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NOTE

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→ Due of the timelag between editing and print/distribution of IFFN, readers interested in meeting announcements are kindly requested to visit the Internet version of this issue for update and short-term announcement of meetings (continuously updated) on <**http://www.uni-freiburg.de/fireglobe**>

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All IFFN contributions published between 1990 and this current issue are accessible through 62 country files and other special files on the GFMC website.

Call for contributions

Readers of the International Forest Fire News are warmly invited to send written contributions to the editor at the above address. These may be in the form of concise reports on activities in wildland fire management, research, public relations campaigns, recent national legislation related to wildfire, reports from national organizations involved in fire management, publications, personal opinions (letters to the editor). Photographs (black and white) and graphs, figures and drawings (originals, not photocopies, also black and white) are also welcome. Contributions are preferably received by **e-mail (text as non-encoded ASCII file, Word Perfect 5.1 or Word 6.0, Word97/8; graphic files saved as *.JPG, *.GIF or similar) or on diskettes**. Hard copies of figures and photographs should be submitted by mail (please do not submit by fax).

The deadlines for submitting contributions to the bi-annual issues are: **15 May and 15 November.**

EDITORIAL

Until recently the mandate of the International Search and Rescue Advisory Group (INSARAG) of the United Nations has been restricted to the "classical" SAR cases such as saving lives after earthquakes. Experience has shown, however, that secondary effects of natural and technogenic disasters, including large wildfires such as those which occurred during the El Niño-Southern Oscillation (ENSO) episode of 1997-98, require additional specialist advice in conjunction with SAR response and other humanitarian aid missions. The INSARAG family offers an appropriate structure. At the regional INSARAG Europe-Africa meeting in Germany (December 1999) a first proposal was elaborated to establish an INSARAG Fire Group consisting of three elements:

* Wildland Fire
* Hazardous Materials (Hazmat)
* Industrial Fire

At a meeting at the UN Office for the Coordination of Humanitarian Affairs (UN-OCHA) in January 2000 it was agreed that the original mandate of INSARAG in addition to search and rescue would also cover wider aspects of disaster/emergency response. This could include a variety of natural and human-made disasters, including wildland fires.

At the upcoming Baltic Exercise on Fire Information and Resources Exchange (BALTEX FIRE 2000) in Finland (June 2000) the meeting of the FAO/ECE/ILO Fire Team of Specialists on Forest Fire and the GFMC Advisory Board will further elaborate on the formation of the INSARAG Wildland Fire Group. It is expected that the INSARAG Europe-Africa Region will be the first to establish the fire component by November 2000; other INSARAG regions are expected to follow and jointly form a network of regional INSARAG Fire Nodes.

During its formation phase the future INSARAG Wildland Fire Subgroup already became operational at the occasion of the forest fire emergency in Ethiopia between February and April 2000. The coordination of a multinational fire fighting task force through the GFMC involved participation of Germany, South Africa, and the United States.

A report - a narrative of the events - is given in the first contribution of this IFFN issue. It reveals that this fire fighting campaign was the very first and successful multinational intervention in a tropical developing country in history. From the beginning of the situation the GFMC, in close collaboration with the Government of Ethiopia and the German Agency for Technical Cooperation (GTZ), has assessed, monitored and supported the campaign in the multinational task force and the United Nations Environment Programme (UNEP) successfully cooperated with the staff of the Ministry of Agriculture, the Armed Forces of Ethiopia, and the numerous villagers and enthusiastic students which provided voluntary help. This smoothly working cooperation is acknowledged here.

The Ethiopia case shows that the international expertise and willingness to manage extreme fire situations under the socio-economic and environmental conditions of a "foreign" country is available. In this context I would like to announce that in the next issue of IFFN a report will be given on the Fire Working Group of the Global Observation of the Forest Cover (GOFC-Fire) initiative of the Committee of Earth Observation Satellites (CEOS) which was established in November 1999. The activities of GOFC-Fire are devoted to develop and promote remote sensing technologies for efficient fire management application and policy support.

Freiburg, April 2000 — Johann G. Goldammer

INSARAG

ETHIOPIA FIRE SPECIAL

The Ethiopia Fire Emergency between February and April 2000

A Summary Retrospective

Between late February and early April 2000 severe forest fires occurred in the mountain forests of Ethiopia. Following a request from the government of Ethiopia the very first and successful multi-national wildland fire fighting campaign in history was initiated in a developing tropical country. This summary provides a narrative of the events as they took place after the Global Fire Monitoring Center (GFMC) had been contacted on 18 February 2000.

The Situation in the Second Half of February 2000

On 18 February 2000 the Federal Ministry of Agriculture (MoA) of Ethiopia receives reports that uncontrolled forest fires have started in different parts of the country. On 20 March the forest advisor to the Ministry of the Deutsche Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation - GTZ) identifies the website of the Global Fire Monitoring Center (GFMC). On 20 February he contacts the GFMC and describes the situation. At this point, the extent of these fires is not yet known, but at the end of the dry season the situation looks serious. Some of the fires had started in woodland areas (lowlands) but have already encroached the neighbouring afro-montane forest areas. The MoA is very concerned about the situation and launches two reconnaissance surveys on 18 February to more accurately assess the situation. Since local capacities for fire fighting are limited (no fire fighting equipment and no special know-how and experience of forestry experts available), it is considered to explore whether there are any possibilities for international assistance in this matter.

On 23 February the Ministry of Agriculture receives more detailed reports on two larger forest fires in Oromiya Regional State. Both fires started in transition zones between woodland and forest areas and have since encroached on the forest. One of the affected areas is located in the Borana Administrative Zone, near Shakiso town. Reportedly, out of a total forested area of 80,000 ha, about 10,000 had been burnt at this stage. There are three major fires in different locations. A task force consisting of forestry experts of all administrative levels and the local administration is established and manages to mobilise the local population for fire fighting activities. A mining company that is operating in the area joins forces and provides heavy equipment like bulldozers and trucks. The MoA and the Regional Agricultural Bureau organises hand tools for fire fighting.

The other affected location is the Bale Massive in the Bale Administrative Zone. The fire encroached one of the state forests which are designated National Forest Priority Area (FPA) and reportedly burned 2500 ha. There are four different FPAs located in this area, totalling some 580,000 ha of forested land. The forests are in most parts disturbed or even heavily disturbed which has resulted in the increased production of combustible biomass, i.e. grasses and herbs. The state forests surround Bale National Park from three directions. The Bale NP is famous for being inhabited by endemic species such as the Ethiopian Wolf and the Mountain Nyala. Because of its great floristic and faunistic diversity, UNESCO has designated the Bale Mountain Area as one of its 200 worldwide Bio Regions, the only one located in Ethiopia. 600 ha of the afro-alpine vegetation in the Park have been burnt but adjoining communities, environmental clubs and school students successfully extinguish the fire. According to one report, the fire was already as close as 80 km to Dinsho, the National Park headquarters. As in the other area, there are different smaller fires constituting the fire threat. Apparently, there is not much fire expansion during the daytime. It mostly occurs during the night when the wind picks up. At this stage the situation needed further assessment but was hoped that the fire could be controlled with local resources. A major problem is the difficult accessibility of the forest areas. The terrain is rugged and dissected. Fire fighters had to walk several hours to reach the fire fronts and were already exhausted by the time they arrive. There is also a shortage of fire fighting hand tools, but additional fire beaters were on the way.

While the lowland areas of the country are burnt regularly and in many parts even annually, forest fires of this extent have not been reported since 1984 when the country was struck by a major drought. It became apparent that there is a lack of specialist know-how in fire fighting and fire management in the country and that there are insufficient capacities for fighting forest fires of this magnitude in all aspects. Therefore, there is a plan to embark on a program for building fire fighting capacities amongst the forest administration. The services of the Global Fire Monitoring Center (GFMC) will be instrumental in this regard.

27 February 2000

The GFMC disseminates a fire situation report and calls for attention and assistance of fire specialists and government authorities in South Africa, Ethiopia, Namibia, Zimbabwe and Ethiopia. At this stage the government of Ethiopia launches its first request for assistance from South Africa. The deployment of South African helicopters to Ethiopia to support fire fighting in the remote areas is rejected due to the high demand for helicopters for rescuing people from the flood-stricken regions of Mozambique, a very prominent humanitarian task.

1-5 March 2000: Commence of the International Response

On 1 March a fire specialist from the GFMC is dispatched to Ethiopia. On 2 March a first situation analysis by GFMC-GTZ is submitted to the government of Ethiopia. It is recommended to immediately request international assistance in delivering hand tools for fire fighting. In addition it is recommended to accept the offer of the Republic of South Africa to deploy a team of three experts to assist the country in fighting the fires. The GTZ-GFMC team is in close contact with US institutions to continuously receive medium- to high resolution near-real time satellite maps (DMSP, NOAA AVHRR). It is proposed to transmit the maps directly to the US embassy in Addis Ababa and the Ministry and to forward the satellite data to the field to support emergency measures. Between Friday 3 and Sunday 5 March 2000 a mixed Ethiopian-German team is dispatched to the fire region South of Addis Ababa and is joined by the South African team on 4 March.

Fig.1. Aerial view of burning mountain forests in Bale Region (Photo dated 4 March 2000)

6-9 March 2000: Formation of an International Fire Emergency Advisory Group

On 6 March 2000 an International Fire Emergency Advisory Group is formed consisting of Ethiopian, GFMC, German, South African and US experts and set up an Incident Command System (ICS). The international community and the media are briefed on the situation in Addis Ababa.

Extracts of the original text of the briefing:

Brief situation assessment

Aerial impressions collected during survey flights on 3-5 March lead to the conclusions that several ten thousands hectares of natural mountain forest have been affected by fire. Numerous fires continued to burn in the last days. Currently there is no reliable damage survey or monitoring system in place.

The quick response of the mission to explore the fire situation did not allow an in-depth investigation of the role of natural and anthropogenic fires in the montane forests of Ethiopia. At this stage the international fire team knows the results of a restricted number of previous investigations which have been conducted in the area. Concluding from this literature, the mountain forests (all broadleaved and mixed broadleaved-coniferous montane forests) represent hotspots of biodiversity are neither adapted nor dependent on recurrent fire. This statement does not exclude the fact that fires have occurred in the past and that burned forest patches have recovered over long fire-free periods.

The current demographic and socio-economic conditions have led to an unprecedented pressure on the remaining mountain forest ecosystems. The reasons for forest clearing by fire are obvious.

Regardless of any uncertainties on the short- and long-term ecological role of fire in these forests all measures have to be taken to protect those forests from conversion and wildfires. The extended drought in the region has aggravated the situation and calls for immediate response.

For this reason it is necessary to immediately take all necessary steps to stop further forest destruction both short-term and long-term. The mobilization of national and international efforts in fighting the current fires is an important step towards a clear commitment to save the endangered forest resources of the country.

We, the international fire experts, agree that after completion of the immediate fire fighting response medium- and long-term fire management programs must follow on the base of a national land-use and fire policy.

Definition of priorities for international assistance in immediate fire-fighting response

Two main fire regions have to be addressed. First, the fires starting in the vicinity of settlements are mainly conversion fires and wildfires escaping from conversion fires. Prevention and suppression of these fires need national and international support both in terms of providing technical advice and logistics, including appropriate technologies. Those fire problem areas which are located in accessible terrain or can be reached in reasonable travel distances are currently taken care by the local population, volunteers and the Armed Forces.

The most alarming fires are burning in the closed mountain forest sites which so far have been excluded from agricultural and pastoral use and the use of fire. During the last weeks large-scale wildfires have spread to these forests and have caused extremely high damage. These fires burn in extremely inaccessible and very steep terrain. The fire sites cannot be reached by ground transport. The only option to suppress these fires is by aerial (helicopter) deployment of specialized fire fighter crews.

Since fighting of any of these fires in extreme terrain involves high investments in terms of finances, personnel and risks, there is no way to attempt extinguishing all detected fires.

Priority areas have to be determined and clearly demarcated. This requires mapping and prioritization.

However, the fire experts recommend to set up an international fire suppression team to contain these priority fires as soon as possible. It is recommended to recruit finances, personnel and logistics on 7 March 2000. The international fire brigades shall be reinforced by the Ethiopian Armed Forces and become operational by mid of the second week of March.

Response requirements

The minimum requirements for using international fire suppression crews in the burning closed mountain forests were listed and included hand tools, airborne Helicopter fire suppression crews, two helicopter Bambi buckets, VHF communication sets (for ground/aircraft communication), one C-206 fire spotter plane (with pilot and aerial fire boss), daily monitoring of fires and weather forecast, helicopter fire fighting instructors and technicians, and fire crew training.

Ethiopia should make available two MI-17 helicopters with crews (it is recommended that these crews should be specifically trained for fire fighting activities by an experienced instructor through on-the-job training); replacement crews for work in shifts must be provided; fuel supply for the duration of the operations (helicopter fuel and Avgas for spotter plane); a group of 20 highly motivated and physically fit members of the Army for aerial crew reinforcement; establishment of the Fire Operations Base Camp; radio station for Fire Operations Base Camp; logistical Support team.

Additional international support should include one Fire Boss/Incident Commander; additional hand tools for ground fire crews in nearby areas; continuation of satellite-derived delivery of fire maps; two additional *helicopters (with winch equipment); four additional fire fighting crews; in kind or cash contributions for fuel and food supply.*

Fire Weather Forecast for Ethiopia

The fire weather forecast for Ethiopia during the Ethiopia fire crisis was generated on a daily base by Net Forecasting. This independent weather forecast service from South Africa usually provides fire weather forecasts for the South African Fire Fighting Association (FFA). The government of South Africa provided the finances of this special Ethiopia forecast under the umbrella of humanitarian aid.

Net Forecasting provided daily two 6-days fire weather forecasts for Addis Ababa and Goba regions for 14:00h and daily fire weather forecast maps on the base of resources from the European Center For Medium Range Weather Forecasts (ECMWF) and the United Kingdom Meteorological Office (UKMO).

Tab.1. Goba Area Forecast for 14:00 h GMT Wednesday 29 March 2000

6 Day 14h00 Forecast Ethiopia Region Goba Area							
Day	Temp (C)	Hum (%)	W Dir	WSpd (km/h)	Bar (Hpa)	FDI	Tendency
Wed 29	28	54	SE	14	1005	53 Yellow	
Thu 30	26	43	SE	17	1008	57 Yellow	
Fri 31	27	39	SE	19	1007	62 Orange	
Sat 1	25	47	SW	17	1005	55 Yellow	
Sun 2	24	49	SE	15	1007	52 Yellow	
Mon 3	24	51	SE	17	1008	52 Yellow	

Satellite Remote Sensing of Fires

The United States National Oceanic and Atmospheric Administration (NOAA), National Environmental Satellite, Data, and Information Service (NESDIS), International and Interagency Affairs Office, on the request of the Government of Ethiopia through its embassy in Addis Ababa, provided the following remote sensing information:

U.S. Air Force Defense Meteorological Satellite Program (DMSP)

The DMSP Operational Linescan System has the capability to detect fires at night in a light intensified visible channel. DMSP images were provided at 2.7 km resolution for the East African region. A special survey area where the fires occurred (Goba and Shakiso Regions - 5-9°N, 38-42°E were produced daily between Monday through Friday.

NOAA Advanced Very High Resolution Radiometer (AVHRR)

The NOAA AVHRR has been designed to provide information for meteorological, hydrologic and oceanographic studies. POES AVHRR Local Area Coverage (LAC) 1 km resolution data recorded onto NOAA-14 spacecraft were processed from 8 to 10 March and occasionally later. Restrictions were due to the fact that the satellite's orbital track changed and the spacecraft did not image directly over Ethiopia due to other commitments for recording 1x1 km resolution data.

The Situation between 8 and 14 March 2000: Building up the Field Forces

Three crew leaders from the Republic of South Africa (RSA) arrive on 8 March. A South African and a US fire specialist leave for Robe/Goba in order to carry out some training of ground crew leaders.

The spotter plane from South Africa arrives on Friday 10 March afternoon. Later that day 15 forest fire fighters arrive from Johannesburg, South Africa. On 11 March they are dispatched to Goba Base Camp and joined by 15 Ethiopian soldiers.

On Saturday morning it is reported from Bale Zone that students from an agricultural training center, soldiers and community members succeeded to contain the fires in Kumbi Forest (south west of the Bale National Park).

On 12 March 2000 the South African pilot trainer, technician and additional four crew leaders arrive. On 13 March 2000 the helicopter-based fire fighting operations come into full swing in Bale Zone. 38 fire fighters (18 South African and 20 Ethiopian), which are organised in four teams, contain fires extending over an area of 25 ha in Berbere and Goro locations in the east of the National Park.

On 14 March 2000 a shipment of 320 back-pack water pumps from Germany arrive by special air freight from Germany in the morning.

The Situation between 15 and 28 March 2000

On 15 March the Global Fire Monitoring Center (GFMC) approaches the UNEP and suggested a cash donation to ensure the continuation of South African fire fighter involvement. On 17 March the government of Ethiopia officially requests UNEP assistance.

Parallel to the UNEP negotiations the GFMC discussed a contribution of the United Kingdom to upgrade the national Ethiopian remote sensing capabilities for fire detection.

Meanwhile 271 mobilised fire fighters (community members, militia men, etc.) have been trained successfully in fire fighting techniques. The previously trained Ethiopian soldiers effectively contribute as trainers and, hence, to the training success.

On 21 March 2000 the United Nations Environment Programme (UNEP) hands over a cash donation of $US 20,000. As scheduled, 14 fire fighters from South Africa return to their home country. The remaining teams continue with training and actual fire fighting in Shakiso area. Funding for this is covered by the UNEP contribution.

On 22 March reports are obtained about new outbreaks of fires in Nechisar (Southern Region, East of Arba Minch) and Awash (Affar Region) National Parks. The Ethiopian Ministry of Agriculture (MoA) did not receive any detailed information on the fires, but it is believed that the fires were occurring in woodland, bushland and grassland ecosystems. All of these are adapted to fire and, hence, do not call for immediate fire fighting action. The fires presumably had been started by pastoralist groups which are residing close to or even inside the parks in order to encourage growth of fresh grass and to eliminate tick populations. The Ministry dispatched some of the withheld back-pack water pumps from Germany to Nechisar Park to make sure that the fires there do not spread into the unique ground water forests of Arba Minch.

On 24 March the fire in Nechisar National Park is contained. It is estimated that 10 to 15% of the total Park Area had been burned. The spotter continues to survey the area and reports to the Incident Command. There is still a serious fire around Amare Mountain, which is located east of the National Park. Another fire is reported from Butajira Mountain (Gurarghe Mountain), approximately 100 km SSW of Addis Ababa. The fire reportedly is raging in the *Erica arborea* Zone of the forest, but no details are known yet.

The remaining South African fire fighters are deployed to combat a fire close to the microwave tower nearby Shakiso town. The fire had been contained at the access road to the tower last night and the suppression activities are presently continued. Winds are fairly strong on 24 March, but calmed down on 25 March. There are no reports about rains.

On 26 March heavy showers are occurring on 24-25 March in Bale Zone around Dolo Mena. The quality of water bombing continues to improve and proves very effective in supporting the ground crews around a fire-threatened micro wave tower. Apart from the already reported rains, no new rainfalls are received in either of the two zones.

All South Africans leave Ethiopia on 29 March as scheduled. On 28 March the South African Embassy had organized a reception in their honour. and they all left with a set of traditional Ethiopian clothes - farewell presents of the Ethiopian Government.

On 31 March reports were received that there were heavy showers, in both Borana and Bale Zones, on 29 and 30 March 2000.

The number of civilians and soldiers that were trained in fire fighting techniques totals 755 on 30 March 2000. Hence, considerable capacities have been built during the fire incident. The Incident Command Team continues to monitor the situation.

