 feddan). The only possibility of increased fire risk would be following an extended drought sufficient to create dead material within the mesquite stands.

The information provided by Range and Pasture Administration (RPA) shows a more active fire history. The RPA is organized on a state by state basis and does not have a sector organizational structure as is the case with the FNC. A range area of four million feddans is managed for seasonal grazing. This includes the open land in the Kassala State with a rainfall of 300 mm per year. **The agency maintains 600 kilometers of firebreaks each year. The average area burned is approximately 7,000 feddans annually. This is a modest loss for such a large area. The firebreaks are effective in limiting the area burned. Fire training for crews is limited to "on the job (fireline) training."**

Mr. Salih arranged for us to meet with Mr. Ali Ibraheim, Nazir (Chief Leader of the local Tribal Chiefs) and Mr. Hamid Ali, chairman of the Kassala Rural Council. These leaders agreed that the main fire problems occurred in the southern sections of Kassala State. **They believe that nomad cooking fires are the cause of most of the fires.** They suggest that contacts by themselves or their representative could be effective in reducing the number of fires. Although they support the extension program, they insisted that the nomads would be more likely to listen to them. They suggest support for transportation (vehicle) so that they could carry out the important contact of the rural council. This is a local government responsibility.

El Rawashda/Wad Kabo Forest Reserves 15.6

Bella Musa Yassin, Conservator in Charge of the Forest, provided an excellent technical and cultural tour of the reserve. We had a short camel ride and tea with a nomad family. This opportunity demonstrated the importance of the forest to this small two- family group.

"13 Conditions That Shout Watch Out". They thought that these would be helpful. I left copies with Bella. We also briefly reviewed other fire prevention and fire suppression information. **Basic fire training would be a great assistance to FNC and tribe support people. They do not have enough training to assure their own safety. Lookout towers would be a good addition to the El Rawashda Reserve and could be used for observation of activities as well as fire.**

We had an interesting meeting with Hamad M. Hamad Abusin, Nazir of the Shukria Tribe. The tribe occupies the area east of Gedaref. The main trees being Kitir. The RPA that manages the area does not have the equipment to maintain the firebreaks. He said that highway travelers and nomads were the main cause of fires in his area. He felt fires were accidentally started. **His local people help in prevention but could use training. The fire season extends from November to April. Several large fires occurred in Nov. of 1994. The present over grazing does reduce the fire hazard. The Rural Councils have little money. They are looking to the government and NGO's for help.**

On 18.6 we drove to the 24,000 fdns Shuaib Forest Reserve about 30 km east of Gedaref and looked at two recent fires. Both had jumped roads and firebreaks. Fires starting in the reserve have not been a problem. Most of the A. senegal trees did survive, resprouting from the ground. The second fire was in an area that experiences fires almost every year. This fire jumped the firebreak and burned for 4-5 days. The A. senegal trees that burned in this fire were small, but old enough to produce gum arabic. Dead tops were evident in about 30% of the trees. It appeared that the fires were started to clean the dura fields and escaped. It is difficult to speculate on fires after the fact. However, it appeared that the fire crossed the firebreak where the line had been inconsistently constructed. **It would be advisable to have a wider firebreak of 30 meters on the parts of the Reserve most susceptible to fire. Two narrow lines could be constructed 30 plus meters apart and the area between them burned. This change would add little to the expense of building the fire lines. The FNC recognizes the process of a burned fire line and specify 80 meters. The wider line is of course safer but removes more land from production. The key point is that the firebreak must be continuously clear. The line observed at this locations had some narrow spots and areas where fuel was not completely removed.**

On our return trip we stopped by the Umsawani Village and looked at the tree nursery installed by SKAP. It is unfortunate that operating funds are not available to continue such efforts. **The staff in Gedaref were very interested in receiving fire suppression training. They seem to understand the extension concepts and the opportunity to add fire prevention to that ongoing program.**

Wad Medani , Gezira State 18.6-19.6

We met with Mr. O. El Sheikh, Asst. Mgr., Mr. E. El Omeri, FAO/Project Community Forester, Mr. A. Karamalla, Range and Pasture Manager FNC and Mr. A. El Bashier RPA. Mr. Karamall spoke primarily from his experience as a former officer at the El Rawashda

Fire is a problem in the A. senegal forests. Grass grows very tall in the forest reserves in Singa and Dali/Mazmum areas. January is the most serious month due to the dryness of the vegetation. Fires during this time can kill the older (20-25 yr.) A. senegal trees. I asked if any studies had been made to evaluate the fuel moisture content of the local trees during the fire prone months. Muza said it was knowledge based on experience alone. A. melifera is the most susceptible to fire followed by A. senegal. A. seyala is the most resistant local species. The major causes of fire are the farmers clearing land or burning crop residues. Personal disputes between gum arabic tappers is also an important cause. Illegal tree felling activities may be a less important cause. The staff at Dali/Mazmum has some experience with fire fighting and have use the wheel tractors to cut fireline. The training is done informally through a verbal exchange of ideas. There is an extension program but no fire prevention information is now being used. Extension Officer, Khalda Ibrahim was very interested in the fire prevention samples that I had for demonstration. Smokey Bear ballpoint pens and symbols were a great hit. **Simple fire prevention material adapted for the Sudan culture would be helpful.**

Kahaliefa H Humir, the local RPA Manager, was very concerned about range fires, particularly on the Wad Eli Nail range. The firebreak construction program has been severely hampered by the budget and poor fee payments. Local grasses will grow to a height of 1-2 meter in a good rain year producing 1.5 tons per fdn. Firebreaks are being constructed with tractor and disk and also by dragging tree branches. In 1994 450 km of firebreaks were constructed in the Eli Dindir area with a normal total in the entire RPA area of 750 km. The local state lacks the funds for the firebreaks. Khartoum has normally financed them. Again we repeated the discussion of mechanized farming taking pasture land without provisions for nomads or their migration routes.