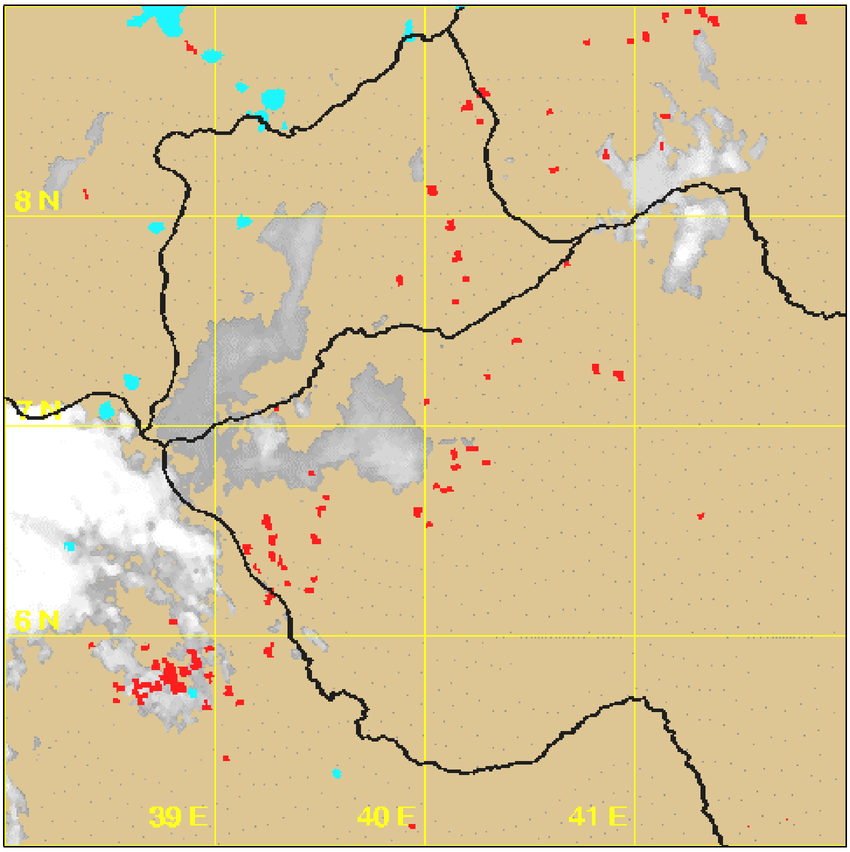

Fig.2. DMSP scene of the Bale region and Borana , 10 March 2000 (upper left corner 9°N, 38°E; lower right corner 5°N, 42°E).

7 April 08:00 GMT: Fires Under Control

On Wednesday 5 April 2000 the Vice Minister of the Ethiopian Ministry of Agriculture, Mr.Belay Ejigu, gives a press conference on the Forest Fires in Bale and Borana Zones. He declares that the wildfires in these Zones are suppressed. The experts of the Ministry of Agriculture are called back to Addis Ababa and asked to prepare their final reports. Except for continued monitoring of the situation by zonal experts the fire fighting activities are being completed for the time being.

Resumé by the GFMC (7 April 2000)

The Global Fire Monitoring Center (GFMC) congratulated national Ethiopian and international partners for successful collaboration in combating the disastrous wildfires.

This fire fighting campaign - the very first and successful multinational intervention in history - had started in late February 2000. On request of the Government of Ethiopia immediate situation analysis and subsequent assistance was provided by a group of countries. The agencies officially involved through the diplomatic channels and the individual fire specialists dispatched to Ethiopia or supporting the campaign from their home offices worked together smoothly and efficiently.

From the beginning of the situation the GFMC, in close collaboration with the Government of Ethiopia and the German Agency for Technical Cooperation (GTZ), has assessed, monitored and supported the campaign in which Germany, South Africa, the United States of America, and the United Nations Environment Programme (UNEP) successfully cooperated with the staff of the Ministry of Agriculture, the Armed Forces of Ethiopia, and the numerous villagers and enthusiastic students which provided voluntary help.

At the peak of the campaign more than 70,000 people have been involved in fire-fighting. All worked together to save the ecologically and biodiversity rich assets of the afro-montane forests of Ethiopia.

More challenges are ahead: The burning of forests and the escaping of wildfires will continue. In order to address uncontrolled and destructive wildfires a long-term prevention and preparedness program in fire management must be installed. The need for such development does not only apply for Ethiopia but also for all other countries in Africa. Following the example of Namibia, a National Round Table on Fire will be convened soon in Ethiopia. At this Round Table all national stakeholders involved in land-use and fire problems will be convened, together with the international community.

Ethiopia is facing another major environmental and humanitarian crisis. The prolonged drought has caused a major decline if agricultural and pastoral production. Millions of Ethiopian people are endangered by famine and death. International solidarity is required to respond fast.

The conflicts are visible: People need land and food. Forests are "reserve" lands for providing space for the rapidly expanding populations. If we all want to save human lives and the forests we need to act responsibly. Let us not forget that humanitarian and environmental disasters interact or cause each other.

The GFMC will further follow the fire situation in Ethiopia. The GFMC has to go back to its working mode which currently allows updating of the global fire situation only during weekdays due to limited finances and personnel.

Johann G. Goldammer
Head, Global Fire Monitoring Center

Fig.3. In traditional slash-and-burn agriculture systems of Ethiopia the forest is not cleared completely. Trees remain for providing shade and regeneration after fields are abandoned.

COUNTRY NOTES

ALGERIA

Forest Fires in Algeria and the Case of the Domanial Forest of Bou-Taleb, Setif

Introduction

Among the factors that threaten the forests of Algeria fire constitutes the most dangerous factor and causes severe ecological, economic and, sometimes, human losses. Within some hours fire destroys what has naturally grown over years and centuries.

In Algeria, the fire statistics established for nine years (1979-1987) provide an average of 37,000 ha of burned surface (Tab.1) (Madoui 1988). Seen its negative aspects, fire is considered like a curse of which we must face periodically. The forest law (forest code) clearly state the struggle against forest fires being a duty of all citizens.

Tab.1. Statistics of fires in forest and non-forest lands (scrub, brushwood, Alfa) during the period 1979-87. Source: Ministry for Water Resources and Forestry, Algeria (1987)

Year	Number of Fires	Burned surface (ha)		Total burned area (ha)	Average area burned (ha)
		Forest Land	Non-Forest Land		
1979	361	15,663	95	15,758	43.65
1980	730	19,731	7,215	26,946	36.91
1981	796	8,982	7,378	16,360	20.55
1982	638	7,354	2,027	9,381	14.70
1983	990	133,042	87,528	220,570	222.80
1984	562	1,398	2,981	4,379	7.79
1985	747	1,757	3,274	5,031	6.73
1986	1,170	7,920	3,689	11,609	9.92
1987	1,321	10,439	12,862	23,301	17.64
Total	**7,315**	**206,286**	**127,049**	**333,335**	**45.57**

Every year a considerable budget is assigned for the active control of forest fires. However, fires continue to affect large vegetated areas. The data of 1983 are unforgettable in the memories of foresters and firemen. This situation was the reason why we conducted the survey presented in this paper to contribute data on forest fires in Algeria and particularly in mountains of Bou-Taleb. From an ecological point of view Bou-Taleb is a primordial importance because it acts as a natural barrier between the influences of the desert and the city of Setif. The mountains are occupied by the most important plant formations in Algeria with tree species such as cedar (*Cedrus libanotica ssp. atlantica* (Manetti) Holm.), oak (*Quercus rotundifolia* Lamk.), and pine (*Pinus halepensis* Mill.).

Characterisation of the Survey Zone

Being located in a distance of about 50 km inland from the coastline the massif of Bou-Taleb is situated between the high plains of Setif in the north and the basin of Hodna in the south. It is part of the mountain chain of Hodna and constitutes an important mountain link but is well fragmented in its oriental part (Fig.1).

The existence many *chaabet* (*chaâba* = ravine) and the relatively elevated altitude of these *djebels* give the massif of Bou-Taleb an extremely intersected relief in its whole. Prevailing steep slopes in its southern part and the sparse vegetative cover encouraged significant hydric erosion after summer downpours. From the climatic viewpoint the lower altitudes are characterized by a semi-arid bioclimate with cool winters in the north, cold winters in the south, and very cold winters in the sub-humid high altitudes. The average annual precipitation ranges between 300 and 600 mm. The dry season is longer at low altitudes and can last up to five months; in the higher altitudes a short dry season usually does not exceed three months.

State of Forest Fires in the Domanial Forest of Bou-Taleb

The number of forest fires recorded in Bou-Taleb, compared to the data noted by Boudy (1955), is in rise since the independence, but irregularly. To highlight this observation, two statistical overviews on fire occurrence have been established for this region. The first concerns the period before the independence and covers the period 1907 to 1957; the second concerns the period after the independence for the period 1971 to 1991 (Tab.2).

During the first period of 51 years, 77 fires have been recorded in Bou-Taleb which destroyed a surface of more than 14,15O hectares, with an average of 1.5 fires per year and an annual mean surface burned of 277 ha. During this period half of the forest vegetation of Bou-Taleb has been devastated (49.76%).

Among the total of all fires recorded half of the number of fires (38 fire locations) devastated six main districts located all on the South flanks of the massif: Kef Haoumars (8 fires); Bou-Rièche (7 fires); Afghan, Thniet Sefra, and Chaabet Khrouf with 6 fires each and finally the Grouve canton with 5 fires. The surfaces affected, however, are relatively small as compared to the total fire occurrence.

Tab.2. Distribution of fires by canton (district) in the domanial forest of Bou-Taleb

Period	**1907-1957 (51 years)**		**1971-1991 (21 years)**	
Cantons (Districts)	**Number**	**Burned surface (ha)**	**Number**	**Burned surface (ha)**
Kef Haoumar	8	836	1	5
Bou-Rièche	7	17	5	4
Afghane	6	8	3	11
Thniet Sefra	6	8	3	30
Chaabet Khrouf	6	181	3	9
Grouve	5	3	3	11
Bou-Ich	1	1,004	4	24
Tinzert	1	167	5	10
Total	**40**	**2,224**	**27**	**104**

It must be noted that in the years 1956 and 1957 the largest burned areas was recorded (10,300 ha) which corresponds to 73% of the total area burned; they corresponded to the war of Algeria (Madoui 1995).

On the other hand the fire statistics for the second period (21 years) show that 63 fires have been recorded in Bou-Taleb which destroyed more than 511 ha, with an average of three fires by year and a yearly mean surface of 24 ha.

The distribution of these fires in the massif, by canton, is irregular and have affected almost all mountains (Fig.1). Table 2 shows that the Bou-Rièche cantons, Tinzert, and Bou-Ich are most affected. In the period of 21 years, these cantons recorded 5 fires and 5 and 4 fires respectively, with the burned surfaces distinctly lower than the mean, except for the Bou-Ich canton.

The canton which recorded the largest burned surface is Chaabet Said and a small part of canton Bou-Rhioul with 225 ha devastated by only one fire. In the massif these two cantons are colonised by a green oak scrub (*Quercus rotundifolia* Lamk.) mixed with juniper (*Juniperus oxycedrus* L.). In some places juniper is dominating. This type of population is not as vulnerable to fires as pine populations but the fire has been encouraged by two favourable factors, the violent winds (sirocco) and a rich and very abundant herbaceous stratum (notably *Aegylops ovata* Eig., *Cynosurus elegans* Desf., *Echinaria capitata* (L.) Desf.).

Come then cantons, Arrhas, Afghan, Chaabet Khrouf, Hadjar Labiod, Thniet Sefra, Oued-guebala, Grouve, Makhrouze with three fires each. Among them, the Oued-Guebala canton is most sensible. Within 21 years more than 72 ha have been affected by fires. One of the major reason was the lack of accessibility (lack of forest roads) which made fire suppression extremely difficult.

All reports are in agreement concerning species affected by fire. As indicated by Le Houerou (1973) and Quezel (1980) Aleppo Pine (*Pinus halepensis* Mill.) is mainly affected, followed mostly by green oak (*Quercus* *rotundifolia* Lamk.) and (or) Juniper (*Juniperus oxycedrus* L.). According to Boudy (1955), the Algerian pine populations attract fire.

Causes of Fires

Vegetation fires are rarely ignited by natural causes. In Bou-Taleb, for instance, no single fire has been caused by lightning, the only possible natural fire cause. The activities of humans, either directly or indirectly, are exclusively causes of wildfires (Boudy 1952).

The statistical data for the 15-year period 1977 to 1991, for which we have almost complete information, show the importance of the unknown origin of fires. Unknown caused fires represent 82% of all cases; they consumed more than 409 ha, equivalent to 94% of the burned surface. Ranking net are fires caused by carelessness, mainly by smokers who throw glowing cigarettes or matches which act as embers in the wind. This category of causes is weak in Bou-Taleb by only representing 6% of all cases.

Another underlying cause of fire are conflicts between residents and forest authorities. Those residents and forest owners who had been penalised by forest rangers due to violation of laws, such as illegal grazing or wood cutting, start fires as an act of revenge. This category of causes is hidden in category unknown and most likely represent a considerable part.

Evolution of Fire Causes in Space and Time

Since our figures established for the domanial forest of Bou-Taleb for a period of 15 years are significant, we considered it useful to compare them with other, more ancient statistics.

The comparison of our present data to those recorded before the independence allows to reconstruct the long-term evolution of fire causes (Tab.3).

Tab.3. Comparison of fire causes (%) during the two observation periods 1907-1957 and 1977-1991

Causes of forest fires	Period 1907-1957	Period 1977-1991
Natural causes Lightning	2.60 %	
Negligence Smokers Hunters of honey Other	51.95 %	17.78 %
Arson	7.79 %	
Unknown causes	37.66 %	82.22 %

The first observation reveals that there is a big difference between the two periods. We have an increase at the level of percentages of the unknown origin fires and reduction at the level of those of fires caused by carelessness. Following explanations are possible:

* the increase of causes declared of unknown origin maybe due to insufficient investigations to determine the real causes and to rigorously enforce sanctions;
* forest management is less intensive, and supervision is more superficially than in the early days, probably because of decreased productivity and the general loss of economic interest; and
* the reduction of the carelessly started fires may be explained by the fact that currently the forest is less inhabited than in the earlier days when rural activities involved a higher fire risk.

The comparison of present fire cause statistics with earlier statistics reveal several tendencies (Tab.4). It seems that before independence the share of unknown cause is lower than at present: 37.7% versus 82%. On the other side the share of 52% of carelessly caused fires were much higher than at present (17.8%). However, the large fires are caused by arson. This category represents 7.8% of all fire causes before the independence versus 0% after. However, actually this category of causes nowadays would be more important if investigations had been conducted more rigorously by the concerned services; this fact explains the elevated percentage of unknown causes.

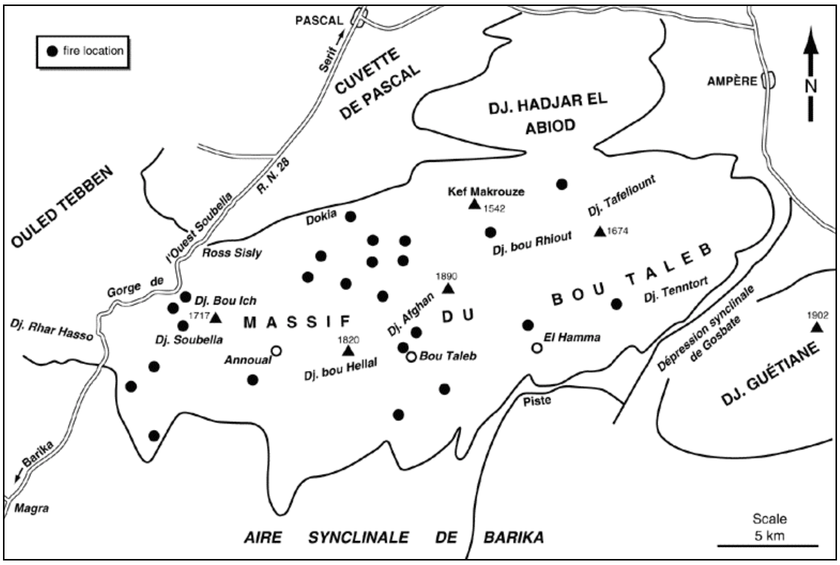

Fig.1. Fire locations in the massif Bou-Taleb

Tab.4. Vegetation fires in the forest massif of Bou-Taleb: causes, frequencies, and burned surfaces. Source: Local fire reports

Period	**1907-1957 (51 years)**				**1977-1991 (15 years)**			
Fire Causes	**Number**	**%**	**Surface burned (ha)**	**Surface burned %**	**Number**	**%**	**Surface burned (ha)**	**Surface burned %**
Negligence	40	51.9	1115.1241	7.9	8	19.8	25.4700	5.9
Unknown	29	37.7	543.8502	3.8	37	82.2	409.0831	94.1
Arson	6	7.8	12200.0000	86.2	-	-	-	-
Lightning	2	2.6	290.4500	2.1	-	-	-	-
Total *	**77**	**100**	**13949.4243**	**100**	**45**	**100**	**434.5531**	**100**

***** *The difference in the total is due of absence of information for some years; so they are not included in this data.*

It is noteworthy to mention lighting-caused fires. The share before the independence was 2.6% of the total number of fires whereas they are absent to our time. One of the possible explanations is that climate changed from more humid to dry.

Seasonality of Forest Fires

Before independence the occurrence of fires was distributed fairly balanced all over the year. Among the 77 fires recorded in Bou-Taleb only 36 were recorded in summer (46.7%), 31 into spring (40.3%) and only 10 (13%) in winter (Tab.5). This distribution of fire occurrences all year round maybe explained by the role the domanial forest of Bou-Taleb played to meet the needs of the local population, especially during the extreme exploitation phase during World War II. According to Boudy (1955) 140,000 steers of green oak and pine and 8,300 m^3 of pine wood were harvested at that time.

Tab.5. Distribution of fires by season

Period	1907-1957 (51 years)		1971-1991 (21 years)	
Seasons	Number of fires	Percentage %	Number of fires	Percentage %
Summer	36	46.7	56	88.9
Winter	10	13.0	3	4.8
Spring	31	40.3	34	6.3
Total	**77**	**100**	**63**	**100**

Currently most reported fires in Bou-Taleb (88.9%) take place in the hot summer months June to September, a period during which the forest is frequently visited for grazing, collecting honey, and picking fruits. The remainder of fires takes place at the end of the spring and the beginning of the winter with 6.4% and 4.8% respectively of all cases. Most fires start in July (41%), mainly during daytime. The concentration of fires is between 09:00h and 18:00h with 50 fires equalling 92.6% of the total number. The majority of fires (43, equalling 79.6%) occur between 11:00h and 17:00h. Only 4 fires (7.4%) occur at night between 21:00h and 08:00h in the morning. It must be assumed that fires started by carelessness start during daytime while night fires can be mainly arson fires (Ministry for Water Resources and Forestry, Algeria 1987).

Tab.6. Long-term forest fire statistics for Algeria: Period 1876 - 1915

Year	Number of Fires	Burnt Surface (ha)	Year	Number of Fires	Burnt Surface (ha)
1876	120	55,172	1896	179	14,091
1877	134	40,538	1897	396	79,203
1878	164	8,156	1898	150	12,384
1879	218	17,663	1899	272	16,099
1880	137	20,881	1900	162	2,937
1881	244	169,056	1901	135	9,687
1882	130	4,018	1902	475	141,141
1883	148	2,464	1903	388	94,398
1884	147	3,232	1904	244	2,759
1885	285	51,569	1905	255	7,676
1886	288	14,043	1906	219	9,126
1887	395	53,714	1907	211	4,457
1888	311	14,788	1908	344	6,54
1889	309	17,807	1909	278	9,751
1890	202	23,165	1910	482	24,294
1891	393	45,924	1911	322	16,309
1892	409	135,574	1912	338	26,505
1893	398	47,757	1913	696	138,191
1894	308	100,89	1914	362	43,305
1895	250	32,907	1915	237	19,35

Tab.7. Long-term forest fire statistics for Algeria: Period 1963 - 1991

Year	Number of Fires	Burnt Surface (x 1000 ha)	Year	Number of Fires	Burnt Surface (x 1000 ha)
1963		3.9233	1978		41.551672
1964		9.38572	1979		15.66256
1965		50.624281	1980		26.944609
1966		2.50343	1981		17.361391
1967		49.56148	1982	638	9.38176
1968		14.54981	1983	990	221.367
1969		13.31432	1984	562	4.73184
1970		30.43867	1985	747	4.6683
1971		57.83518	1986	1170	21.53775
1972		4.09776	1987	1321	23.300359
1973		34.53025	1988	1146	27.757801
1974		11.0025	1989	595	3.23666
1975		37.331	1990	911	28.046529
1976		19.945289	1991	1189	13.17615
1977		43.947			

Conclusions

Fires in forest and other vegetation are a common feature in Mediterranean ecosystems, including in the biogeographical region of Algeria, and have contributed to shape vegetation composition and model landscapes. With the modern increase of wildfire frequency a catastrophic dimension has been reached and it is time to think seriously about taking action to reduce the negative impacts of fire. The statistical approach presented in this paper contributes towards a better understanding of the role and causes of fires and will facilitate the search for solutions. As Effenterre (1990) points out, an analysis of the vegetation types affected by fire allows to determine the need for reforestation including the selection of species which are best adapted to a fire environment. Action must be taken.

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BRAZIL

Ten Years Monitoring and Mapping Fires in Brazil
Current Products and Information Networks

Introduction

The burned areas in Brazil have been the cause of much concern and controversy. The burnings affect many ecological and agricultural systems, creating negative environmental impacts on both local and regional level. Unlike the temperate forests, the Brazilian tropical forests (Amazon and Atlantic forests) do not burn by accident, nor because of lightnings, not even if someone sets fire on them. Almost all the different kinds of forests that occur in the Amazon Basin and in the Atlantic Coastal areas are too humid to burn. Many of them - like *Igapó* forests or palm tree forests - are literally under the water, six to eight months a year. The so-called *terra firme* forests ("highlands" vegetation) are the driest forest types. But even there, accidental fires only occur if the vegetation is disturbed as a consequence of logging and trails formed by hunters trails. Here, branches and leaves are exposed to the sun and become dry and highly flammable after a very dry season. During the last 10 years of the fire monitoring programme extremely large wildfires on uncut forested areas were observed only twice: at a very disturbed area near Santarém, state of Pará, and at Roraima State, both during severe dry seasons, due to El Niño episodes.

In the Brazilian Amazon forests fire is used because it is the cheapest way to reduce the logging residuals, to control weeds and pests, to renew pastures and to harvest some crops (specially sugar cane). Trees have to be cut down, then dried during a period of several months, to be ready for burning. That is why Brazilians distinguish burnings (*queimadas*) from wildfires (*incêndios*). Burnings are made purposely. Wildfires can be the result of uncontrolled burnings, that reach the native vegetation, besides all other well known fire causes, e.g. cigarettes on roadside grasslands, lightnings, arson, etc.

Some 20% of the Amazon region, however, is covered by grasslands or savannahs (, called *cerrados*) with small dispersed trees. Like the African savannahs, this vegetation burns easily and periodically. But, still there, natural fires are minor. The *cerrados* usually are the first patches of wildland occupied by farmers and settlers, because it demands less efforts to be cultivated. The burnings, in fact, have been occurring all over Brazil for centuries.

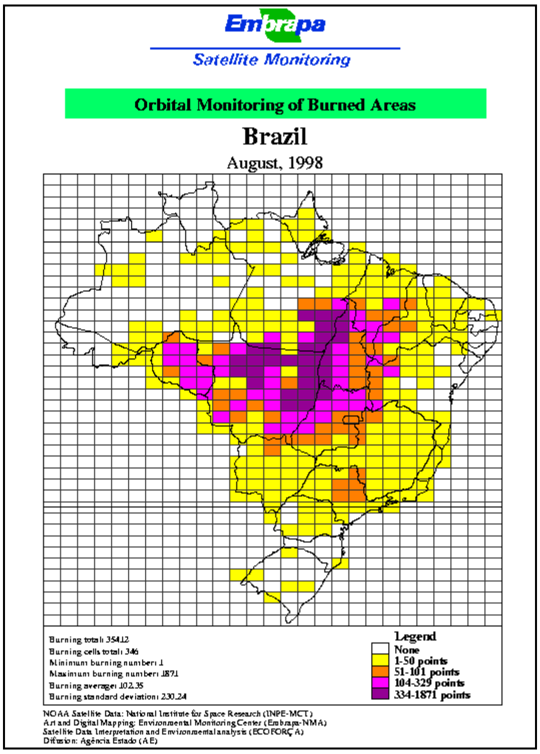
By 1987, the NOAA/AVHRR images were first successfully tested to identify the burnings. The team at the National Institute for Space Research (INPE) in São Paulo state used the temperature sensor of the North American meteorological satellite (NOAA AVHRR) to localize burning and burned areas. Their purpose was to produce a list of geographical coordinates, spotting the major fires for the Brazilian Environmental Agency (IBAMA), supposed to fiscalize those burnings in the field. In 1988, the scientists decided to send the information also to the press. The Agência Estado (AE) news wire service started a public campaign to stop the Amazon burnings, using this data.

The monitoring of the burnings became a routine. Since 1988, burnings are listed and counted every day, during the whole dry season (from June to October or November), not only on the Amazon Basin, but all over Brazil and, sometimes also on the territories of neighbour countries. After the main media campaign against the Amazon burnings, in 1989 and 1990, Brazilian scientists started to produce better maps. An agreement was made among INPE, AE, the Environmental Monitoring Center (NMA) and an NGO called *Ecoforce* (Ecoforce - Research & Development <http://www.ecof.org.br>) in order to produce maps that could be easily understood by the general public. Developing activities, through agreements and scientific partnerships, the NMA adjusted and spread out knowledge in the geoprocessing applications area (remote sensing and digital cartography) for agriculture and the environment. Acting over all national territory, it assists federal, state, and municipal entities and the private initiative.

Current Products and Information Networks

Since 1991, as a public service of information, weekly burnings maps were published on several newspapers with an interpretation. A mapping system is also available on Internet, since then. One may consult weekly, monthly and annual burning maps, of either whole Brazil or its regions and states (Fig. 1 and 2). It is the country biggest data bank on burnings available on Internet, as well as the most accessed site. This homepage (http://www.nma.embrapa.br/projects/qmd_us/index.html) gets around 150,000 hits per year, due to its reliability and availability.

All the system routines are frequently updated. The detection and mapping homogeneity allowed NMA researchers to study the space and time patterns of the burnings.



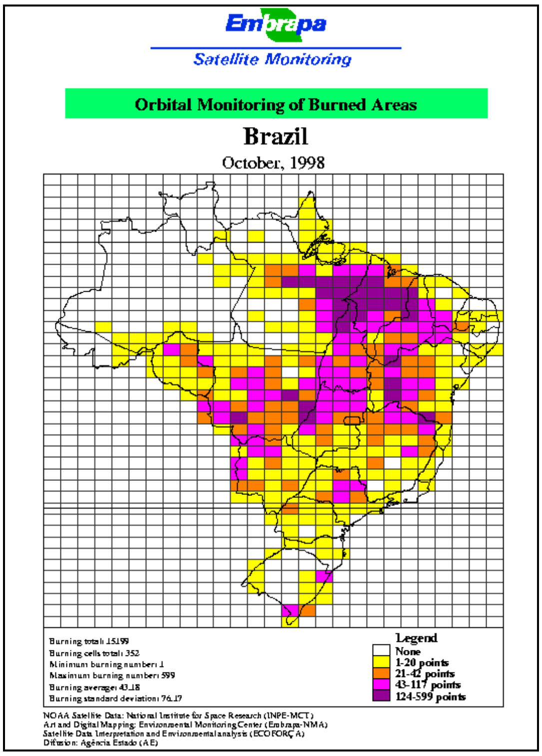


Fig.1. & 2. Burned area maps based on NOAA satellite data, August and October 1998 (http://www.nma.embrapa.br/projects/qmd_us/index.html)

The NMA team also does an hydrologic monitoring, based on satellite data, which gives information on water availability on 25 soil types at 11 states of Brazil, as an extra indicator of fire risk and generates weekly around 12,000 pages on the Internet (http://www.agrocast.com.br).

The follow up of over 450 farmers for the last 10 years, on amazon region, has also helped to understand the causes of interannual fluctuations of burnings, not related to climate (http://www.nma.embrapa.br/projects/machadinho) and the relationship between deforestation and burnings. Finally, the allocation and use of a mobile antenna for NOAA/AVHRR data reception, by the NMA team was decisive on supporting the *in situ* wildfires combat at Roraima state in early 1998.

Deforestation vs. Burnings: A Misunderstanding

Since the international "campaign" to preserve the Brazilian Amazon "caught fire", in 1988-89, almost all the international press has mixed up two different kinds of environmental concerns, the deforestation and the burnings. This happened, first, because both problems started to be monitored through satellite data almost at the same time. Second, because, during some time, scientists thought they could estimate the deforested area from the burned data. Third, because the smoke of the burnings were interesting to drive the attention away from the air pollution records of some developed countries. And fourth, because most of the foreign (and many Southern Brazilian) journalists did not know the Amazon forests and its ecological and land-use peculiarities.

Now, the scientists have reviewed their methods. Some Brazilian journalists and authorities learned to point the difference. Even international organizations - like the World Bank and the World Resources Institute - seem to recognize the mistake. But the average international media maintain the misunderstanding.

Deforestation is defined as the conversion of forest for timber harvesting and to other land uses, e.g. agriculture, cattle raising, establishment of settlements, or mining. It causes local climate changes and biodiversity reduction and contributes to the greenhouse effect. The burnings are the main tools of farmers to dispose residuals of trees, to control weeds and pests, to renew pastures and to harvest some crops. It causes local and regional pollution; reduces visibility on highways and airports; reduces the soil biological fertility and increases the risk of erosion. It also contributes to the greenhouse house effect, but only when the tree trunks are burned, during the first years after deforestation. Repeated burnings do not contribute to a net release of carbon to the atmosphere.

The measurements of the two environmental problems are distinct. Almost every burned area, in Brazilian Amazon, was first deforested. Most part of the burned areas will be hit by the fire every year, again and again. But there is a lot of deforested areas that do not burn. This means one cannot measure the deforestation by the burnings, because there would be areas not considered at all, while other areas would be counted several times.

Monitoring Forest Fires in Roraima State in 1998

Due to an exceptional dry period, related to the El Niño phenomenon, the Roraima State, located on the farthest northern part of Brazil, on the Northern Hemisphere, was severely hit by extended burnings and a series of wildfires. The fires took place on its savannahs, grassland and deciduous forests in early 1998. Until late March the fire combat actions were based on NOAA images, sent from United States and retransmitted by INPE for the 7th Forest Army Command, at Roraima, since the fixed antennas for NOAA data reception in Brazil do not receive data from the Northern Hemisphere. The timelag between image acquisition and its reception by the military operation command at the fires fronts was more than one day. Therefore, its utilization was very limited, jeopardized by the delay.

By demand of the Terrestrian Operations Command (COTER), the NMA has moved its NOAA imagery reception antenna to Roraima. This allowed imagery acquisition several times a day. The time gap from the data reception and the delivery of images, maps and analysis to the operation command turned to be less than one hour. All the fire combat logistic was optimized, with meaningful practical results. Even after the first rainfalls, this monitoring allowed the detection of isolated fire spots and their effective extinction. All obtained data were made available on Internet (http://www.nma.embrapa.br/projetos/queimadas).

Final Comments

In Brazil, the fire detection and mapping system is available, on a regular basis, for ten years. This information, through the Internet, is reaching a large audience, that includes NGOs, media, research institutions, governmental organisms and policy makers.

In terms of active fire detection, despite the physical limitations of the NOAA-AVHRR data, ten years of monitoring allowed researchers to validate patterns for the spatial and temporal dynamics of the fires, in different regions in Brazil. Several research initiatives, fire management and environmental policies could be implemented. The reliability and availability of the current products on fire detection and mapping increased the national awareness of the media and public opinion. Lately, a special effort has been done - from research to governmental and non-governmental levels - in the search for agricultural technologies that can replace the use of fire in some Brazilian farming systems (http://www.nma.embrapa.br/projetos/qmd/tab_qmd.html).

The forest fires in Roraima showed how relevant it was to have a mobile antenna for NOAA-AVHRR imagery reception. Communication networks are not enough to deliver images, maps and analysis from a remote center of acquisition of data, specially when there is an emergency on a remote and isolated area, as are almost all national parks and environmentally important sites in Brazil. On those regions, with appropriate support and trained technicians, it is possible to aquire and process the images several times a day. As it happened at Roraima, the time gap from the data reception and the delivery of images, maps and analysis for the operation command responsible for the fire combat can be less than one hour. All the fire combat logistic can be optimized, with meaningful practical results. Even after the first rainfalls, this monitoring allowed the detection of isolated fire spots and their effective extinction.

With the regular monitoring and mapping, at the Amazon region, it was easier to compare the active fire maps and the deforestation maps, produced with Landsat images, also in a regular basis. For many years, the National Institute for Space Research (INPE) has been promoting the interpretation of images from the Landsat satellite to monitor the evolution of the extent and rate of gross deforestation in the Brazilian Amazon. This effort has generated results for the 1974 to 97 period (http://www.inpe.br/Informacoes_Eventos/-amz/amz.html). This comparison showed that most part of the burnings occurred either on *cerrado* areas, or on occupied areas in the Amazon Southern and Eastern border, specially along the highways, where there are settlers and farmers. About 75% of the deforested areas are located within 50km of the highways and roads. Also, 87% of the newly deforested areas (cut down on the 90s) are within 25km of the old deforested areas (cut down until 1978). This means there are no new agricultural frontiers and there have been no big expansions, but, rather, a vegetative growing of the human presence in the region.

The public and policy makers want a fire product that allows, not only active fires detection and mapping, but also a reasonably accurate estimation of area burned. The NMA is starting a research proposal for the future use of the WFI camera, on board of the CBERS-1 (China-Brazil Earth Resources Satellite) (http://www.inpe.br/programas/cbers/english/index.html). The WFI has a ground swath of 890 km which provides a synoptic view with spatial resolution of 260m. The Earth surface is completely covered in about five days in two spectral bands: 0.66 µm (green) and 0.83 µm (near-infrared). This use of the WFI will provide, if a development of a burned area algorithms is achieved, the way to get an area burned fire product on the same information network.

There is also a high correlation between burnings and rainfall. Every time it rains out of season, burnings are delayed or reduced. One can almost tell the weather in different parts of Brazil, just looking at the burnings blanks on daily maps. That also means some burnings reductions self attributed by governmental institutions to its "fiscalization" are clearly linked to the occurrence of unexpected rainfalls. The rainfall explains, yet, some decreases on the total fire points detected by the monitoring system, during the last ten years. It is worth to remark that, even if the burnings number changes, the spatial pattern usually remains the same, showing how closely is the fire related with structural and permanent factors and how distant it is from accidents.

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BULGARIA

The 1998 Forest Fires Season

Number of Fires and Area Burned

In 1998 the number of forest fires and the burned area increased in Bulgaria as compared to the years 1995 - 1997 (Tab.1).

It is obvious that in 1998 the percentage (ca. 0.2%) of the burned area in relation to the countries' total forested area (approx. 3,600,000 ha) has been the highest for the last four years. Nevertheless, this percentage and the total burned area is still lower than in the years 1993 (17,500 ha = 0.5%) and 1994 (14,254 ha = 0.4 %). These figures have even been the highest for the last 50 years.

Tab.1. Number of forest fires and area burned in Bulgaria during the period 1995 to 1998

Year	Number of Fires	Area burned (ha)	Percentage of forest cover burned
1995	114	550	0.015
1996	246	2150	0.060
1997	167	860	0.024
1998	578	6967	0.194

Fire Causes

In 1998 about 60% (n = 345) of the fires which burned 3,218 ha forested land have an unknown cause. A large number of fires (n = 206) were caused by general negligence and uncontrolled fires that were ignited for field clearing; these fires burned 3,494 ha forested land. A total of 21 fires were set intentionally and burned 224 ha. The authors of these fires could not be detected. Finally, only six forest fires were caused by lightning (n = 31 ha).

Economic Losses

The total economic loss of the forest fires amounts to approx. 1.2 million $US. The fires destroyed 82,000 m³ of standing timber, 2,500 m³ of cut timber, 1,670 m³ of fire wood and 2 million trees in plantations.

Fire Season

The highest fire occurrence (n = 357) was registered during the summer season. In spring 122 fires burned, which was the driest season in the year 1998. The dryness was the most accentuated for the last three years.

Forest Fire Characteristics

Forest fires started mostly in coniferous forests (5,510 ha = 80 %), including 603 ha in plantations. Burned deciduous stands summed up to 1,854 ha (20 %), including 304 ha plantations, 251 ha in coppice and 420 ha in deciduous stands degraded previously by grazing.

The most common fire types were ground or surface fires (6,047 ha, n = 475). A total of 105 crown fires were counted burning 920 ha.

The most frequent forest fires were recorded near fields or agricultural lands, recreational areas, routes, etc. where forest plantations were in the vicinity.

Research Needs

Unfortunately there has been no research conducted in the field remote sensing and GIS applications to forest fire management. There have been some studies at the University for Forestry Sciences and at the Forest Research Institute but without any practical application.

Fire Fighting

Forest fire fighting capacities are still quite primitive and rudimentary. Nowadays, after the political change, it is even difficult to use agricultural planes as initial attack planes since there use has been reduced in the last years. In some cases the National Army is called in for help, when weather conditions deteriorate rendering fire fighting very difficult. The use of aerial water tankers, like CANADAIR, has not yet been considered. In Bulgaria forest fires are still considered as only a minor problem, as, for instance, compared to poaching. The State Forest Service has only one forestry expert who is in charge of forest fire protection in Bulgaria.

Errata in the last Bulgaria Fire Report (IFFN No. 19, September 1998, p.50): The total area burned in Bulgaria in 1996 was 2,150 ha (instead of 21,500 ha).

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CUBA

An Overview about Forest Fires in Cuba

Introduction

Cuba is a tropical country located in the Caribbean sea to the North of the Equator between 19° and 24° N and 74º - 85º W. Its total area and population are 110,922 km^2 and more than 11 million people, respectively.

Concerning climate there are two very well defined seasons, the rainy season (May to October) and the dry season (November to April). The average annual rainfall ranges from 1110 mm to 1300 mm and the average annual temperature ranges from 22°C (January) to 28°C (August). Humidity ranges from 77 % (April) to 82 % (September).

Agriculture and tourism are the main sources of income to the National Economy. Sugar cane, tobacco and coffee constitute the major agricultural products of the country, while the forest resource does not surpass even 1 % out of the gross national product.

Owing to the increase in afforestation and reforestation developed in Cuba since 1959, together with continuous population growth, forest fire risks have also increased. This paper offers an overview about forest fires in Cuba.