Mr. Fadle Ibrahim is the Nazir of the Kenana Tribe which occupies the area between the Blue and the White Nile Rivers. In the past the local Kenana Tribe Administration had a powerful hand in directing rural activities. They used a rotation system for farming and grazing. On areas designated for farming, fire was permitted for land clearing. The remainder of the area was reserved for grazing. Setting fires was forbidden. Areas farmed were rested for four years before being farmed again. This local administrative system was dissolved in 1972. "So our system of managing the rural resources was destroyed," Mr. Ibrahim stated. In 1989 the original system was to be reinstalled, but the big land owners complained. All that the tribe leaders can do now is as a volunteers. Concerning the questions about fire, Mr. Ibrahim said that fires occur both northeast and southeast of the town of Singa with a fire season that extends from November to February. Fire causes are mostly the activity of people both accidental and intentional. Local Sheikhs are supposed to look after the prevention measures. Under the old administrative system, tribes prepared firebreaks as a village volunteer project.

Travel from Singa via Wad Medani to Khartoum 21.6

Traveled to Khartoum, stopped off at Wad Medani and picked up the fire statistical reports. Met with Mr. Adam El Amin, Administrative Officer and his staff of women and answered the questions they had about where I live and work.

15. Fire control activities were started by this administration a long time ago.
16. In earlier times the work was carried out by local "traditional" governing councils.
17. In 1970 the use of the local tribe administration was abolished. Since that time the local participation has been partially replaced by the government.
18. Fire is a major biomass removing force.
19. The effect of fires interacts with both the grazing activities and the climate.
20. Fire has several effects on the soil and the organic material.
21. Some production is lost due to fires. For example fire reduces the production of gum arabic.
22. Firebreak construction is an important program summarized as follows:
 - a. In 1994 the target length was 40,000 km.
 - b. About 32,000 km or 79% were actually completed.
 - c. As a result of a comprehensive national strategy it was determined that 70,000 km of firebreaks should be constructed each year.
 - b. This amount of firebreak will protect 100 Million fdns of rangeland.

Niyala 26.6

Abdulla Gaffar Dep. Director for Darfur Sector met with Mr. Karamella and me before we left Khartoum for Niyala. He suggested some emphasis for our visit and that we proceed to Jebel Marra before we completed our business in Niyala.

Seated on the north view side of the Federal Air Lines (FAL) Russian AN24b the scene from Khartoum to El Obeid was primarily of desert showing little sign of the onset of a wet season. Resuming the flight from El Obeid, we began to notice both farm residue burning and the scars of recent and old fires. I looked carefully for indications of firebreaks, but could only identify roads and field boundaries. In many cases the wildfires seem to have started at the boundary of a field or a road then escaped into the open rangeland. Several fires appeared to have exceeded 5,000 fdns in size.

When we were about 100-150 km from Niyala, the combination of this years fires and those of the recent past (2-3 years) covered 90% of the landscape. Trees and brush could be seen on the few unburned areas that had been protected by khors or other natural firebreaks. **It appeared to me that the deeper rooted trees and shrubs were being killed by repeated burning. Wind erosion must be removing topsoil from the hundreds of thousands of feddans of burned lands.** We were later able to confirm with satellite imagery that my interpretation of the view from the aircraft was an accurate definition of the extent of fires in South Darfur and West Kordofan States.

We were greeted by Edris Eldow, Asst. to the Dep. Director for the Darfur Sector. A dust storm (gubar) hurried us on our way. Dust followed by rain and more dust illustrated the ability of the winds to move large amounts of soil. The rains cleared the air as we approached Jebel Marra.

burning. Older tribal members have related to Mr. Uhlig that the size and number of fires have increased in recent years.

Mr. Karamells, my counterpart for the visit, provided further comment on the vegetation. Jebel Marra has a unique rich flora which may vary according to soil type, water availability, and altitude. The main herbs are Hypoetis spp. and Biden spp. The dominant grasses are Hyparrhenia spp. and Cymbopogon spp. The dominant trees are Anogeissus leiocarpus and Azanza spp.

The fire experience of the local foresters and the tribal members and leaders is very high. Mr. Yahia A. Abdalla and Mr. Mohamed Elgamery were knowledgeable and enthusiastic about the fire challenges. I reviewed Mr. Elgamery's slides from the night executed early burning. The results were text book examples of effective execution.