Forest vegetation

In 1492, the forests covered 80 % of Cuba. Since then selective harvesting of the best species of wood began. Owing to this activity and the development of agriculture the forest covered only 13.4 % of the total area of the country by 1959. Since 1959 important afforestation and reforestation plans have been put into action in Cuba. These plans are responsible for 21 % of the total area being covered by forests (2,400,000 ha) in 1998. The main species included in the afforestation and reforestation plans are: *Pinus caribaea*, *Eucalyptus* spp. and *Casuarina* spp. These species have a high level of inflammability. For that reason and also for the rising population, forest fire risks have been increasing this past decade. In 1998 the Cuban government signed the Forest Law (Law 85/98) with the objective of guaranteeing the conservation and development of the forest resource, based on a sustainability.

Fire occurrence

Several forest fires occur every year in Cuba, as well as in other countries. However, this does not represent a great problem. Table 1 shows a summary of data from 1984 to 1998 on forest fires and its burned area. In this period a mean of 325 forest fires occurred annually, and 4878 ha were affected. The average area burned by fire was of 15 ha/fire. The fire season is defined according to rainy and dry season. Data from Figure 1 show that in the period February - May the ca. 80% of total fires occur.

Tab.1. Forest fire occurrence and burned area in Cuba 1984-1998
Source: Cuerpo de Guardabosques. Cuba. 1999

Years	Fires		Burned area		Average
	Number	**%**	**ha**	**%**	**ha/fire**
1984	296	6.07	3854	5.27	13.02
1985	390	8.00	4800	6.56	12.31
1986	552	11.32	6651	9.09	12.05
1987	269	5.51	3220	4.40	11.97
1988	369	7.56	4545	6.21	12.32
1989	310	6.36	2929	4.00	9.45
1990	307	6.29	3127	4.27	10.19
1991	566	11.60	6582	9.00	11.63
1992	312	6.40	4442	6.07	14.24
1993	182	3.73	5380	7.35	29.56
1994	237	4.86	6152	8.41	25.96
1995	363	7.44	8731	11.93	24.05
1996	211	4.33	3905	5.34	18.51
1997	255	5.23	4708	6.43	18.46
1998	259	5.31	4144	5.66	16.00
Total	**4878**	**100**	**73,170**	**100**	
Average	**325.2**		**4878**		**15,00**

Causes of forest fires

Table 2 illustrates forest fires started in the most common ways in Cuba from 1989 to 1998. The main cause is human activity (88 %). Table 2 further shows that in the last years the real number of forest fire causes is not definitely known. This situation does not help forest fire prevention.

Fire in other land-use systems - often cause of forest fires

Fire is used frequently as a handling tool of the land in Cuba. Burning is practised at the end of the dry season in order to renew grass to feed livestock. It is also used by farmers to eliminate crop waste and to clean the soil before planting. From November until April fire is used to facilitate the harvest of sugar cane or to cultivate sugar cane plantations in order to increase yields. The sugar cane fields are divided with firebreak which are kept clean during the whole year to avoid spreading planned or uncontrolled fires over large areas.

In order to prevent the development of uncontrollable fires and the escape of wildfires precaution measures are taken when igniting sugar cane. The controlled fires are started late in the afternoon when air temperature and wind speeds are low and the relative humidity is high. The fires are set by trained people, and fire trucks and water tenders are on standby for controlling the fires. It is required to obtain an official burning permission since the legislation generally prohibits burning of vegetation. Despite these prevention rules negligence in burning sugar cane and using fire in other land use-systems frequently cause forest fires.

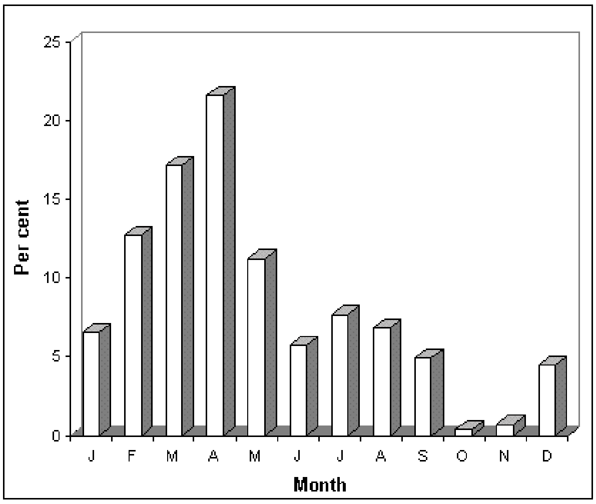

Fig. 1. Fire distribution by month in Cuba 1981 - 1996

Tab.2. Major causes of forest fires in Cuba 1989 - 1998 Source: Cuerpo de Guardabosques Cuba (1999)

Years	Incendiary		Negligence		Lightning		Unknown	
	Number	%	Number	%	Number	%	Number	%
1989	11	3.55	130	41.94	84	27.10	85	27.42
1990	12	3.91	166	54.07	36	11.73	93	30.29
1991	47	8.30	156	27.56	26	4.59	337	59.54
1992	38	12.18	123	39.42	19	6.09	132	42.31
1993	14	7.69	73	40.11	51	28.02	44	24.18
1994	17	7.17	134	56.54	21	8.86	65	27.43
1995	32	8.82	157	43.25	15	4.13	159	43.80
1996	7	3.32	83	39.34	24	11.37	97	45.97
1997	7	2.75	110	43.14	49	19.22	89	34.90
1998	9	3.47	71	27.41	36	13.90	143	55.21
Totals	**194**		**1203**		**361**		**1244**	
Averages	**19.4**		**120.3**		**36.1**		**124.4**	
%	**6.46**		**40.07**		**12.03**		**41.44**	

Ways of fires prevention and suppressions.

The organization and management of fire protection in Cuba is undertaken by the Forest Ranger Department (CGB) in the Ministry of the Interior, as set out in the Forest Law. This department in conjunction with the Ministry of Agriculture has set out specialised measures of fire prevention. As established by the above mentioned law, the system for forest fire protection comprises activities for prevention, control and suppression, as well as research and training in this area. These activities are regulated by a National Program created by the Ministry of the Interior in collaboration with the Ministries of Science, Technology and the Environment, and the National Council of Civil Defence.

The main actions to be undertaken are:

- In periods of drought the majority of CGB workers are dedicated fundamentally to forest fire protection, activating control points, paying particular attention to ground patrols and increasing consciousness through personal contacts and participatory events with food growers, farmers, and villagers from wooded regions, as well as speakers in bush primary schools.
- The used lookout towers, placement of personal on hilltops (lookout points) and the employment of other efficient ways of notifying the authorities of fire will improve vigilance and protection from forest fires. During fire season (February to May) AN-2 (Antonov) airplanes for aerial detection are used. These planes patrol the areas of highest risk during the hours when fires tend to occur.
- Cuba is divided into six ecological regions and each one is further divided into territories of protection. Recent technical studies have assured the establishment of effective means of fire prevention in each one of these areas.
- The CGB is working together with various organisations and entities in the forests and surrounding areas.
- Locally brochures and flyers are being printed and distributed. These reinforce the campaign of consciousness - raising through local and mass media.

Concerning fire suppression, forestry law sets out that suppression of fires in wildlands is to be carried out by the CGB.

In Cuba there more than 30 Forest Fires Control Units (UCIF) are situated in highest risk forests and are operating all year. The personnel in these units are trained to suppress forest fires and have at their disposal telephones or 2-way radios, manual equipment and fire trucks, although in limited numbers. PZL–M18 (Dromader) airtankers are also used during the fire season every year.

Direct and indirect methods are used to attack forest fires. Branches obtained from the same area are used as a fire swatter. Owing to the fact that a considerable part of the forest is located in mountainous zone of complex topography, backfiring techniques are used.

Volunteer brigades are also used for the protection of the forest and fauna. They are comprised mostly of local villagers.

In case of extensive forest fires, the government and political authorities help with resources. Also, command posts and other temporary infrastructures are set up from which collective decisions are made in to take the most effective action.

Conclusions

Forest fires are not a great problem in Cuba, but every year some fires occur that have a negative effect on forest vegetation impacting on the environment. Forest fire protection in Cuba is organised, however, the CGB has been instituting a National Program for Forest Fires Protection.

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FINLAND

New Forest Fire Risk and Fire Behaviour Research Project

The Ministry of the Interior has prepared a plan to start research activities concerning forest fire behaviour in boreal forests in Finland. The aim of this project is to develop:

* Classification of the fuel types and forest fire risk assessment in boreal forest
* Modelling the fire behaviour in boreal forest

This project will be coordinated by Ministry of the Interior. All research activities will be conducted in collaboration with:

* University of Helsinki, Department of Forest Ecology
* Finnish Forest Research Institute
* Forest and Park Service, and
* Forest companies in Finland

It is intended to start the research project in the beginning of the year 2000. A collaboration with partners from other EU countries is considered. Mr. Timo Heikkilä will act as project secretary in the Ministry of the Interior. For more information contact:

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Simulation of Disturbance and Successional Dynamics of Natural and Managed Boreal Forest Landscapes

The research aims at better understanding of disturbance and successional dynamics in boreal forests to provide the ecological basis for successful restoration and management of forest biodiversity. For this we develop and use a simulation model for forest landscape disturbance, succession and management (FIN-LANDIS).

The modelling project started with modification of the original LANDIS model (developed by D.J. Mladenoff, Madison, USA) to suit the Finnish conditions, and to satisfy the needs of the project. A literature survey on forest dynamics and modelling was made for model development and model evaluation. In addition, tools were developed for parameterisation of the model and for processing the model input and output. Large parts of the original model code written in C++ were rewritten. Among other things, the changes facilitate realistic simulation of tree regeneration and development on uneven-aged stands during post-fire succession as well as use of variable assumptions about the behaviour of fire disturbances. Capacity for using processed satellite images and GIS data of Forest and Park Service as model input was developed. First applications of the model were started using GIS data of Ulvinsalo Nature Reserve as model input, aiming at better understanding of historical fire regimes and forest development in the area. The simulation model developed will provide a strategic-level tool for forest landscape and biodiversity management. This will help in elucidating long-term management objectives to maintain dynamic biodiversity-fostering processes that change over large spatial and temporal scales. Contact information:

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GREECE

The 1999 Forest Fire Season

The 1999 forest fire season in Greece has been a very good one. The total burned area fell to the lowest level since 1976, in sharp contrast to the 1998 fire season that had been one of the worst on record (Fig.1). This success, which has been reason for celebration for the Greek Fire Service (GFS), was the result of serious preparation work in combination with a relatively mild summer season in regard to fire danger.

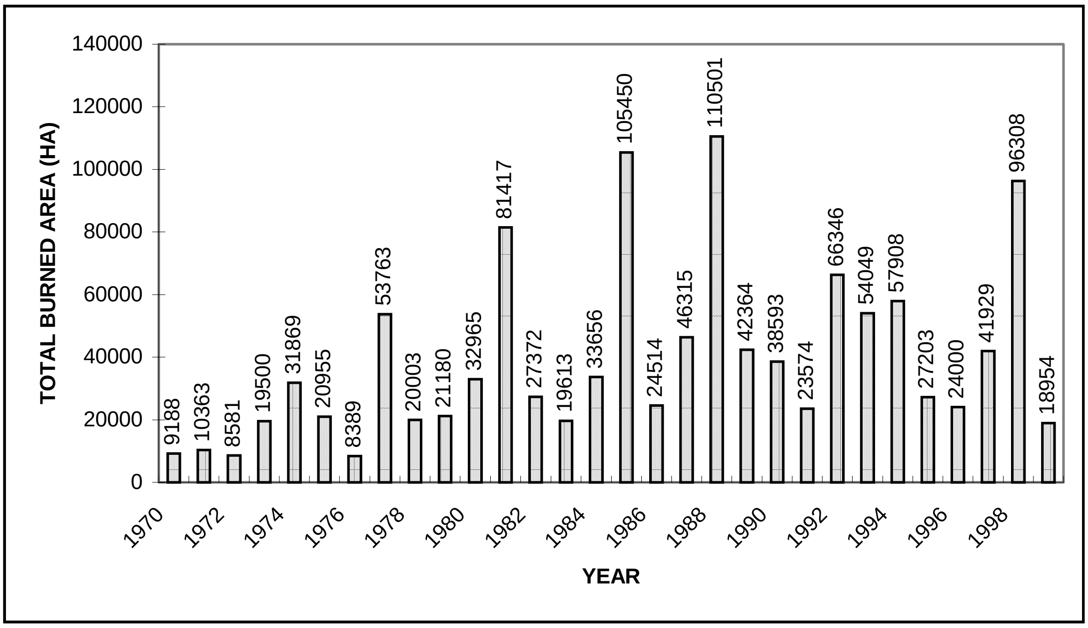

Fig.1. Total annually burned area in Greece in the period 1970-1999

As reported last year, the GFS had been given full responsibility for forest fire fighting in May 1998, just before the beginning of the fire season. Having no time to prepare, it proved inadequate for this new duty. Many fires became very large bringing the total burned area to 95571 ha, fuelling a serious controversy between the GFS and Forest Service officers who were upset for losing the responsibility for forest fire fighting.

After the end of the 1998 fire season the GFS, being fully supported by the government, started preparing immediately for the summer of 1999. For this purpose it mobilized all of its people, recognized its weaknesses and tried to cure them before the beginning of the next fire season (June). The most important improvements were:

Personnel

* The permanent personnel of the GFS increased by 1300, bringing the total up to 8000 fire fighters and officers. This is a 19.4% increase.
* 4000 seasonal fire fighters were hired in time for the fire season. This number is lower by 25% compared to previous years.
* Every effort was made to bring the morale of personnel up.
* Recognizing the need for well trained personnel, the GFS organized a series of week-long seminars to train its officers in aspects of forest fire fighting on which their knowledge was inadequate. Subjects included introduction to fire behaviour and fire danger concepts, fire meteorology, forest fire fighting methods and techniques, and safety considerations. The seminars were taught by Greek specialists including the author.

Furthermore, two seminars taught by Canadian training officers, focused on aerial fire fighting and fire fighting using ground crews (*handcrews*).

Aerial fire fighting means

- ∗ Ten new amphibian CANADAIR CL-415 water bombers were ordered from BOMBARDIER in Canada. The first two were delivered in Greece before the start of the 1999 fire season.
- ∗ Four heavy-lift helicopters were contracted from the international market for fire fighting. They were one Ericsson Air-Crane, two MI-26, and one Kamov. All of them performed very effectively. The MI-26, being able to carry 2 fire trucks plus personnel in its hull, proved indispensable for the protection of the hundreds of islands in the Aegean sea.
- ∗ Two amphibian CANADAIR CL-215 water bombers and an Illyushin (IL 76 TD) airplane that can deliver up to 42 tons of water per drop were also contracted, to complement the 15 CANADAIR CL-215 operated by the Greek Air Force.
- ∗ The use of Greek Army CHINOOK CH-47D and UH-1H "Huey" helicopters that had been extensive in previous years was limited in 1999.
- ∗ The existing 18 PZL Dromader and six smaller Grumman agricultural aircraft operated by the Greek Air Force were used as usual, both for aerial patrol and initial attack.

Ground fire fighting forces

- ∗ The total of the fire fighting trucks of the GFS (all types and ages) reached 1100, including 15 new units.
- ∗ The fire fighting telecommunications network was improved significantly.
- ∗ Many important needed tools, such as backpack pumps, appropriate hoses, etc. were acquired.
- ∗ The number of handcrews increased and they were better organized. Most important the significance of their contribution was recognized so they were used more effectively.

Planning and organization

- ∗ Starting in fall of 1998, all GFS units had to develop detailed pre-suppression plans for their jurisdiction. These plans were based on five fire danger/alertness levels provided by a fire danger prediction map for the country that was issued daily throughout the fire season. The author was responsible for preparing the map. The plans included such elements as planning for aerial and ground patrols, alerting local authorities on high fire danger days, forbidding access to specific forest areas under critical conditions, etc.
- ∗ A general plan was prepared at the national level.
- ∗ The principle of effective initial attack was applied both locally and at the dispatching center in Athens. The dispatchers were encouraged to send more resources than the minimum needed. Cost was a second priority.

Fire prevention

- ∗ A very intensive prevention campaign, based on TV and radio spots, was launched at the beginning of the fire season. It continued until the end of August.
- ∗ The roads to sensitive forest areas, according to plans, were closed on critical days with the help of the Police and local authorities.
- ∗ The GFS cooperated with the police in order to track-down suspected arsonists.

Results

From the onset of the fire season it became evident that the whole organization worked more effectively than the year before. All fires and especially those close to Athens were attacked massively both from the air and from the ground. The aerial resources, especially the heavy lift helicopters, the new CL-415s and the contracted CL-215s performed exceptionally well and made the difference in terms of effective initial attack. Avoidance of delays in their dispatching and simultaneous concentration of large numbers of ground forces on each new fire minimized the chances of escaped fires. This approach was helped greatly by the relatively favourable weather conditions.

The climate in Greece is typically Mediterranean over most of the country. Most areas in the south part of the country, including Attica (the area around Athens), usually receive no rain in the summer months. This year was an exception with significant rain events interrupting the build-up of fire danger both in July and in August. On one occasion there was even flooding in Athens. Furthermore, air relative humidity remained at higher than usual levels on most days. As a result, fire potential was less than usual and, with effective initial attack, no fires reached 500 ha in size.

In spite of the successful results, the fire season was, unfortunately, marked by some tragic moments. On 28 July 1999, at night, three experienced fire fighters from an eleven-person handcrew were trapped by the flames on the island of Chios. The fire was burning in light fuels and there was a sudden wind change. Two of the fire fighters, who worked as seasonals for the GFS, lost their life. One of them, a 27 year-old girl who was an assistant-forester, died on the spot, while the second, a 31 year-old man suffered extensive burns (>60% of his body) and died a week later in the hospital. The third fire fighter trapped by the flames, a GFS officer, escaped with intense burns over 40% of his body, and managed to survive after a long treatment in the hospital.

Also, in September, one civilian driver of a water-truck belonging to the Town of Poros in Peloponnese, got killed when his truck fell-off a forest road. He had just refilled Fire Service fire trucks that were fighting a small wildfire and was returning to his base.

Another negative moment for the 1999 fire season was the destruction of a small number of houses on the island of Salamis, close to Athens, by two wildfires on different dates. Most of these houses were illegally built, close or within an Aleppo pine (*Pinus halepensis*) forest. They were of poor construction, built with flammable materials and had no safety measures in case of fire (poor road access, in contact with vegetation, no water tanks etc.). The fires occurred early in the afternoon with medium strength winds (4-5 Beaufort) but under very low air relative humidity (<20%) and accelerated very rapidly. Although very strong fire fighting forces were dispatched at once and controlled the fires in a few hours, many houses on the path of the fire front were destroyed or damaged within the first hour.

The latest count, covering the period 1 January to 30 September 1999, provided the following fire statistics:

Forest area burned	6,470 ha
Non-forest area burned	12,484 ha
Total area burned	18,954 ha
Total number of fires	10,560

It should be noted that the number of fires reported by the GFS includes all fires to which GFS has been called and is not comparable with the number reported by the Forest Service until 1997. The latter generally reported less than 3000 fires per year.

The future

The success of the 1999 fire season brought great relief to all those who care about the Greek forests. The results proved that the GFS has been working hard in the right direction rapidly improving its ability to control forest fires. However, it should be noted that there is still a lot of work to be done and there are still significant questions to be answered and problems to be solved:

- In terms of the GFS, two elements that have not been tested in 1999 are its ability to control large fires, as there were not any, and the effectiveness of the massive initial attack strategy under more difficult fire danger conditions.
- The cost of fire fighting has increased sharply in the last two years, especially due to the use of contracted aerial means.

* The dispute with the Forest Service has not been resolved and cooperation between the two organizations is not smooth.
* Fire prevention, especially through forest management, cannot be carried out effectively by the Forest Service which has been weakened significantly in the last two years. The same holds true about grazing on forest lands, where, without a serious grazing management program, the problem of "range improvement" fires set by shepherds will continue to exist. Without such management, the forest fire problem will never be rationally controlled and fire fighting costs will continue to rise.

The GFS and the government gradually recognize these problems and there is optimism that in the future the necessary measures will be taken to solve them. In the meantime, preparations for the next fire season are well in progress.

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INDIA

Forest Fire Causing Poor Stocking of Santalum album and Terminalia chebula in Southern India

Forest fires whether natural or unnatural have a significant role in ecosystem dynamics. The unnatural fire in Indian Sub-Continent is at the maximum due to various causes. Amongst them the main culprits are graziers, encroachers, and collectors of minor forest products who put fire in the forest just to fetch their basic needs and they are totally unaware of the biodiversity and its importance. In the process of repeated fires not only it is withdrawing soil support system but also leads to innumerable loss of various flora and fauna species of which plays a vital role in the growth of the forest. Any disturbance to one of them leads to imbalance the ecosystem. Recurrent fire decreases the green cover through prevention of regeneration and leads to the slow death of the forest (Ranganathan 1934). It also increases erosion and alters the physical and chemical properties of the soil converting organic ground cover to soluble ash and modifying the microclimate through the removal of overhead foliage. The soluble ash is washed away in the next rain. Fires can also make trees more susceptible to insect attack. For the sustainable development of the forests repeated forest fires has to be checked. Otherwise the loss of biodiversity will be on the increase every year at the cruel hands of few human beings and many of the species will disappear even before they are documented.

The biological resources - genes, species and ecosystem which have actual and potential values to the people - are the physical manifestation of the globe's biodiversity. Species are the building blocks of ecosystems which provide the life support systems for humans. Biodiversity is an umbrella term covering the totality of species, genes and ecosystems but biological resources can actually be managed. (Srivastava 1998) They can be consumed or replenished and they can be the subjects of directed conservation action. The loss of the world's biodiversity, mainly from habitat destruction, forest fires, over harvesting, pollution and inappropriate introduction of foreign plants and animals is continuing. Natural plant cover being the important natural resources of the earth has been steadily depleted in the recent past. It is estimated that up to half the world's woodlands and forested areas might have vanished since 1950 and yearly global losses are in the range of 10-20 million hectares. Therefore the importance of conserving the valuable natural resources is very much felt.

The ancient civilization leads to the modern civilization and the latter leads to industrialization. In the process of which the human beings have evolved, no doubt, modern techniques at the cost of destruction of own habitats. Indiscriminate cutting, and forest fire have attributed to poor stocking to the composition of various flora and fauna. In this paper two very important species which have been severely affected in southern India by way of human interference and recurrent fire is highlighted. One is Sandalwood (*Santalum album*), the costliest scented wood in the world, while the other one is *Terminalia chebula*, a highly valued medicinal species.

Santalum album

Sandalwood is the fragrant heartwood species of genus *Santalum* (family *Santalaceae*). In India, the genus is represented by *Santalum album* Linn. Its wood, known commercially as "East Indian Sandal wood" and essential oil from it as "East Indian Sandalwood oil" are among the oldest known perfumery materials. The word Sandal has been derived from Chandana (Sanskrit) and Chandan (Persian). It is called *Safed Chandan* in Hindi, *Srigandha, Gandha* in Kannada. *Sandanam* in Tamil, and *Chandanamu* in Telegu. Historical review reveals that sandalwood has been referred to in Indian mythology, folklore and ancient scriptures. It is generally accepted that sandal is indigenous to peninsular India as its history of recorded occurrence dates back to at least 2500 years. The sandal family is distributed between 30°N and 40°S from Indonesia in the West to Juan Fernandez Island in the North, to New Zealand in the South (ICFRE).

In India *Santalum album* is found all over the country, with over 90% of the area in Karnataka and Tamil Nadu covering 8300 km^2. In Karnataka it naturally in the southern as well as Western parts over an area of 5000 km^2. In Tamil Vadu, it is distributed over an area of 3000 km^2, and dense population exists in North Arcot (Javadis and Yelagiri hills) and Chitteri hills. The other states where sandal trees are found are Andhra Pradesh, Kerala, Maharashtra, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh, Bihar and Manipur.

The tree flourishes well from sea level up to 1800m a.s.l. in different types of soil like sandy, clayey red soils, lateritic loamy and even in black cotton soils. Trees growing on. stony or gravel soils are known to have more highly scented wood. Generally this species is located in the undulating terrains and survives well in the moderate rainfall of 600 to 1600mm and temperature varying between 20°C and 45°C. It grows well in early stages under partial shade but at the middle and later stages shows intolerance to heavy overhead shade.

Approximately a century back the habitat was not under severe pressure and was thriving well. Slowly and slowly with increase in population, greed indiscriminate felling and recurrent fires have depleted the stocking, Generally *Santalum album* fruits in two seasons in April-May and subsequently in October-November. But these new recruits which come up well in the Southwest monsoon and Northeast monsoon get affected with severe blows of forest fire in the month of January - April leaving behind poor stocking of species leading to mosaic pattern of its distribution.

Even some time the fire is so severe that it affects the cortex of the tree thereby the tree develops crack and is easily attacked by insects and in the process of which the tree dies. It. has been noticed that the areas more prone to the fire are subject to the attack of spike diseases in the tree. McCarthy has first noticed it as early as 1899 in Frazerpet (Coorg, Karnataka). The disease is caused by mycoplasma like organism. It occurs at any stage of development of the tree. As the disease progresses, the new leaves become smaller, narrower or more pointed and fewer in number with each successive year until the new shoots give an appearance of fine spike. At the advanced stage of disease, the inter-nodal distance on twigs becomes small, haustorial connection between the host and sandal breaks and the plant dies in about 2 to 3 years. Apart from this, due to recurrent fire, invasion of the exotic weed *Lantana camara* in this type of forests does not allow the species to grow in its composition in any way and influence of spike disease in *Santalum album* in other way. in one way forest fire affects the matured trees by giving continuous heat effect to the trunk which subsequently leads to suppression of growth and in other way the natural regeneration which already existed in the previous years gets washed away with the flame of forest fire. This vicious process of destruction of this particular species has lead to the poor stocking in Southern India on the one hand by way of forest fire and on the other by indiscriminate cutting by sandalwood smuggling.

Terminalia chebula

Terminalia chebula is a moderate sized, large deciduous tree with round crown, spreading branches and usually short trunk throughout in Burma it often grows tall and straight with dark brown colour bark often longitudinally cracked, exfoliating in woody scales. It is widely distributed in the greater part of India and Burma in mixed deciduous forests of comparatively dry types. It extends to considerable elevation up to 1500m in the outer Himalayas. In Burma it occurs in dry deciduous forests both in upper and lower mixed types along with Teak

(*Tectona grandis*), *Terminalia tomentosa* and their associates. It feels comfortable to laterite, clayey as well as sandy soils. In the peninsular India it is found in mixed deciduous forests to dry deciduous forests and extends up to elevations of 1000m. In Tamil Nadu it is one of the pride trees in the Eastern Ghats. Specifically Kalrayan hills is rich in best base population of *Terminalia chebula.* (Anonymous 1996). It survives well with the temperature between minimum -1°C to 15°C. and 38°C to 82°C and rainfall from 75 to 150 mm. It is fairly hardy against frost as well as drought. It withstands fire well and has good powers of recovery from burning. It coppices fairly well. The fruit is drupe, and ellipsoid to obviate in shape with yellowish orange brown.

Terminalia chebula is widely distributed from Himalayas to Southern India. The best stocking, is confined to lower Himalayas as well as Southern India particularly in Kalrayans and Pachayamalai hills of Eastern Ghats. But these hills, which in the past had very good stocking were badly affected due to fragmentation of these hillocks due to human pressure by way of illicit lopping and chopping and annual burning of the area in the process of collecting fruits, which subsequently has given a severe blow on the soil texture. The type of forest where it has found place gets frequently burnt and in the process of which seeds and new recruits get wiped away with the sweep of flame in the forest fire and in the next rain, it takes away the top fertile soil. This vicious process attributes to sterility and poor stocking of species annually. The humus formation process is stopped. Populations of micro-organisms get reduced subsequently, leaving behind sterile soil, which is insufficient for the germination of seed of *Terminalia chebula*. As *Terminalia chebula* is a drupe and hard-coated seed it requires longer period for its decay, which is only possible with. the help of moisture and sufficient humus. The soil certainly lacks these contents in this area the result of which is at present the different age plants are not available in this forests. Only old trees are standing in the hills. Once felled down, these trees will be facing extinction the next century. Since this particular species is found only in the slopes, in summer due to heavy wind they fall down. Unless it is checked, the stocking of this particular species cannot be improved.

Conclusion

The two important species *Santalum album* and *Terminalia chebula*, which is having highly commercial value and medicinal value respectively is facing severe problem due to forest fire leaving behind poor stocking. In the form. of fire, new recruits get. eloped away. Unless sincere efforts is not being made this species will be at the verge of extinction which can be done by way of creating awareness so that intentional fire can be avoided to facilitate germination of these species for better stocking. It also requires creation of germplasm bank of' these by identification of best phenotypes and genotypes and multiplication for planting stock improvement.

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INDONESIA

Fire Damages in East Kalimantan in 1997/98:
Relations to Land Use and Proposals for Further Action

After the severe fire episodes during the El Niño-Southern Oscillation (ENSO) events of 1982-83, 1991 and 1994 a prolonged and extremely severe fire season occurred during the last ENSO of 1997-98 in South East Asia (Goldammer et al. 1996, Goldammer 1999). The Indonesian province of East Kalimantan was the area worst affected by extended wildfires between late 1997 and May 1998. Daily satellite (NOAA AVHRR) maps provided by the Integrated Forest Fire Management (IFFM) project, a joint Technical Cooperation project between the Indonesian Ministry of Forests and Estate Crops (MoFEC) and the German Technical Cooperation Agency (GTZ), showed that the fires affected the entire Mahakam basin, its tributaries and spread as far as the Sangkulirang peninsula (Siegert and Hoffmann 1999). Many forest concessions as well as forest and industrial crop plantations were severely burned. In August 1998 the Sustainable Forest Management (SFMP) project (MoFEC/GTZ), proposed an ***Actions After Forest Fire in Natural Forest Concessions Program*** to the MoFEC. The proposal included the following five steps be implemented in fire-affected concessions operating in natural forest lands (HPH: Hak Pengusahaan Hutan):

- Conduct a low-intensity fire damage inventory (separately for each fire affected forest concession)
- Develop rehabilitation maps for all heavily damaged areas
- Improve the fire prevention and management system of each forest concession
- Shift logging activities: stop logging in unburned areas and conduct salvage felling of dead trees in burned areas (where possible)
- Adjust the Annual Allowable Cut (AAC) of each fire affected natural forest concession to a sustainable level and revise the long term forest planning (RKPH) accordingly

In order to obtain a data basis for this five-step proposal IFFM and SFMP jointly conducted on request of the MoFEC a study using ERS-2 SAR (European Radar Satellite 2, Synthetic Aperture Radar sensor) spaceborne radar images to disclose the size of the fire affected area for the entire province according to all land uses. Fire damage was assessed by discriminating three damage classes which are explained in the footnote of Table 1 (Hoffmann et al. 1999a, Siegert and Hoffmann 1999, Siegert and Rücker 1999a,b). The Directorate of Forest Inventory and Land-use Planning (INTAG) and the two MoFEC- GTZ projects further agreed to develop a revised forest land-use map, exposing the actual locations and boundaries of the current forest and industrial crop utilization right holders, in East Kalimantan. The overlay of the radar survey results with the actual forest land use boundaries revealed the fire damages for each land-use type. Furthermore the data is intended to support the provincial agencies to revise the current land-use plan of East Kalimantan. It shall be used as basis for the implementation of appropriate salvage felling activities, rehabilitation measures and adjustments of the long-term forest planning in each natural forest concession. Moreover, the data will be used within the IFFM Fire Information System to point out future fire hazard and fire risk zones in East Kalimantan and hence support fire management planning, prevention work and fire suppression (Hoffmann et al. 1999b).

The results of the ERS-SAR radar inventory show that the 1997/98 fires affected a total of 5.2 million ha - corresponding to ca. 25% of the total land area of the province. Almost 2.3 million ha are located in natural forest concession areas (56 HPH and Ex-HPHs), 0.4 million ha in protected forests, and 0.9 million ha 30 HTI forest plantation enterprises (HTI: Hutan Tanaman Industri) and 0.7 million ha industrial crop plantations were affected. Almost 75% of the plantation areas (forest, oil palm, etc.), that were located within the 1997/98 fire zone, have been fire affected, a large number of them severely. This demonstrates the very high fire risk of types of all plantations. Table 1 shows an overview of the fire damage related to the current land-use system.

Tab.1. Overview of area burned in East Kalimantan, Indonesia, in 1997-98 related to land-use classes and damage levels (see footnote*)

				Damage Classes *			
Land Status	**Total Area in East Kalimantan [ha]**	**Burned Area [ha]**	**% Burned**	**25-50 %**	**50-80 %**	**>80 %** (Dead Trees still standing)	**>80%** (without standing large trees: pre-fire degraded or converted)
Natural Forest Concession area (HPH)	9,771,384	2,347,717	24%	767,629	1,234,413	237,719	107,956
Forest Plantation (HTI) Area	1,393,074	883,987	64%	209,498	429,623	111,935	132,931
Estate Crop (Perkebunan) Area	746,603	382,509	51%	83,731	198,151	11,966	88,661
Total Protected Area (HL)	4,562,059	440,381	10%	84,146	263,656	23,656	68,923
Undefined Land Use (e.g., farmland)	3,275,441	1,161,174	36%	106,684	69,650	233,088	753,876
Total		**5,215,768**		**1,249,564**	**2,195,493**	**618,364**	**1,152,347**

** The damage classes 3 and 4 represent two different conditions of severely damaged forests. Damage class 3 represents the conditions prevailing in the (peat-) swamp forests of the Middle Mahakam lake area where almost the entire area was affected by fire. The dead trees are still standing. This condition provides a high future fire risk given the high fuel loads remaining after the fires. Damage level 4 includes forest plantations, degraded forest, bush and grassland as well as farmland.*

The recent loss to forest economy is immense, considering short and long term economic losses to the natural forest alone. In 1982/83 a severe fire catastrophe had already occurred in East Kalimantan, damaging 3.5 million ha of land and forest. Out of this 0.8 million ha was primary forest and 1.4 million ha was logged-over forest (Lennertz and Panzer 1983). In 1997/98 the area of the 1982/83 fire burned again to an even greater extent, particularly towards the west, north-west and south west. The long term effects due to repeated damage, the loss of natural regeneration and the need for large scale rehabilitation under the high risk of future fires by far outnumber the short term losses. Without financial support many areas will not be successfully rehabilitated. Active rehabilitation of natural forest concession areas is mainly needed in areas with a fire damage greater than 50%. It can be expected that most of the former well stocked areas with a 25-50% fire damage will recover naturally, especially if further damage through logging does not occur. This still leaves a rehabilitation area of almost 1.6 million ha in the natural forest concessions alone. Funding and investment security are the largest obstacles to be overcome before effectively starting forest rehabilitation.

After the 1997/98 fires the forest is much more susceptible to fire due to degradation and accumulation of fuel and thus now even during normal dry seasons it will be prone to fires. Furthermore, El Niño events are predicted to occur more frequently than in the past, creating conditions that could trigger even more fires in the future. Land use conflicts between the local people and concession and plantation owners, carelessness and land clearing using fire can under these conditions easily bring forest activities to an end. Already many degraded and undefined land use areas are prone to *Imperata cylindrica* (alang-alang) grassland cycles, where fire becomes a part of the succession cycle.

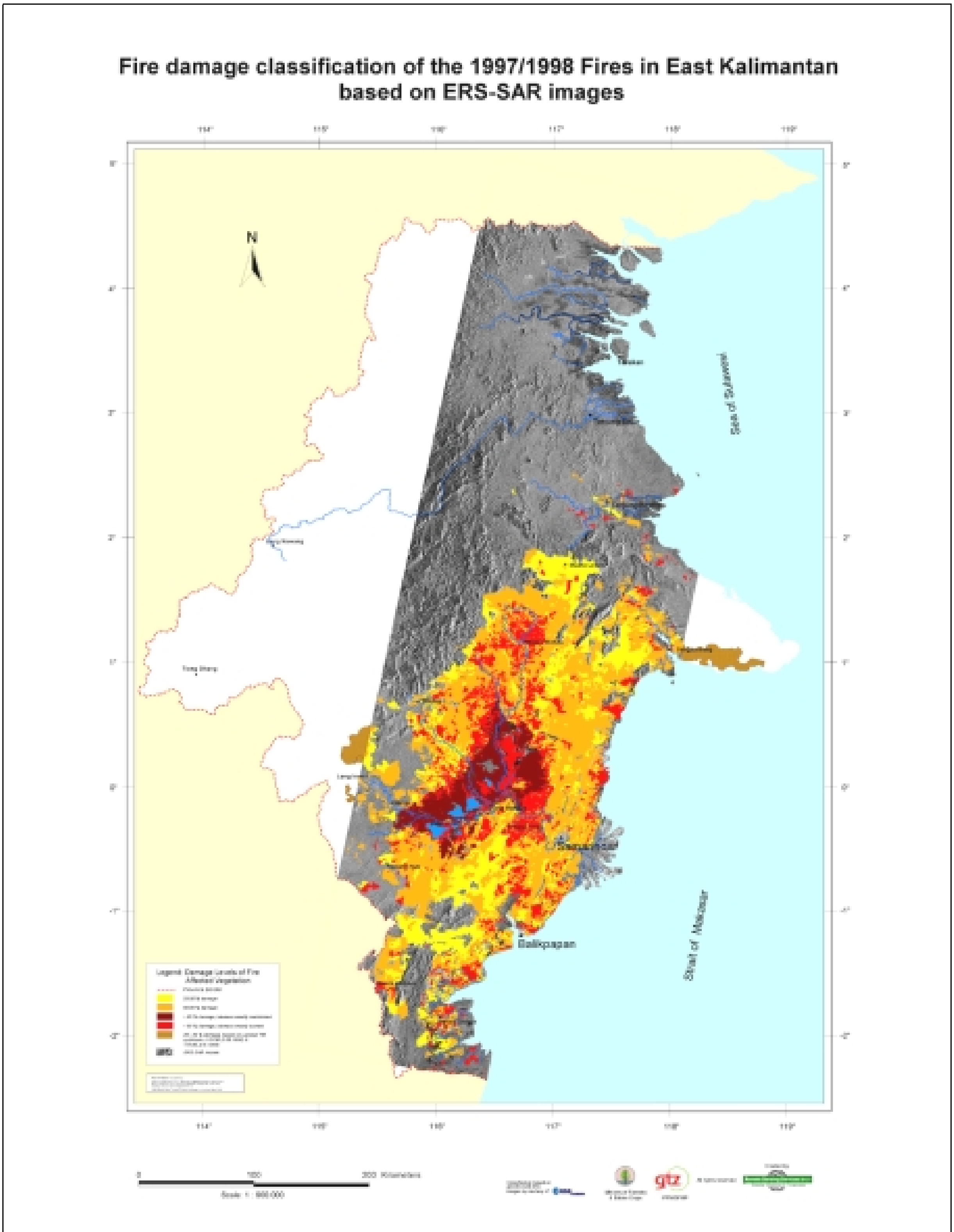

Fig.1. Fire damage classification of the 1997-98 fires in East Kalimantan, Indonesia, based on ERS-SAR images

Therefore fire management is a key issue in achieving the goal of sustainable forest management. To have further action on the 1997/98 fire catastrophe and to be prepared to prevent future fire disasters the following recommendations are proposed:

* Implement and control the "Actions after Forest Fires in Natural Forest Concessions"
* Revise provincial land use map (RTRWP) based on the 1997/98 fire damage
* Stop conversion in unburned areas and concentrate plantation activities in depleted and/or heavily burned areas
* Stop illegal cutting of living trees in salvage felling areas to support natural regeneration and successful rehabilitation
* Develop financial support schemes for large scale rehabilitation activities
* Revise the long term planning of the fire affected natural forest concessions
* Implement an integrated fire management, prevention and information system at the regional as well as on concession levels

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Causes and Impacts of Forest Fires: A Case Study from East Kalimantan, Indonesia

Introduction

The 1997-98 Indonesian forest and land fires affected more than 5.2 million ha in East Kalimantan (Hoffmann et al. 1999; see Hoffmann et al., this IFFN volume). A prolonged drought of almost one year, caused by a strong El Niño - Southern Oscillation (ENSO) event, created an extraordinary fire-prone situation, that lead to the worst ever fire catastrophe of the province.