The Jebel Marra staff can provide a "center of excellence" for fire training in the Sudan. The present level of experience could be easily enhanced by some additional fire behavior and prescribed fire training. They also need to be equipped with some weather station equipment so they can better describe the correct burning conditions that are most effective for the early burns. Forest personnel from other parts of the Sudan should be trained during the early burning period. Fire experienced staff from Jebel Marra could assist in firebreak preparation and fuel treatment at other location such as Gedaref and Dali/Mazmum.

Out of country experience and training in Cyprus, Australia, the U.S. or Canada would expand the ability of the experienced fire personnel. A fire behavior and prescribed burning consultant visit during the early burning or the fire season could also be effective.

FNC and the Project plan for the protection of the Forest Reserves from wildfire that approach the valuable timber. Extension programs and initial attack extend well beyond the boundaries. These actions are necessary but illustrate the lack of any organized response to a fire protection program for the grazing areas or the small farms adjacent to the mountain. The absence of a responsible organization to provide any fire protection outside of the FNC Reserves creates an untenable situation for the long term cost effective protection of the Jebel Marra Forests.

Mr. Abdelsalam Ismail and the staff were great hosts. I felt very welcome in the cooler and rainy forest, regretting only the need to move on to warmer locations.

Niyala, South Darfur 28.6 - 30.6

We briefed Mr. Abdulla Gaffar on our successful trip. I also reviewed the "Fire Report Form" and "Statistical Summary Report Forms." He agreed that the forms would be a good place to start gathering better information on fires. The FNC has little fire problem in the

Upon our departure from Niyala we chose the south viewing side of the aircraft and viewed a very similar burning pattern to the one we saw on our arrival. The burning pattern became less intense as we left South Darfur. The typical overuse from grazing and fuel wood gathering pressure could be seen for 5-10 km around larger town. Farm plots became more evident as we approached El Obeid and the fire scars less dominate on the landscape.

El Obeid, North Kordofan State 30.6-3.7

Mr. Ahmed Eltaib, Dep. Director for the Kordofan Sector and Ali M. A. Korak, Manager of the Gum Arabic Project and North Kordofan Forest Director, met us and arranged excellent accommodations and support.

Mr. El Taib was very supportive of the need for a fire reporting form and a system to begin gathering statistics. He felt that most of the fires were going unreported.

The sector contains 315 Forest Reserves with 3 million feddans in the northern part of the state set aside for stabilization of the sand dunes.

The production of gum arabic in the sector was a major program. The expansion of the gum arabic forest has been a priority project since 1981 and has involved 274 villages with 11,944 farmer members covering an area of 57,178 fdns.

Mr. Radhdi A. Aziz conducted an informative field trip to the El Ain Natural Forest Management Project. Sahel International (SOS) is a United Kingdom financed project involving 42,000 feddans. The first phase (1989-93) established the management direction using a participative approach to the development of a Land Management Plan. The main goals are extension, forest management, and research. Programs of special interest included (1.) micro-catchment basins in clay soils, (2.) village nurseries to encourage the expansion of local forests and provide an opportunity to sell extra seedlings, (3.) improvement in wood and charcoal stoves, (4.) backyard cultivation (home gardens), and (5.) encouraging the use of "Green Hedges" lessening the need to cut trees to build "Zariba" thorn fenced compounds. Some specific classes for sheikhs are a part of the program. We also toured a major fire in the El Ain Hill area of 9,000 ha. His report follows:

In November fire erupted two times in the project area. Normally behind the setting of fires are the nomads who use fire to cook their food and the intruders who want to burn wood for making charcoal. Mostly when this happens, the fire is not completely extinguished. That means the fire after the nomads leave the area starts to light again when there is a wind. The first fire happened on 5th of November and continued for 28 hours. It started near El Ain hill outside the forest reserve and spread with the help of wind in the south-west direction burning a large area in the reserve and the buffer. The total area burned was estimated to be about 9,000 ha. The fire was controlled by the project staff with the assistance of police

Mr. Ali Abu Zaid, West Bank Conservator of the Forest, and Mr. Kholofalla Seed Ahmed, East Bank Conservator of the Forest, were our Kosti hosts. Mr. See Ahmed invited us for tea with excellent home prepared desserts in abundance.

The fire problems for the FNC are minor in this state. However, the RPA Statistical Report shows that 20% to 60% of the range land burns each year. He believes that the firebreaks are important in limiting the loss. The new highway to El Obeid has changed some of the grazing patterns. The water sources along the road have encouraged numerous villages to be created about 1 km from the highway. He formerly worked with one Rural Council; now there are five. Conflicts for water between the Selien and the Ahamda nomadic tribe cause problems. During times of drought the cattle and sheep nomads have difficulty getting access to the White Nile for water. Fires are sometimes the result of the conflicts. He feels that the "food for work" program is a good way to get the needed firebreaks cleared.

Amani Osman Hassan, Extension Officer and Acting Manager of the Kosti Nursery, showed us that effective operation. They are producing 300,000 seedlings that will be planted in community forests in 300 villages. She is also very active in the improved stove extension program. The nursery does raise some ornamental plants for local sale.