According to local farmers of the indigenous Dayak population, 'these fires did not fall down from the skies...'. So, where did they come from?

The culprits, slash-and-burn farmers as well as plantation companies were soon identified by the reporting media, although journalists rarely got into rural areas where the tragedy took its course. But also the scientific literature remained rather general about fire causes with the exception of a few case studies (cf. comments of Potter and Lee 1998; for more detailed case studies see: Abberger 1999, Aspianur and Mujarni 1999, Colfer 1999, Gönner 1998 and 1999, State Ministry for Environment Republic of Indonesia and UNDP 1998, Vayda 1998). Yet, the understanding of the complex causal interactions leading to forest fires is essential in order to anticipate future fire emergencies and to take measurements to reduce fire risk.

The study presented here was carried out in the Jempang sub-district of East Kalimantan, covering the whole fire period from September 1997 until April 1998.

Study Area and Chronology

Jempang sub-district mainly consists of secondary lowland dipterocarp forests managed by local Dayak people since more than 350 years. The predominant land use is an integrated agroforestry system based on annually rotating swidden fields (rainfed upland rice) and hundreds of forest gardens (fruits, rubber, rattan). Fire is traditionally used for preparing the swiddens, which measure on average 1.5 ha. The burning of swiddens is generally done between September and early November in a controlled way. In dry years, so-called *ladakng* firebreaks are established around the fields to prevent the fire from escaping into nearby forest gardens.

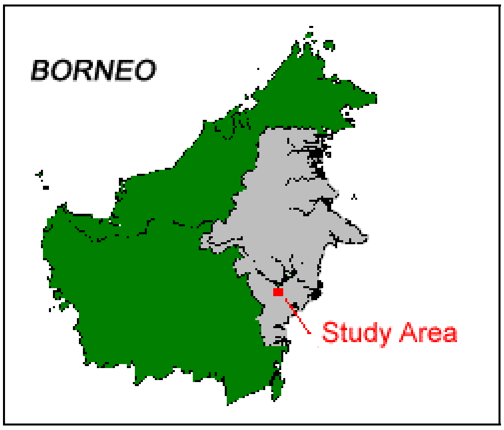

Fig.1. Location of the study area in the Indonesian Province East Kalimantan

This traditional land use pattern has changed substantially during the 1990s. In 1993 a combined HTI industrial forest plantation (HTI: *hutan tanaman industri*).and transmigration project cleared several hundred hectare of managed forest. This lead to severe land-rights conflicts with the local population, which are still unsolved, although the project stopped its operation in 1997/98. Then, in early 1996 a large Indonesian oil palm company started opening another plantation project with a total planned area of 96,000 ha of which approximately 30,000 ha were cleared by 1997. These activities caused new land tenure problems, and first violent conflicts rose in mid 1996.

Fig.2. *Ladakng* firebreak

Fig.3. Preparation of a firebreak

Most conflicts were related to the company's way of compensating converted forest gardens. Occasionally, gardens were '*sold*' by villagers who did not hold valid rights according the traditional *adat* law, while others were cleared without the permit of the owner. Hence, those garden owners who wanted to keep their gardens labled them with signs saying *'do not convert*'. When the fires started in September 1997, these gardens were the very sites that burned first. The fires continued until early November when rain finally came. However, they started again in early February 1998 and lasted until April, affecting approximately 75-80% of the forest gardens in the main research area. Village life suffered in many respects such as due to material losses (rattan stocks, rubber and fruit trees, crops, extracted forest resources), health problems (respiratory problems, diseases due to the drought, nutritional problems due to failed harvests and a general lack of resources), emotional problems (despair, sadness, anger, frustration, rage) or because of a devastated infrastructure (impassable forest trails and rivers due to fallen trees). For more details about the damage and the responses by the local population see Gönner (1999) or State Ministry for Environment Republic of Indonesia and UNDP (1998).

Fire Causes

If the fire did not fall down from the skies, where did it come from. The general answer of the farmers was that the fires were caused by the oil palm company. The rationale behind this answer is simple: During the ENSO 1982/83 there was no oil palm company and there were no fires; now there was the company and there were fires. Although this explanation sounds too simplistic it contains a certain truth, yet not in a monocausal sense.

Causes and effects of the fires and the drought were assessed through interviews of key-informants, semi-structured interviews, and field observation during the fires. The explanations were accepted if they were positively cross-checked between different trustworthy informants or if they were eye-witnessed by myself or by my wife. These data suggest four major groups of fire causes:

- Fires caused by the oil palm company's land clearing activities
- Arson linked to financial compensation of forest gardens
- Other kinds of arson
- Incidental fires

Fires caused by the oil palm company's land clearing activities

Up to December 1997 and again in February 1998 workers of the oil palm company were observed by key informants and by ourselves setting secondary forests on fire. These forests were part of the company's concession area and were to be opened in the forthcoming months. It was widely assumed that plantation companies tried to save expenses by using of fire, which is cheap compared with 'zero burning' techniques (e.g.

Schindler 1998). Some of these fires had obviously entered local forest gardens. Although there were most probably many cases of fires unintendendly destroying villager's gardens, there is also substantial evidence of fires set by oil palm company workers specifically to burn forest gardens, that might even have happened without the knowledge of the company's management. In some cases field assistants seem to have ordered the burning of enclosed gardens to reduce the financial compensation without the field manager's knowledge. As they were given a certain budget for handling compensation problems with local people (in general with the help of local negotiators), they tried to save money by paying less compensation for burned gardens.

In other cases the company's concession area overlaped with gardens of villagers, who wanted to keep them (cf. above). However, during our field trips we found many such gardens burned, eventhough they were not linked to bush land or to other fires, but were completely isolated within a cleared part of the future plantation. There is no direct proof, that these gardens were burned by the company, but the company remained the overall winner in these cases.

Fires for land clearing caused by farmers

Until the first rain came in early November 1997 no farmer in the investigated villages had burned to prepare a swidden, although several had slashed their sites. A major reason for not burning during the drought was the general opinion that such a fire might become out of control. Hence, it was quite likely that the fire would escape into one of the hundreds of forest gardens. The origin of such a fire would have been obvious and the high traditional *adat* fine was enough to prevent farmers from taking this risk.

Few people had burned small areas of bush land to prepare gardens. In at least one case such a fire might have escaped and caused immense damage in one of the villages by burning several hundred forest gardens.

Arson linked to financial compensation

Besides the arson committed by workers of the oil palm company, there were also villagers who set other people's gardens on fire. According to several informants this was mainly induced by the relatively big sums of compensation money. In cases where people wanted to 'sell' their gardens to the company, gardens of people, who did not want to 'sell' but whose land was in-between were some times burned in order to provide access for the company. In other cases large forest gardens, which were likely to receive big compensation were burned out of envy.

Other kinds of arson

Once the fires had destroyed many forest gardens, some villagers just did not want others to be better off, not only regarding possible financial compensation but also future income from rattan, rubber or fruit. Remarks like 'if I lost my gardens, others should also lose theirs' were frequently heard, and there was a local saying 'if it burns on the left side of the path, it will also burn on its right side'. This mental frustration coincided in some cases with long term feuds, which were revitalized through fire. This turned out to be a vicious circle, as revange was often taken just on suspicion.

In at least one other case the harvest of illegal external loggers was burned by angry villagers.

Incidental fires

Fires probably also occurred incidentally by discarded cigarette butts or escaping camp fires. A simple test proved that a glowing cigarette could cause a forest fire. In one case a Kapur tree (*Dryobalanops* spec.) kept glowing inside its stem for five months until the fire broke out again.

Conclusions

The evidence of the local fire causes in Jempang sub-district indicates the crucial role of social conflicts and large-scale land use changes. The use of 'fire as a weapon' is also reported from other areas of Kalimantan (Colfer 1999), as well as the link between plantation concessions and forest fires (Hoffmann et al. 1999). Nevertheless, the processes leading to the use of fire as a weapon are complex and often recursive.

One of the most fatal feedback loop was the relation between fires and emotions. Whatever the actual fire cause was, a person who has lost his or her resources to a forest fire ascribes the cause of this disaster to other actors (personal enemies, the oil palm company), which often results in new revange fires. The trigger of this *circus vitiosus*, however, was the oil palm company which destabilized the local setting to an extend that the farmers had never experienced before. Traditional conflict management strategies failed to work, and social unrest resulted out of the insensitive *modus operandi* of the company.

Fig.4. A forest fire approaches the village

Finally, the local people hit back in this conflict, and the company was forced to stop its illegal operation (cf. website at http://members.xoom.com/Oilpalm/Lonsum.html). But by then hundreds of forest gardens were cleared, and thousands of hectare were burned.

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KAZAKHSTAN

Overview on Forest Fires in Kazakhstan

Kazakhstan is a large country covering a total surface of 2.7 million km^2. The southern portions of the West-Siberian lowlands enter into the North of country. The central part of country is taken by the Kazakh low hill lands (Sary-Arka). There are separate mountain arrays: Kyzyl-Ray, Karkaraly, Ulutau, with elevations of up to 1565 m a.s.l.. In the South the Central Kazakhstan low hill lands stretch into one of the most anhydrous deserts - Betpak-Dala. Extensive area Zhetysu is located to the East from Betpak-Dala. Its majority consist of Balkhash Hollow, and Sasykkol-Alakol Hollow is the east part of it [4]. There are mountain arrays of Southern and Rudnyj Altai, with elevations up to 4506 m (Mt. Belukha), Saura (3805 m), Tarbagatai (2992 m), Zhungar Alatau (4463 m), Northern Tien-Shan (up to 6995 m - peak Khan-Tengri) are located in East and Southeast.

The climate of Kazakhstan is extremely continental. There are cold and long winters and dry, short summers in the northern part, and, vice-versa, short and low-snow winters and long, dry and hot summers in the south. Summer droughts accompanied by dusty storms and dry winds are very common [4]. In such phases the fire danger increases sharply and the number of wildfires occurring on wooded land is extremely high.

There are about 50,000 lakes on the territory of Kazakhstan. Balkhash, Zaisan, Alakol, Tengiz, Sasykkol, Kushmurun, Markakol are the largest. The northern and northeastern parts of the Caspian Sea and northern part of the Aral sea enter Kazakhstan.

The large size of the territory of Kazakhstan stipulates the high variety in natural landscapes. Five major natural zones are distinguished:

High-mountainous landscape zone
Subzones:

* Nival with eternal snow
* Alpine meadows
* High-mountainous coniferous forests

Forest-steppe landscape zone
Subzones:

* Southern forest-steppe
* Typical forest-steppe

Temperate steppe landscape zone
Subzones:

* Northern different grassy-cereal steppes
* Southern dry tipchak-kovyl steppes

Semi-desert landscape zone
Subzones:

* Lowhill-foothill semi-desert
* Flat semi-desert.

Desert landscape zone
Subzones:

* wormwood-solsolary deserts
* ephemerial-wormwood deserts

The climatic features of these zones are shown in Table 1.

Tab.1. Basic climatic indexes of natural zones of Kazakhstan

Climate Indices	Highland	Forest-Steppe	Steppe	Semi-Desert	Desert
Air temperature -annual average (°C)	+ 0.3... +1.0	+ 0.3... +1.0	+1.1...+3.1	+4.4... +6.4	+7... +12
Average temperature in July (°C)	+5... +17	+18... +19	+18... +22	+23... +25	+25... +30
Average temperature in January (°C)	-25	-19	-16... - 19	-12... -20	-5... -15
Annual precipitation (mm)	500... 1200	350... 400	200... 400	150... 280	100... 200
Summer precipitation (% of total annual)	30... 60	60	70	40	35
Duration of vegetation period (days)	0... 150	160... 170	170... 180	170... 200	200... 240
Duration of the snow period (days)	200... 365	150... 170	140... 160	120... 140	30... 120
Area (percentage of land cover)	1.0	10.3	19.7	22	47

Despite of the overall rigid climatic conditions, forests grow practically in all landscape zones of the country, and Kazakhstan has a large Forest Fund; its structure is given in Table 2.

It is necessary, however, to note the particularities of these forests which have a quite distinctly different image distinguishing them from European forests. Most important is the occurrence of "desert forests", which cover half of the forest fund and which are dominated by the unique wood plant Saksaoul (*Haloxylon* sp.). Practically Saksaoul is not subject to natural fires. However, due to its high calorific value the wood is used as ecologically pure cooking fuel. Due to its unique large-rooted system Saksaoul is a principal anchorage of the soil in the struggle with to the transition to sand. Due to the root system Saksaoul can grow on sites where there is practically no precipitation. The scanty surface of its specifically drought-adapted leaves prevents water evaporation and saving water for survival.

Tab.2. Structure of the Forest Fund of Kazakhstan

Forest Types	Area (x 1000 ha)	%	Fire Danger
Saksaoul (desert forest)	5365.5	48.5	Low
Bushes	2523.6	22.8	Average
Coniferous	1687.3	15.2	High
Soft-foliage	1371.0	12.4	Average
Craft-foliage	98.0	0.9	Average
Other	22.4	0.2	Average
Common afforested	11067.8	43.3	
Common wood	25565.0	100	

The Forest Fund of Kazakhstan is divided in natural fire danger classes (Tab.3). Figure 1 shows the types and pyrological classification of forests in Kazakhstan.

From a firefighting point of view in limits of landscape zones it is possible to allocate regions distinguishing in conditions of origin, distribution and development of fires.

The forest-steppe zone is located at the limits of the West-Siberian Lowland and occupies the northern part of Kazakhstan (territory of North-Kazakhstan, Aqmola and Pavlodar administrative provinces) with a total share of more than 10 % of the territory of the country. This is occupied by intensive agriculture (grain, pastures and grasslands for hay production) and large areas of wooded lands. Fires occurring on these territories cause high losses in the agriculture and forest sectors. Systematic wildland fire protection is therefore required by state forest and agricultural enterprises. The fires usually occur in the early spring and in autumn, especially in dry years. The basic reasons of wildfires are agricultural burning and violation of the requirements of fire safety.

The steppe landscape zone takes up to 20 % of the total territory of the republic. All steppe vegetation and the crops grain quite often suffer from human-caused fires, mainly from agricultural burning. The steppe phytomass after its drying becomes a dangerous combustible material. The fire in conditions of kovyl (*Stipa capillata* L.) and tipchak (*Festuca sulcata* Hack) grassy steppe usually last for long time and spread over large areas. The load of a dry phytomass of a herb on such sites changes from 0.22 up to 0.38 ton/ha. The fires start due to negligence of shepherds, fishers and hunters, machines, members of expeditions, agricultural burnings and dry thunder-storms, and cause large harm to the national economy. The crops of agricultural cultures, pastures, haymakings and groves are damaged and destroyed by fires. The velocity of distribution of a steppe fire is directly dependent of wind velocity. Flame heights usually reach 0.9-1.0 m in grass fuelbeds of 30 to 40 cm height. In the kovyl steppe fire can spread against the wind with a velocity of 5 to 10 times below the wind-driven spread rate. During such a wind-driven headfire a convective movement is formed, and the fire quite often "runs" along a top of grass stand. When it reaches either a natural barrier or a mineralised strip (firebreak) it stops, and the phytomass on the whole area burned over by the headfire gradually burns down.

Tab. 3. Classes of natural fire danger by V. Arkhipov

Danger Class	Groups of Forest Types, Planted and Deforested Territories	Characteristic Fire Types and phases of their origin
1 Very High	Coniferous saplings. Logged sites of dry and fresh pines, larch, fir and grassy cedar forests, bushy broad grassy silver fir forests. Dry and rocky pine forests. Damaged and dying tree stands (died dry stands, sites of storm debris and wind Falls, unfinished harvest sites, slash, insect-damaged stands).	Surface fires during the whole fire season. Crown fires occur on sites with high fuel loads.
2 High	Young pine forests, especially with pine undergrowth. Periodically dry larch forests. Cedar forests on country rocks of southern slopes. Dry growing conditions of flood-plain forests.	Surface fires are possible during the whole fire season. Crown fires occur during the phase of highest fire intensity.
3 Medium	Continuous harvest areas of coniferous forests in moist and wet sites. Dry fir forests, fresh larch and fir forests, wet pine forests. Mountainous-valley silver fir and fir forests. Cedar forests of remaining types of a forest. Fresh growing conditions of flood-plain forests. Radical and derivative fresh birch and aspen groves and their cut sites.	Surface and crown fires are possible in phases of summer fire maxima, and in mountain forests - in phases of spring and autumn maximas.
4 Low	Wet pine forests. Wet dark-coniferous taiga forests. Wet larch forests. Mossy-grassy silver fir forests, wet fir forests. Mossy fir forests. Bushy, dog-rose and aspen fir forests. Apple, birch and aspen groves. Wet growing parts of flood-plain forests. Black saksaoul.	The occurrence of fires is possible in phases of spring and autumn fire maximas. In a phase of summer maxima the fires are possible in pine forests
5 Very Low	Sub-alpine coniferous forests. Cedar forests on bare rocks. Wet birch and aspen groves. Damp poplar groves. Willow groves of all types. All types of saksaoul (except black saksaoul).	The start of a fire is possible only under extraordinarily unfavourable conditions.

Fig.1. A forest pyrological map of Kazakhstan. The legend at the left side of the map shows forest types and fire danger classes.

The Central Kazakhstan Low Hill Land is located in wood zone on a height of a northwest part of Sary-Arka (Aqmola province, Baian-Aoul of the Pavlodar province, Karkaraly of the Karagandy province) [1, 4]. Wood and steppe vegetation, climate and relief of region promote origin, distribution and development of wildfires, especially in hot, dry and windy weather. The struggle with fires is hampered here because of inaccessibility of wood sites. At the same time rocky ledges and the stony looses act as natural obstacle of further fire spread.

Fires in pine forests of Sary-Arka represent a major factor influencing to shape plantings and bringing large damage to the forest economy. Afforested wood species here are the pine (*Pinus sylvestris*), and birch (*Betula verrucosa* Ehrh). Fire hazard and flammability are highest in the following forest types: very dry stony-rocky pine forests, dry stony lichen-pine forests, dry cereals-berry pine forest. Average annual amount of fires here is about hundred, the average area of one fire is 5.4 ha during an average fire season. The basic reason of forest fires here is a violation of the fire prevention rules by many people having a rest in sanatoriums, boarding houses, camping sites, motels and tourist bases, and by the local population (see Tab.4). Lightning represents only a minor fraction of all fire starts. Coniferous wood arrays, especially undergrowth and wood plantations, differ by high flammability, that is stipulated by high fire danger of coniferous stands, dryness of a climate and availability of a many surface wood combustible materials in the mentioned above types of forests - from 9 up to 30 tons/ha. Special attention in forests of this region should be given to preventive maintenance of fires and regulating recreational activities.