Our trip to Khartoum was interesting due to the large herds of cattle that were searching for the new green grass. The movement of the desert was evident near villages, and sand was across the highway in a few locations. Planting of stabilizing vegetation seemed helpful. But, much more will need to be done to slow the movement of sand and soil.

Khartoum 9.7-10.7

Fire Training Notes

The people that attended the training were given copies of the documents mentioned in the training discussion, **6.TRAINING**. In addition two work groups submitted written reports as follows:

Extension and Fire Prevention Group Recommendations

1. Have an intensive extension program.
2. Lookout towers should be established in the Forest Reserves.
3. Good communications [radio or telephone] between the field and the office.
4. Training for the target groups.
5. Periodic patrolling.
6. Preparation of firebreaks inside and outside of the Forest Reserves.
7. Means [equipment and training] of fighting fires.
8. Plantations of trees resistant to fire.
9. Legislation to punish (people who start fires).

1. Fire Suppression Officer

(In the fire literature from the U.N. ,U.S. or Canada this position is called "Fire Boss" the old term ...or" Incident Commander" the new term) Normally this will be the District Manager or the Forest Officer in Charge. It may be delegated to a well-trained assistant at the discretion of the local Administrator responsible for the area.

2. Assistants (Forest Overseers)

The overseer position is one that is recognized in the tribal organization as a supervisory crew leader. (Crew boss would be the term used in the fire literature.)

3. Fire Fighters

People from nearby villages and camps can be mobilized. The villagers may mobilize themselves to put out the fire. It is advisable to provide transportation for people from villages some distance from the fire. Technical Laborer can also be assigned as fire fighters.

Note: All local people should be willing to help in accordance with the Management and Forestry Laws.

" In case of occurrence of fire which may threaten a reserved area or any property, every person being in or near a reserve is required under S.23 of the Act to assist any forest officer, policeman or magistrate or other public official who may ask him for reasonable assistance to extinguish such fire or protect such a property."

Excerpts from Mr. Mustafa Basshar Report (Attached map shows the historical burning pattern in Natural Grazing Lands)

In 1954 a pilot scheme which utilized the joint benefit of installing stock water and conserving the grazing around it from brush fires was successfully started. It was the first time in living memory that the northern part of the area between Bahr El Arab and Abu Mutarig was saved from wild fires and that big numbers of cattle and sheep amounting to 50,000 were made to stay during the dry period. This scheme has been going on for the last seven years during which time basic changes were made in the thinking of the Rezeigat tribe bringing about the modification of their seasonal tribal migration. Much of the faulty ideas about animal nutrition and practical husbandry have been corrected in their minds after they have seen the value and the practical side of keeping animals tied to a far shorter distance and confined to dry grazing for part of the year. Unfortunately this is the only planned scheme operating in the country where water and grass have been utilized side by side and clearly demonstrates that water has its abuses if other conditions which are prerequisite to its utilization are not present.

Fire prevention in our grazing land constitutes one of the big headaches which faces the progress of improved techniques in management of our grazing land. Experiments on methods of fire-lining are still going on and temporary recommendations were made to suit certain parts of the country. Unless this problem is solved and its implications are understood and more financial support for its immediate solution is not furnished, other improvements in livestock production and water development are to me not justifiable. Prevention of burning in our grassland does give us the first raw material of unimproved range land which can be managed or improved and where a year-to-year plan of management can be followed to bring about a stage where rotational grazing can be recommended. The problem of water distribution in such amounts and manner to insure effective and lasting use of our range and water supplies is a grave one. Engineering ingenuity in installing water structures though appreciated under high standard of management of range land, is frowned on and considered incompatible under free range and uncontrolled grazing. The engineer, under such conditions, in his effort to minimize seepage, evaporation losses and catering for exceptional high floods in his designs, increases the storage capacity which in turn maximizes the danger of the depletion of the resources around such structures leading to silting up if not break down.

The accompanying map shows the possibilities of improvement and distribution of stock water in the country. Water development among others is the key to range development. (see table).

The common use of our tree range where animals of different grazing habits and grazing capacities utilize the same range brings serious problems. The distance animals can be forced to travel to and from water and the optimum distances for maximum production are two different things. In the first case the distance for cattle is about 15 miles and in the second no more than three miles. At the same time camels can easily withstand walking distances of 40 miles while sheep are only able to utilize half of this distance. It is obvious that common use does bring water and grazing....

Harig	Slash and burn farming
Mesquite	Introduced from America, used for firewood charcoal and stock feed. An aggressive invader spread by animal. Prevents the Acacia from becoming established. Very difficult to eradicate.
Mukhait	<u>Boscia spp.</u>
Kurmut	<u>Caddaba spp.</u>
Gobar	Blowing dust
Haboob	Wind
Kisra	Sorghum fermented thin pancake
Tabaldi	Boabob tree with large truck
Goorasa	Whole wheat pancake, north Sudanese food.

EQUIVALENCE TABLES

Areas

1 feddan (fd)	=	0.421 hectares
	=	1.038 acres
1 hectare (ha)	=	2.47 acres
	=	2.38 feddans
1 acre (ac)	=	0.962 feddans
	=	0.405 hectares

Weights

1 sack	sorghum	feterita	=	91.50 kg
		mugud	=	88.73 kg
		daber	=	94.35 kg
1 sack	millet	=	91.35 kg	
1 kantar (kt)	gum arabic	=	44.93 kg	
1 kilogram (kg)	=	2.2-64 English Pounds (lb)		
	=	2.2258 Sudanese Pounds (Rotls)		

Currency (Nov. 1994)

1 \$US	=	527 Sudanese Pounds
1 \$US	=	527 Sudanese Pounds

National Summary of Sudan Fire Statistical Reports
Fire Advisory Visit June, 1995

Five Year Average 1990-1995

State	Number of Fires	Feddans Burned	% of Feddans		
			Forests & Woodland	Range	Farm
<u>Eastern Sector</u>					
Kassala					
Gedaref					
<u>Central Sector</u>					
Gezira					
Sennar					
Blue Nile					
White Nile					
<u>Kordofan Sector</u>					
Northern K.					
Western K.					
Southern K.					
<u>Darfur Sector</u>					
Northern D.					
Western D					
Southern D.					
Totals For Reporting States					

**Sudan Fire Statistical Report
Fire Advisory Visit June, 95**

Five Year Average 1990-1995

Year	Number of Fires	Feddans Burned	% of Feddans		
			Forests & Woodland	Range	Farm
1995					
1994					
1993					
1992					
1991					
Sub total of 5 years					
If possible provide data for 1990 - 1986					
1990					
1989					
1988					
1987					
1986					
Sub total of 5 years					
Total of 10 years					

* Use the best information possible. An estimate is acceptable if no better data is available.

Fire Personnel and Equipment:

1. Number of part or full time forest guards that have fire as a partial or full responsibility?
Training. What training do they receive?
Equipment. What transportation and equipment are they provided?
2. Equipment held for fire fighting?
3. Number of fire gangs (fire crews) # of people/gang?
Training. What training do these crews receive?
Equipment. How are the crews equipped?
4. Number of km of fuel (firebreaks) maintained annually?
5. Feddans of early season burning permitted?
6. Feddans of prescribed under-burning completed each year?
7. What are the 3 highest priority fire prevention or fire extension activities that need to be started or continued?
 - 1.
 - 2.
 - 3.
8. In what plant communities is fire:
 1. Most damaging to the ecology and planned management?
 2. Most beneficial to the ecology and planned management?
9. From the point of view of the small village or similar community/group what inexpensive suggestions would you make to improve the effectiveness of fire suppression actions?

pedunculata, Lannea humilis, and Guiera senegalensis. Acacia senegal is usually found on land abandoned after cultivation

When the rainfall is over 6000 mm, the vegetation approaches the high rainfall savannah type of vegetation. The dominant species are Terminalia laxiflora, Sclerocarya birrea, Anogeissus leiocarpus and Prosopis africana. While Tamarindus indica shares dominance in the drier parts, Acacia senegal and Dalberia melanoxylon appear occasionally.

Some special forest types are classified under the low rainfall savannah due to the existence of some common features, but these types are very special and cannot strictly be regarded as such. The type that concerns most is the Acacia nilotica forest along the banks of the Blue Nile and its tributaries Rahad and Dinder rivers and Khor al Atshan and the White Nile. The forests are dominated by pure stands of large crowned ever green Acacia nilotica, sometimes with an under storey of Zizyphus spinachristi, Mimosa nilotica and Crateva adansonii, while lofty trees of Acacia albida and A. sieberiana make occasional appearance near the water front. Most of the Acacia nilotica forests were declared forest reserves and were put under intensive management for the production of sawn timber.

The Inflammable Environment

The most important characteristics of the low rainfall savannah forests are the open stands with wide spaced trees, and the ground vegetation of tall grasses such as Hyparrhenia pseudocymbaria, Penisetum purpureum, Sorghum halpense and Cymbopogum nervatus. This association of open tree stands and tall grasses alternate with wide stretches of grassland. The grasses dry up suddenly and very fast over extensive areas of land immediately after the last rain. The grasses are highly inflammable when dry, giving the low rainfall savannah region its most important characteristic, the phenomenon of bush and grassland fires.

Effect of Fire on the Species Composition

Fire is an important factor in determining the species composition in the forest stands because of the profound changes it brings about in the soil through the destruction of litter, and because of the differences in the resisting powers of the tree species. Shallow-rooted species are less resistant than deep-rooted species and thick barked species are more resistant than thin barked species. Acacia seyal with its thick bark and deep roots is extremely resistant to fire, gaining dominance wherever bush and grass fire are sever and more common. Broad leaf species are restricted to the wetter parts of the region in its southern portions and hilly areas where fires are less common and less sever. But repeated burning in such stands would soon convert them to Acacia seyal. Even controlled burning, popularly known as early burning, traditionally practiced in the high rainfall savannah in the South, invariability results in the appearance of isolated trees of Acacia seyal and some of its associates among the board leaf less resistant trees.

edges of grass blades. Lightning was reported to start a fire in a fuel depot in a forest reserve, but the fire was put under control before spreading to the rest of the forest, Ibrahim (1976). Fires were noted to start in the natural bush without any visible human or other agency. Such fires are believed to be started by glass chips or silica crystals concentrating the heat rays of the noon sun on the inflammable dry grass. Empty bottles are known to start fires in the conical roofed grass huts of the farming communities living along the banks of the Blue Nile. A farmer may decorate his hut by planting an empty bottle bottom up half buried in the tip of the roof. When the noon sun is approaching the zenith, the glass bottom concentrates the heat rays to a focal point on the grass roof and sets the whole hut on fire. Several fires may start instantaneously in the village. Unaware of the physical phenomenon, the villagers attribute the action to bad spirits.