The Band (Strip) Pine Forests (Lentochnyie Groves) of Western Siberia and Kazakhstan are located in a steppe part between Irtysh and Ob' rivers [4]. The forests have large water-, soil-, field-protective and aesthetic importance, are a basic source of wood in region. The basic afforestation species is Scotch pine (*Pinus sylvestris*). Fire hazard and flammability are highest in the following pine forest types: dry forest of high dunes, dry forests of slanting hillocks, topographic depressions, lowlands. In the indicated forest types fires are even common in wet years. In the very dry year 1997 extremely large, catastrophic fires occurred in the timber enterprises of Semey (Semipalatinsk) Forest Management Department, totalling 511 fires affecting anarea of 58,893 ha. In timber enterprises of Band Pine Forests of the Pavlodar province 316 forest fires burned 17,672 ha in the same year. The basic reasons of wood fires is violation of the fire prevention rules. In connection to high fire danger and flammability of Band Pine Forests, basic work on protection them from fires should be preventive maintenance and operative work on a detection and suppression of the originating centers of combustion.

The island pine forests of Kostanai province are located by green islands among extensive unforested spaces. There is a plain relief. The climate is extremely arid, annual precipitation is 240 to 350 mm. The duration of an average fire season exceeds 180 days. The forests here repeatedly were exposed to excessive burning. For instance, the large fires on the territory of Naurzum Reserve have essentially reduced the total size of forest stands. There is no natural renewing on burned sites; only occasionally in saucer-shape lowerings pine, aspen, and birch are meeting. The saved pine stands are damaged noticeably.

The remaining pine forests of the region also were exposed to pernicious action of fire, to what testify burning wound on trunks of trees. Despite of the damages, pine forests represent favourite vacation spots for people from the cities Kostanai, Rudnyj, Lissakovsk, and tourists from other regions. During the summer season numerous children camps, recreation houses, tourist bases are functioning here. The gains of the personnel of wood protection service should be directed on preventive work among the population, tourists, fishers and hunters.

The semi-desert engaging the central part of country (22 % of the territory) represents the transitional zone between steppe and desert. Typical landscapes are hillock-sandy plains with wormwood-grassy and bushy vegetation. For these conditions wormwood-salsola (*Artemisia* / *Salsola regida*) vegetation is characteristic which is not forming closed grass stands. In valleys of the drying up rivers, in crevices of hills there are small sites of meadows. A climate rather droughty: cold and low-snow winter, dry and hot summer. Fires are occurring frequently. The steadfast attention is required by protection of fires first of all on pastures and haymaking grasslands. The zone of deserts reaches to the central and southwest parts of Kazakhstan, between 48° and 41°N. It is covered by Aral-side sand Kyzyl-Kum and Kara-Kum (drainage-basin of Syr-Darya river) and sand southern Balqash-side (drainage-basin of Ile river), that represents about 47 % of territory of country [5]. Characteristics of the climate is a large insolation sum, extreme continentality and high aridity. The large rivers (Ural, Syr-Darya, Ile, Lepsy) and other rivers begin outside deserted zone. Landscapes are characterised by black saksaoul (*Haloxylon aphyllum*), white saksaoul (*Haloxylon persicum*), zhuzgun (*Calligonum arborescens*), tamarisk (*Tamarix*), chingil (*Halinodendron Vess.*), sandy acacia (*Caragana* Lam.), zhantaq (*Alhagi pseudalhagi*),

Tab.4. Distribution of the number of forest fires with regards to their origin in Kazakhstan 1997

Forest Management ssociations and Reserves	**Total Number of Fires**	**Violation of the Fire Prevention Rules (%)**	**Lightning (%)**
Aqmola	204	99.5	0.5
Almaty	22	100.0	0.0
Aqtobe	0	0.0	0.0
Taldy-Qorgan	18	100.0	0.0
East Kazakhstan	141	65 *	35 **
Semey	511	67 *	33 **
Zhambyl	5	100.0	0.0
West-Kazakhstan	5	100.0	0.0
Karagandy	143	99.3	0.7
Kyzyl-Orda	3	100.0	0.0
Kokshetau	353	99.2	0.8
Kostanai	127	97.0	3.0
Pavlodar	316	64 *	36 **
North-Kazakhstan	152	?	?
South-Kazakhstan	4	?	?
Baian-Aoul GNPP	107	97.2	2.8
Ile-Alatau GNPP	19	100.0	0.0
Kokshetau GNPP	114	100.0	0.0
Almaty State Reserve	2	100.0	0.0
Naurzum Reserve	12	100.0	0.0
TOTAL	**2258**		

**data are probably underestimated **data are probably overestimated*

wormwood (*Artemisia*), salsola (*Salsola regida*). Relief and climate promote fire occurrence. Despite of high flammability fires are a rare phenomenon, in basic because of a lack of fuel continuity. The groves of black saksaoul are characterized by highest fire hazard since a continuous grass allows the spread of fire to extended areas. Though these are surface fires, saksaoul is highly damaged because of its small height.

Fire protection of arid vegetation in the described zone has an important value, as fire destroys a valuable fodder basis consisting of wood, bushy and grassy vegetation which also promotes fastening of sand and creation of the appropriate desert microclimate

Fig.2. Start of the fire on Kokshe on 13 May 1999 (see text)

Tougai (bottom glade forests) growing on territory of five southern provinces of country: Almaty, Zhambyl, Kyzyl-Orda, Taldy-Korgan, and South-Kazakhstan. The total area occupied by these forests comprises more than 473,000 ha. The forest have a high value for soil and pasture protection and recreational activities. They aprovide habitats for a high concentration and variety of wildlife and birds, and they serve as winter range of domestic and wild animals. Tougai grounds of agricultural farms are used for haymaking, pastures, kitchen gardens and cattle wintering. Tougais are intersected by tracks and roads, suitable for travel of a motor transport; the latter also serving as barrier in the path of a fire. Long-term statistical data show an occurrence of eight forest fires per year (with an average area burned per fire of 28 ha). The basic reason is agricultural burning for improving haymaking sites and pastures embedded in woody vegetation. It is necessary to strengthen monitoring for burning, as the fires damage significant areas of valuable forests [2]. By expert evaluation three groups of fire dangers of basic groves types are determined: high, average and low. Here forest vegetation is replaced by various wood and bushy species: willows *(Salix wilhelmsiana, S. fragilis* L.), lokh (*Elacagnus angustifolia* L.), poplar (*Populus diversifolia*), turn (*Padus rasemosa gilib*).

The fire season in northern part of tougais begins in middle of April and comes to an end in October, and in the southern part in February/March and November respectively [2].

The mountain arrays are located in the Southeast and East of Kazakhstan. The elevations range from 500 m a.s.l. in the depressions up to 7000 m in mountains. They represent an important pasture area where dark and light coniferous forests are growing. The climate is highly to moderately continental, with large oscillations of temperatures in the winter and summer and with variable precipitation of 500 to 800+ mm in the mountains and 300 to 400 mm in the foothills) [8]. During extremely dry and hot years fires are frequent and spread over large areas. The foothill plains of the Zaissan and Ile plains are used as spring-autumn pastures and their protection from fires is required.

The most fire-prone forest types are cedar, larch and fir forests. They especially have suffered during the droughts of 1974 and 1997. Fire suppression in mountain terrain is a very labour-consuming process requiring high expenditures of forces and firefighting tools, development of special detection methods. A forest fire which occurred on 13 May 1999 on a slope of Kokshe Mountain can serve as an example. Having been started by negligent tourists in dry windy weather (see Fig.2) the fire quickly transformed to a fire running upslope. The fire was not extinguished before fully burning out a forest array up to the top of the mountain. The area affected by this fire was 32 ha (red boundary line in Fig.3).

For the last half-century the Forest Fund of the republic has undergone modifications shown on Fig. 4. Here pressure of agriculture - "assimilation of virgin soils" in the Soviet time on wood fund is seen clearly.

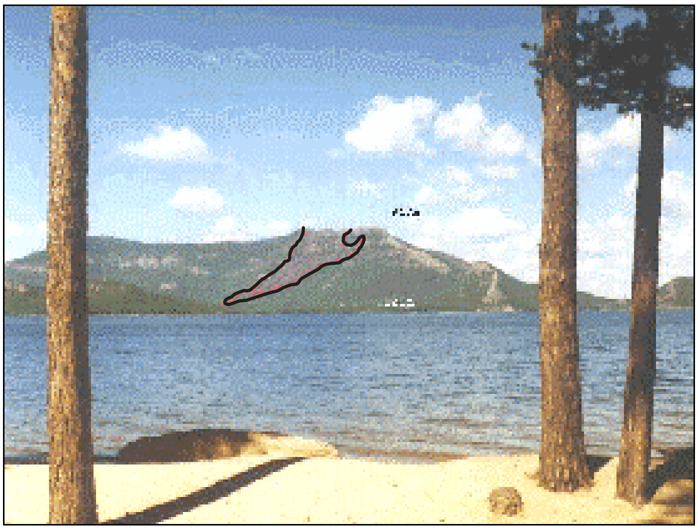

Fig.3. Kokshe fire burn scar (delineation by line)

Under the light green curve on Figure 4 the total forest area is given; under the dark green curve the afforested area of the country; red is the cumulative area of forest fires.

Forest fire statistics for the second half of the 20th Century in Kazakhstan is given in Figure 5. The pink curve shows changes of the annual area burned; the red curve shows the dynamics of the annual number of forest fires; the blue curve shows changes of the annual amount of precipitation for the arid-steppe zone. On this diagram it is visible, that the amount of fires is highly correlated with droughty years. The steady trend on magnification of number of fires together with a secular diminution of annual precipitation is seen.

At the same time, it is necessary to indicate, that the connection between area burned with the number of fires and the dryness are more complicated. We have identified two different types of years: Normal, when the average area of area burned is equal 5.4 ha, and anomalous, when the average area is equal 114 ha. The comparison of fire activities between 1954 and 1999 is shown in Figure 6 where the amount of fires for one year is shown on the abscissa , and the annual area burned the ordinate.

The lines of regression for normal and anomalous years determine the average burned area for each type of years. Between 1954 and 1999 only three years were anomalous: 1962, 1974 and 1997. The histogram of distribution of years on annual average area burned is shown in Figure 7. On the abscissa the logarithm of the average area burned in one year and on the ordinate the smoothed distribution of annually burned areas given. It is clearly visible that this distribution is not only two-modal, but that the modes are precisely divided. Thus, we deal with two principally different types of fire processes. We do not know yet the cause of the aggression of fire in anomalous years. It is impossible to explain it only by low precipitation, as these years are not so anomalous on dryness. The detection of the true reasons of this phenomena would allow to predict and a manage these catastrophic fire events.

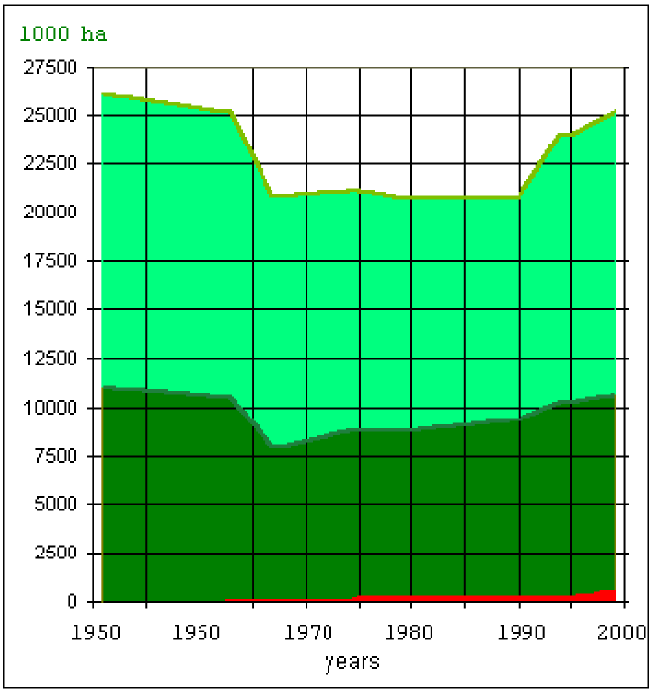

Fig.4. Changes of the area of the Forest Fund, Republic of Kazakhstan, between 1950 and 1999

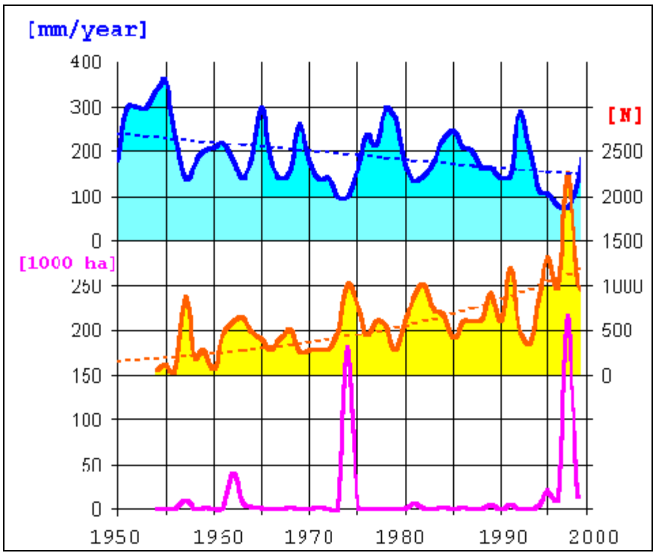

Fig.5. Forest fire statistics of the Forest Fund, Republic of Kazakhstan, between 1950 and 1999. The statistics include number of fires and area burned as well as changing precipitation regimes for the arid-steppe zone during the same period.

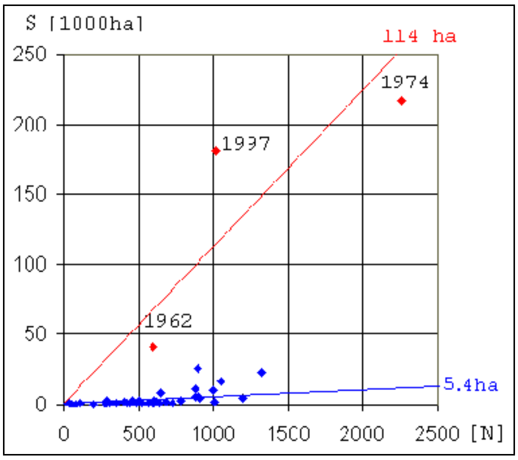

Fig.6. Two branches of fire processes (explanation: see text)

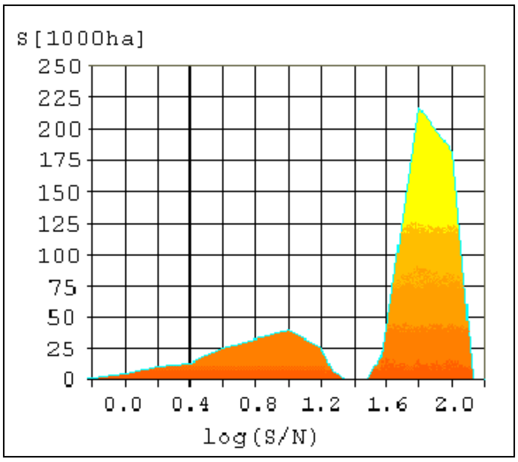

Fig.7. Distribution of area burned by fires (explanation: see text)

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NAMIBIA

Fire Monitoring and Management in Namibia

Introduction

Namibia lies in the west of Southern Africa, bordering Botswana and South Africa to the east and the Atlantic Ocean to the west, and covers an area of approximately 824,000 km^2. A gradient in average annual rainfall, from more than 750 mm in the extreme northeast to less than 100 mm in the west largely explains a predominance of woodland and savanna vegetation in the eastern and central regions and a transition to deserts in the west.

Large areas burn each year with a distribution relating to the rainfall gradient (and hence fuel loading) so that fires are most widespread and frequent in the north, and especially in the northeast. There is a perception that excessive, indiscriminate burning is having highly negative effects on some ecosystems, whilst in other areas, fire frequencies are more in equilibrium with requirements for long-term stability of existing vegetation communities (Goldammer 1999). The Namibia Forestry Strategic Plan consequently recognises the need for different regions in Namibia to be able to adopt different fire management policies as necessary.

Formulating national fire policy, and planning, monitoring and evaluating fire management programmes requires a wide range of information, including the timing, extent and frequency of fires. With such large areas involved, the only way to provide these parameters at a national level is to use satellite data.

Satellite-based monitoring of vegetation fires has been ongoing in Namibia since 1996 using data from the Advanced Very High Resolution Radiometer (AVHRR) onboard the NOAA (National Oceanic and Atmospheric Administration) satellite series. This data is downloaded daily by two PC-based receivers stationed in Namibia, at the National Weather Bureau, Windhoek and the Etosha Ecological Institute (EEI). Both receivers were established by projects funded by the UK-Department for International Development (DfID) and implemented by the UK - Natural Resources Institute (NRI) of the University of Greenwich.

Usually, the main fire information required is to delimit the areas burned, detected after the fire, rather than on the occurrence and distribution of active fires, which, while interesting, reveal little about the true fire extents. Burned areas are detected using a simple change detection technique applied to AVHRR thermal imagery. This identifies burns as pixels which increase significantly in brightness temperature between consecutive image dates as compared to background variation.

Examples of Namibian fire information and issues are given below.

Super-Regional Fire Statistics

Figure 1 shows a area of northern Namibia which burned during 1997. Based on this map, it was calculated that 3,032,000 ha of vegetation burned during 1997. The bar chart in Figure 2a shows the area in hectares that burned within each administrative region. Figure 2b expresses these areas as percentages of the total area of each region. The Kavango region contains the largest area of burn, partly a function of its large size, whilst Caprivi was the region with the highest percentage its total area burned. This basic kind of information is valuable for identifying areas where fires may pose a sufficiently serious problem to require some form of action, especially if the burns are mapped over a number of years to derive fire frequency (Frost 1999).

Fire Information for Local Fire Management

Maps of burned areas are used more locally in the two areas of Namibia where fire is actively managed, namely, east Caprivi and the Etosha National Park.

Caprivi

Caprivi forms the finger-like extension to the north east of Namibia and covers an area of approximately 22,000 km^2 and is vegetated predominantly by woodland, woodland savannah and floodplain grasses.

Rapidly increasing human population in Caprivi is resulting in fire being used more extensively than before, with approximately 60% of its vegetated area now burning annually (Trigg 1997, Mendelsohn and Roberts 1997, Trigg 1998). Although deliberate starting of fires is discouraged by government, it is still the main cause (Mendelsohn and Roberts 1997). The principal reasons for lighting fires are to convert wooded areas into croplands, to maintain grazing land and to assist (illegal) hunting of wild animals (Trollope and Trollope 1997).

The increased frequency of burning is thought mainly responsible for a host of negative impacts, including economic losses through damage to valuable timber and non-timber resources, increased losses of grazing and consequent livestock mortalities, all of which are to the detriment of the local population. The Directorate of Forestry has therefore focused on fire suppression, via the implementation of the Integrated Forest Fire Management component of the Namibia-Finland Forestry Programme (NFFP).

This programme has been highly successful at reducing areas burned in East Caprivi over the last three years, by both mobilising local communities to cut fire breaks, and educating the public about fire's detrimental effects. The success is however tempered by an ongoing necessity to set fires to maintain ecosystems in certain areas. For example, frequent fires are unlikely to have any adverse effects in floodplains, whist fire exclusion prevents the regeneration of river grasses, an important raw material for thatching, and the socio-economy of the area (Trollope and Trollope 1999). Emphasis is therefore shifting towards continuing fire exclusion in areas where frequencies are clearly too high, whilst still allowing fires to be set under carefully controlled conditions in areas where impacts would be beneficial.