(ii) **Man**

Fires are largely caused by man during his daily or seasonal activities to acquire his basic needs of subsistence. Man may in a deliberate criminal act set fire to a forest or pasture as an expression of resentment or difference of opinion with the authority over an issue such as land or in settlement of a grievance with a rival group.

Several human niches are responsible for starting fire in Sudan. Classification of the fire incidents reported according to the niche of the culprit is shown in table (1).

Table (1)

**Classification of 31 fire incidents
According to Cause**

Niche	Percent of the Fire Incidents
Farmers	36
Nomadic grazers	45
Deliberate criminal act	3
Travellers	13
Picnickers	3

The nomadic grazers and farmers are jointly responsible for 81% of the fire cases affecting forest reserves. The travellers or more precisely careless smoking travellers can be combined with the nomadic grazers for the obvious similarity between the two as both are extremely mobile. In this respect they are jointly responsible for 58% of the cases.

Table (2)

**Distribution of 31 Fire Incidents
According to Month of Occurrence**

Month	Percent of Fire Incidents	Remarks
October	7	Winter starts, winds NE
November	23	
December	19	
January	16	Lowest winter temperatures
February	6	
March	16	Low relative humidity
April	13	High summer temperature
May	10	Highest summer temperatures
June	0	Rains start, winds SE
July	0	Rainy season
August	0	
September	0	Light showers

Perhaps this situation is better understood by a closer examination of the changing patterns in the activities of the nomadic grazers and the farmers both of whom are responsible for most of the fire incidents. This necessitates the re-arrangement of the basic data for tables 1 and 2 and pooling them together. Table (3) is a condensation of table (2) by grouping the months into quarters combined with table (1) for the fire incidents caused by the nomadic grazers and farmers only.

Table (3)

**Fire Incidents Caused by Nomadic
Grazers and Farmers in Percent**

Quarters	Caused by		Total
	Farmers	Grazers	
October/December	25	25	50
January/March	11	18	29
April/June	14	7	21
July/August	0	0	0
Total	50	50	100

During the period October/November, the nomadic grazers are starting to move from their northern low rainfall autumn grazing grounds towards the south where they make their first contact for the season or in many cases conflict with the settled farming communities.

During the active combat of a forest fire, the fire fighting gangs generally operate under technical leadership. A fire advancing from a distance is sometimes intercepted by application of a backfire under appropriate weather condition, an operation that needs a degree of skill and good judgement. Lack of skill and technical leadership was catastrophic in increasing the fire vigor in a reserve in Darfur Region, Director of Forests Darfur, (1973).

The Fire Behavior and the Effectiveness of the Fireline

Wind and windspeed are two important elements in the promotion and spread of forest fire. During the fire hazard period, the prevailing winds are north easterly, cold and dry with high speed in October/January, gaining higher speeds in February. As from March, the winds are warm and dry with slow speeds. Bush and grass fires normally spread in the direction of the prevailing wind. But this is not always the case specially in the conditions of atmospheric instability in which a fire would develop strong convection column very rapidly and spread fast, Hall et al (1972). In such conditions, the fire creates its own wind system in the form of strong whirlwinds that spread the fire in an ever widening circle round a central point. Hassanein (1972) reports on a fire which broke simultaneously through the fireline defences of two forest reserves which were 4 km apart in an east-west line. The fire started halfway between the two spreading east and westward while the prevailing wind was north easterly. Two other forests were attacked by different fires in the same area in the same time. In one case the fire swept northwards and in the other case both northwards and southwards.

The fireline is not always effective in the interception of fires approaching from outside the forest reserve. In fact 68% of the fire incidents reports were on bush and grass fires originating from distant localities outside the reserves, while only 32% were from within. The fireline is rendered ineffective under gusts of strong wind which may blow the high flames down into a horizontal position across the fireline. In many cases the fire crosses the fireline with the help of flaming splinters from climbers and the burning nests of Quelea quelea ethiopica. The nests when catching fire are detached from the tree crown and become air-burned in the form of flame balls. The burning nests were reported to take the fire across a natural barrier such as River Rahad, Director of Forests Eastern Region (1988).

What is to be done?

The ecologists have elaborately subdivided the country into distinct vegetational zones or regions ranging from desert, sub-desert, low rainfall savannah sometimes also known as dry savannah and high rainfall savannah or wet savannah that contains isolated pockets of high tropical forest. Similar exercises were done in most of the countries neighboring the Sudan with elaborate comparisons and enumerations of similarities and affinities. Professor Stebbing (1953) doubts the correctness of this nomenclature from the point of view of practical forestry however, correct it may be botanically. In his opinion, these zones or regions despite their floristic disparities are nothing than various stages of degradation of one type of vegetation - the high tropical forest under the influence of fire.

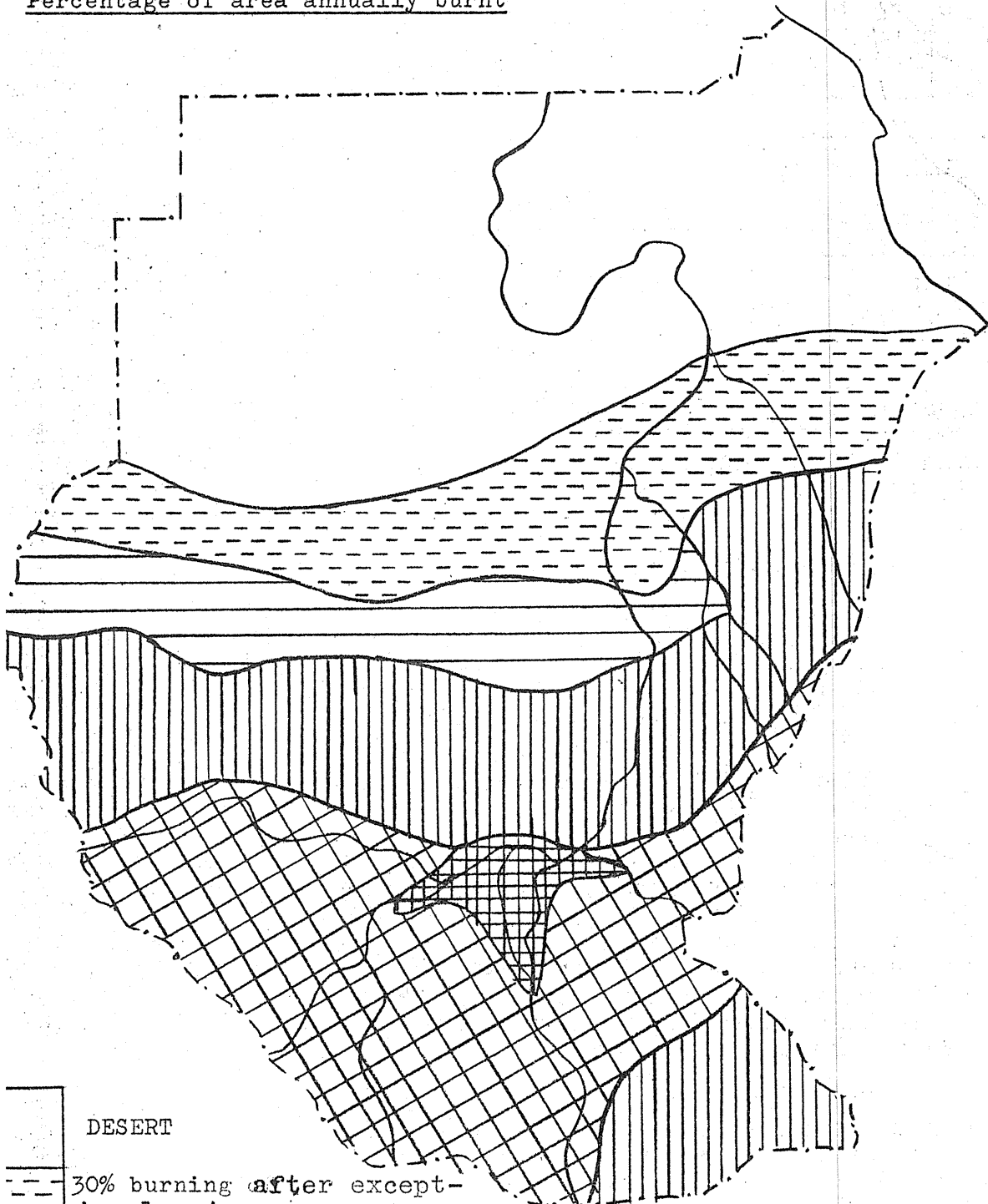
REFERENCES

- Abdulla, Abdin Mohammed (1973). Report on Fire Incident in Layuna Forest Reserve. Forest Administration Records (Unpublished).
- Ali, Taj ed Din (1982). Wood Fuel in the Sudan. National Energy Administration, Khartoum.
- Badi, K.H., Ahmed, A. H., Bayoumi, A.M.S., (1989). The Forests of the Sudan. National Council for Research, Khartoum. pp. 17.
- Director of Forests Eastern Region (1988). Report on Fire Incident in the Rahad Forest Reserves of Khummi East, Khummi West and Bartawi. Forests Administration Records (Unpublished).
- Director of Forests Darfur (1973). Report on Fire Incident in Montagello Forest Reserve. Forests Administration Records (Unpublished).
- Forests Department (1963). Annual Report for the Period July 1961 - June 1962. Ministry of Agriculture, Khartoum. pp. 46.
- Forest Officer Hawata (1973). Report on Fire Incident in the Rahad Forest Reserves of Um Trimbeil and Al Mikheirim. Forests Administration Records (Unpublished).
- Hall, Norman and others (1972). The Use of Trees and Shrubs in the Dry Country of Australia. Forestry and Timber Bureau, Canberra. pp. 503.
- Hassanein, Hussein B. (1972). Report on Fire Incidents in Various Khor Al Atshan Forest Reserves. Forests Administration Records (Unpublished).
- Ibrahim, Abdulla M. (1974). Report on Fire Incident in the Cupressus lusitanica Plantations in Saura and Galol Forest Reserves. Forests Administration Records (Unpublished).
- Ibrahim, Al Tayib (1976). Report on Fire Incident in Shasheina Forest Reserve Fuel Depot. Forests Administration Records (Unpublished).
- Stebbing, E.P. (1953). The Creeping Desert in the Sudan and Elsewhere in Africa. Sudan Government, Khartoum. pp. 27.

REQUENCY OF BURNING IN THE
NATURAL GRAZING LANDS

MAP 3.

Percentage of area annually burnt



DESERT

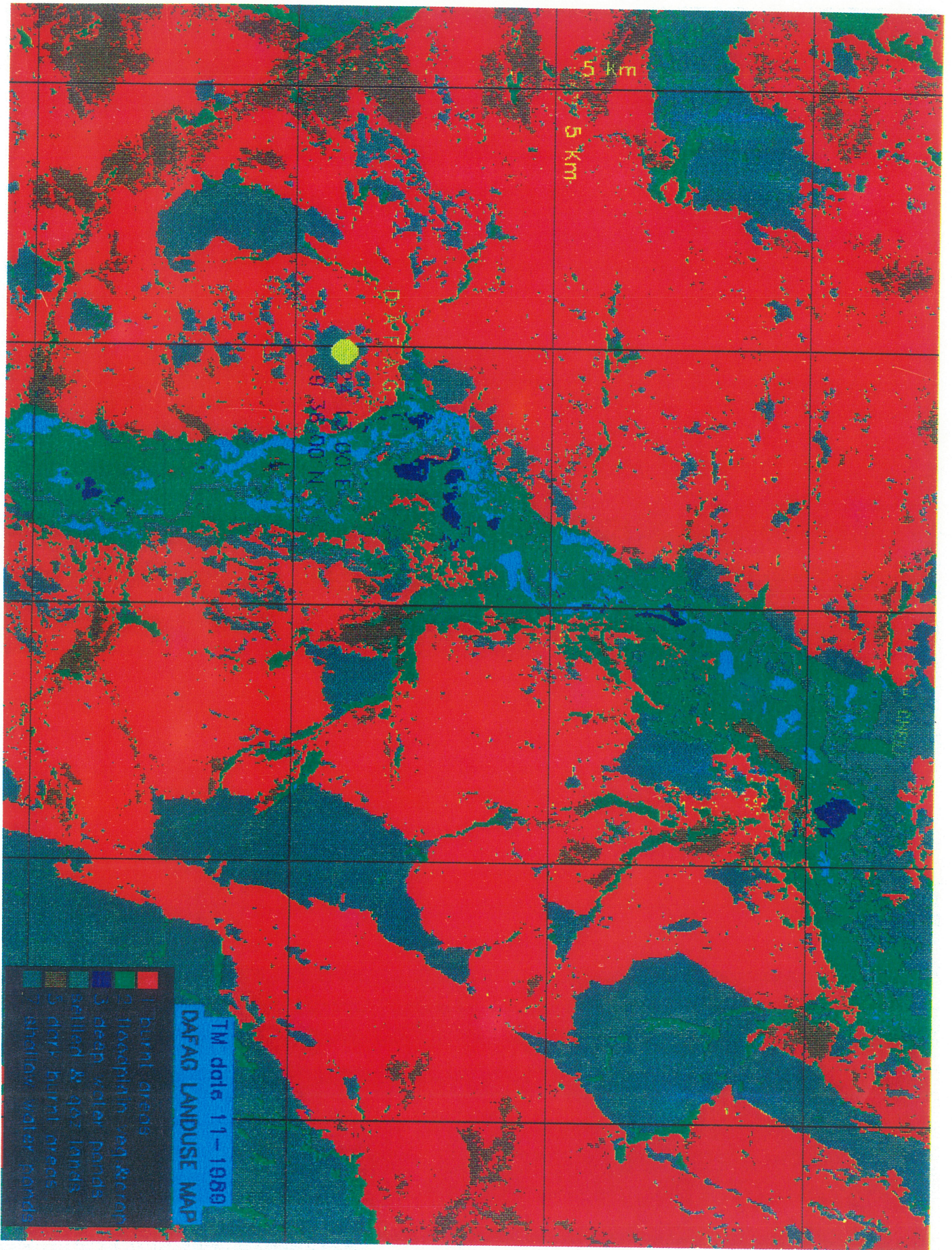
30% burning after exceptional rainy season

30-60% annually burnt

60-80% annually burnt

More than 60% of annual burning mostly perennial grass

Little or no burning



TM date 11 - 1989
DAFAQ LANDUSE MAP

- 1 burial areas
- 2 floodplain, sea, desert
- 3 deep water ponds settled & qaz lands
- 4 shallow water ponds

5 km

5 km

21 13 00 E
 9 36 00 N