Satellite monitoring of burned areas in East Caprivi has been useful at different stages. A first assessment of burning (Trigg 1997, Mendelsohn and Roberts 1997) found that 60 % of the Caprivi region had burned during the course of 1996. The large area affected meant that it was highly probable that many areas would be burning every year, with certain detrimental effects to woodland biodiversity and its potential to regenerate.

A preliminary assessment was made of whether fire lines cut in 1997 had reduced the area subsequently burned compared to the area burned in 1996 (Trigg 1998). Maps of the areas burned both years are shown in Figure 3. It was found that seven percent less of East Caprivi burned in 1997 than burned in 1996, against a 8% increase in the area burned over the same two year period in west Caprivi. This supported the proposition that the fire lines had a positive effect in reducing fire extent. However, the assessment would be improved markedly by combining the maps in Figure 3 with an accurate map of the fire lines cut and by mapping burns over additional years to better understand normal variation. Additional work is planned to map susceptible areas with high fire frequencies by mapping additional burn years.

The utility of satellite-derived information on the actual fire situation would be enhanced greatly when used in combination with ecological information on desired fire regimes for each intended land use. A recent ecological survey (Trollope and Trollope 1999) stratified East Caprivi into areas where fires are desirable and those where fire should continue to be excluded (the latter class still accounting for the vast majority of the total area). The next step in improving the fire information will be to establish an integrated fire information system which combines the remotely sensed fire occurrence data with field-derived ecological information in a Geographic Information System. Using the GIS, it will then be possible to discriminate ecologically acceptable fires from ecologically unacceptable ones as an improved basis for planning, monitoring and evaluating fire management activities.

Etosha

The Etosha National Park (Etosha), covers an area of 22,915 km^2 and has been managed as a wildlife reserve since 1907. It is Namibia's best-known tourist attraction, with abundant large mammal and bird life. The vegetation is mostly semi-arid to arid savanna.

Official policy forbade intentional burning of vegetation within the boundaries of the Etosha National Park until 1980, when the beneficial effects of fire were officially recognised. Since 1981, fires have been prescribed by park management, to remove moribund grasses, control bush encroachment, recycle nutrients and to manipulate game movements, all in line with an overall aim of maintaining and in specific cases increasing biotic diversity (Du Plessis 1997). For the purpose of prescribed burning, the Park is divided into 25 blocks. Each block is burned periodically in an attempt to simulate natural fire frequencies derived from historical records.

The selection of areas to be burned each year depends on the mean seasonal rainfall in each burning block, the time since it last burned and the accumulation of herbaceous fuel (Du Plessis 1997). For this, EEI's AVHRR receiver is used to map burned areas during the current season, which are then compared with burned area records to derive the date of last burn. With blocks ranging in size from 68 to 1788 km^2, the satellite-derived burned area maps are considered both more accurate (in terms of areal extent) and cost-effective than the previous method of driving block perimeters after fires. AVHRR data is also used to eliminate spurious rain gauge data by comparing interpolated rainfall maps with NDVI composites of the same period. Active fires, detected in near-real time using AVHRR thermal data have also been used to direct fighting teams to tackle unwanted fires.

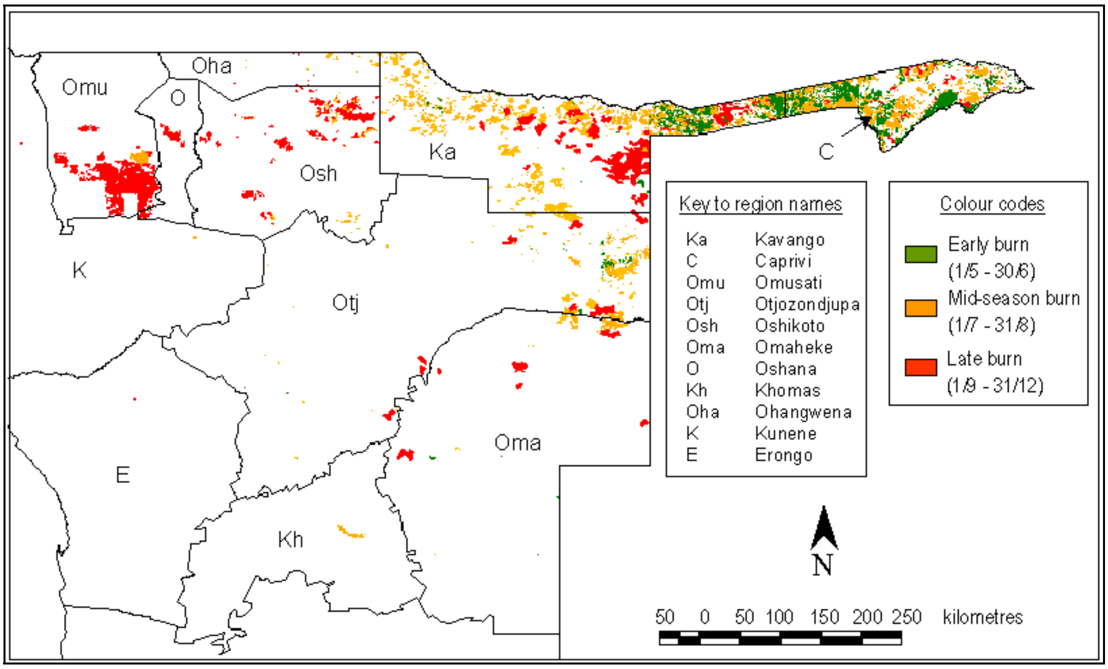

Fig.1. Areas of northern Namibia which burned during 1997

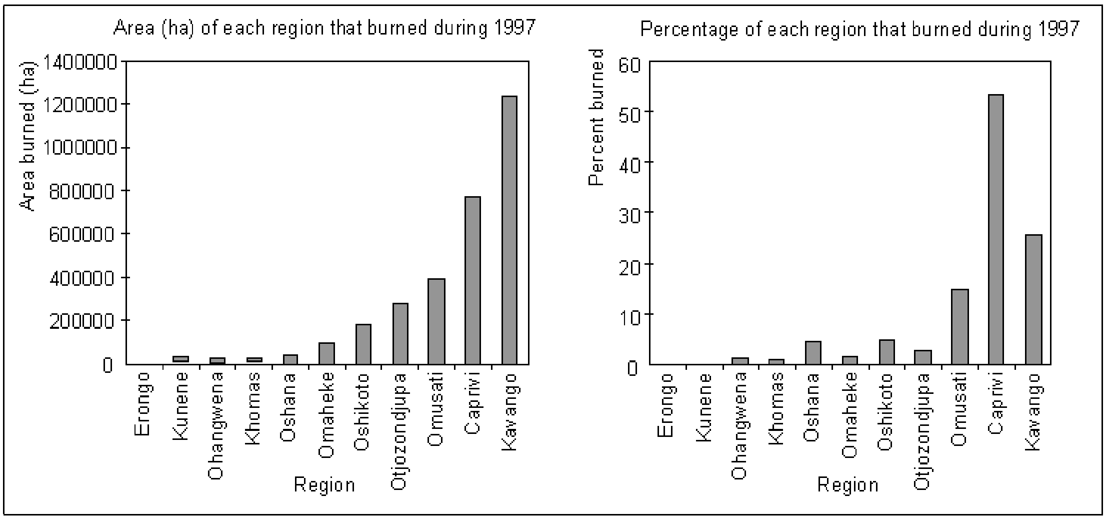

Fig.2. Area of burn for each administrative region shown in Figure 1, expressed in hectares (2a) and in percentage of each regions area that burned (2b).

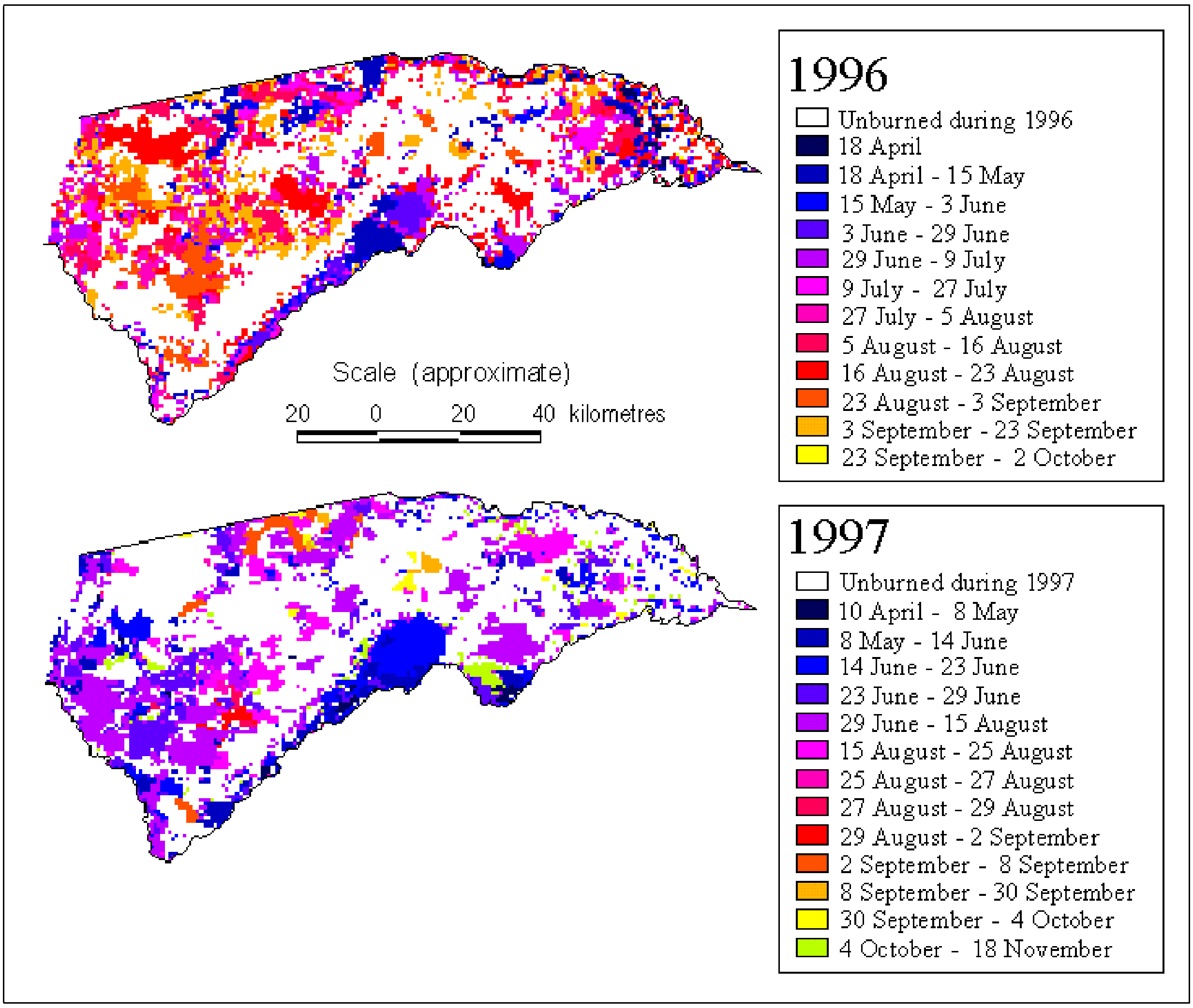

Fig.3. Areas which burned in East Caprivi during 1996 and 1997. Seven percent less was found to have burned in 1997, the year when most fire lines were cut by the community-based fire control project.

Further Research and Development

Forthcoming improvements to satellite sensors will allow burned areas to be mapped with improved accuracy and in more detail. For instance, the MODIS sensor, due to be online in early 2000, will provide data with excellent spectral discrimination (36 bands) and at a spatial resolution up to 19 times finer than the approximately 1.1 km spatial resolution of the AVHRR instrument. Research has been conducted to characterise the spectral evolution of burned savanna and shrubland sites in Caprivi. This will form the basis of research aiming to design improved algorithms for detecting burned areas in northern Namibia using data from the new and improved satellites.For the full potential to be realised, the burned areas detected should be integrated with field-derived knowledge on desired fire regimes (i.e. desired timing, intensity and frequency of fires), for each intended land use. Such information can be used to put detected fires into context, by indicating whether impacts are likely to be beneficial or detrimental, as part of an improved basis for action.

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RUSSIAN FEDERATION

Ecological and Economic Evaluation of the Consequences of Catastrophic Fires in the Russian Far East: The Khabarovsk Territory Example of 1998

Introduction

The Russian Far East region differs from the other parts of Russia by a high fire danger and frequent forest fires due to the specific climatic and forest vegetation characteristics. The frequent recurrence of extreme dry seasons, abundance of combustible materials representing high fire danger, mountain relief, inaccessibility of territory, and the hard wind regime in the end predetermine the high probability of forest fire occurrence, the speed of their spread, and also the difficulties to control them.

In addition the level of financing and material support of forest fire services sharply decreased during the last decade. This has negatively influenced the efficiency of their work to prevent, detect and to put out forest fires in time.

As a consequence of these adverse circumstances, anomalous dry seasons which naturally occur in 10-15 year intervals, inevitably predetermine the occurrence of mass forest fire. In such extreme dry seasons up to 150 wildfires or more burn simultaneously. Many of them reach catastrophic dimensions and are considered as natural disasters. Statistical data from Khabarovsk Territory for the period 1966-1998 reveal the tendency of increasing occurrence of wildfire catastrophes (Tab.1).

The statistical data testify that up to 1400 fires occur during extreme fire seasons and the forest area affected by fire varies from 300,000 up to 2,000,000 ha and more. On the average 780 fires occur annually, and the average forest area burned is 190,000 ha. The long-term average of fire size is 325 ha/fire.

Extreme fire situation in Khabarovsk Territory for the last 50 years were observed during the dry seasons of 1949, 1954, 1968, 1976, 1988, and 1998. The situation in 1998 which was especially severe and complex offered an opportunity to evaluate the ecological and economic damages not only on the territory but to consider the diapason of ecological effects from a local/regional levels up to the global level and to put the fires into the context of the large fires which occurred in the same year in Southeast Asia (Indonesia), Brazil and other countries.

1. Characteristic of the Forest Fire Situation in Khabarovsk Territory in 1998

The mass outbreak of forest fires in 1998 appeared already in spring. Starting in mid of May till mid of June about 30-40 fires occurred daily. From mid of June the fire situation became complicated and daily amount of fires reached several hundreds. There were huge concentrations of both small-sized, and large-sized fires on an area of hundreds of square kilometers, basically in the central and boreal parts of Khabarovsk Territory, in particular in Low Priamurya (Fig.1).

The situation got completely out of control. Because of continuous and dense near-ground smoke coverage the monitoring of fire spread was impossible by any means of ground, airborne or satellite observation. This situation lasted until 20 October 1998.

As a result the area affected by fires reached 2,389,000 ha between May and October 1998 (Tab.2). In some forest enterprises the area burned reached up to 28-29 % of the total forest enterprise areas.

The majority of fires (more than 60 %) fell into the litter-humus category. This resulted in high tree mortality. The average mortality in forests reached about 80-85 % or 95-99 m^3/ha. The total losses of wood damaged by fire was ca. 154 million m^3.

2. Basic Reasons of Extreme Fire Conditions

2.1. Climatic

A high potential fire danger in forests in boreal and central areas of Kray was already noted in spring. In April - May the precipitation exceeded the average by 2-3 times and air temperature was above 2-5°C of monthly averages. It led to the fast thawing of the snow cover, but as the soils were frozen, the intensive surface flow was formed and the moisture did not penetrated into the soil. As a result by the beginning of summer the soil and the forest fuels had a high deficiency of moisture content.

At the same time, in north of the territory in June rainfall was reduced to 20-50 % of the monthly averages and in the central regions only 15-20 % of its monthly average of 50-75 mm. In July the precipitation was down to 0-20 %, in August to 20-50 % (75-100 mm).

Such sharp deflections from average annual rainfall averages in 1998 were determined by summer atmospheric processes. Usually in May - June there an anticyclone is formed under effect of monsoon circulation above the *Okhotsk Sea* and leads to dry and cool weather in the territory. The average precipitation is rather low (50-75 mm). However, in the second half of July the anticyclone is shifted and south cyclones with abundant rainfall begin to influence Primorye and Priamurye. Tropical humid air is common in July - August stretching from low latitudes up to Primorye and Khabarovsk territories. In 1998 the highest latitude reached was 30-35^0 N. The cyclones caused catastrophic floods in the basin of the Yangtse river in China, as well as in in Korea and in Japan. At the same time an extensive tropospheric crest which caused dry and hot weather was above the Okhotsk Sea, Khabarovsk territory and Yakutia . The air temperature was 2-5°C above average.

work in the *Krays* and financed from central sources continued during the past years. In 1997 only 24 % of the average forest fire protection budget was available.

The situation is revealed by comparing 1998 with an analogue year with similar dryness and fire danger. With a total of 1224 forest fires the year 1988 had the same potential as the year 1998, but due to the availability of resources for fire prevention, detection and suppression and both sufficient material and financial support, the total area of fires was contained to only 353,000 ha. Therefore economic factors which determined the degree of the forest fire catastrophe in 1998 should be interpreted in comparison with 1988.

The financial support from central sources was practically absent for some years. The amount of funding available for forest fire protection in 1988 was 3.75 rubles / ha ($US 25) and 0.9 rubles/ha ($US 0.6) in 1998. This inevitably led to the weakening of forest fire services, decrease of volumes of the fire-prevention arrangement of forest territory, reduction of staff of working in forest protection. Also the number of staff personnel of the aerial forest fire protection service was sharply reduced by 3.1 times in comparison with 1988.

Tab.1. Forest fire statistics of the Primorskii and Khabarovsk Territories for the period 1966-1998

Year	Number of Fires	Forest Area Burned (x 1000 ha)	Number of Fires	Forest Area Burned (x 1000 ha)
	Primorskii Territory		Khabarovsk Territory	
1966	304	4.8	999	53.8
1967	610	8.0	715	15.9
1968	531	3.7	1149	213.0
1969	202	0.5	625	24.6
1970	457	5.7	830	88.1
∑	**2104**	**22.7**	**4318**	**395.4**
1971	245	1.1	505	20.3
1972	210	2.3	514	32.1
1973	226	0.6	943	26.3
1974	118	4.0	853	19.7
1975	247	2.0	1142	78.8
∑	**1046**	**10.0**	**3957**	**177.2**
1976	395	3.4	1251	1800.0
1977	383	20.6	643	99.8
1978	336	32.1	694	18.1
1979	265	3.1	692	23.2
1980	216	2.2	1018	65.8
∑	**1595**	**61.4**	**4298**	**2006.9**
1981	172	0.9	596	24.2
1982	589	60.7	641	49.3
1983	269	2.6	678	71.9
1984	152	1.0	677	33.7
1985	315	2.7	518	19.2
∑	**1497**	**67.9**	**3110**	**198.2**
1986	433	3.3	1128	44.9
1987	319	28.7	805	68.5
1988	217	4.3	1224	353.0
1989	351	19.3	997	115.7
1990	227	1.3	953	130.9
∑	**1497**	**56.9**	**5107**	**713.0**
1991	127	3.1	291	11.5
1992	216	6.9	372	17.1
1993	262	14.4	651	60.3
1994	78	3.3	278	13.0
1995	178	22.5	569	53.8
∑	**861**	**50.2**	**2161**	**155.7**
1996	187	6.8	1128	191.0
1997	425	13.3	389	34.0
1998	556	58.6	1314	23.9
Total for 33 years	**9818**	**347.8**	**25782**	**6260.4**
Average / year	**298**	**10.5**	**780**	**190**

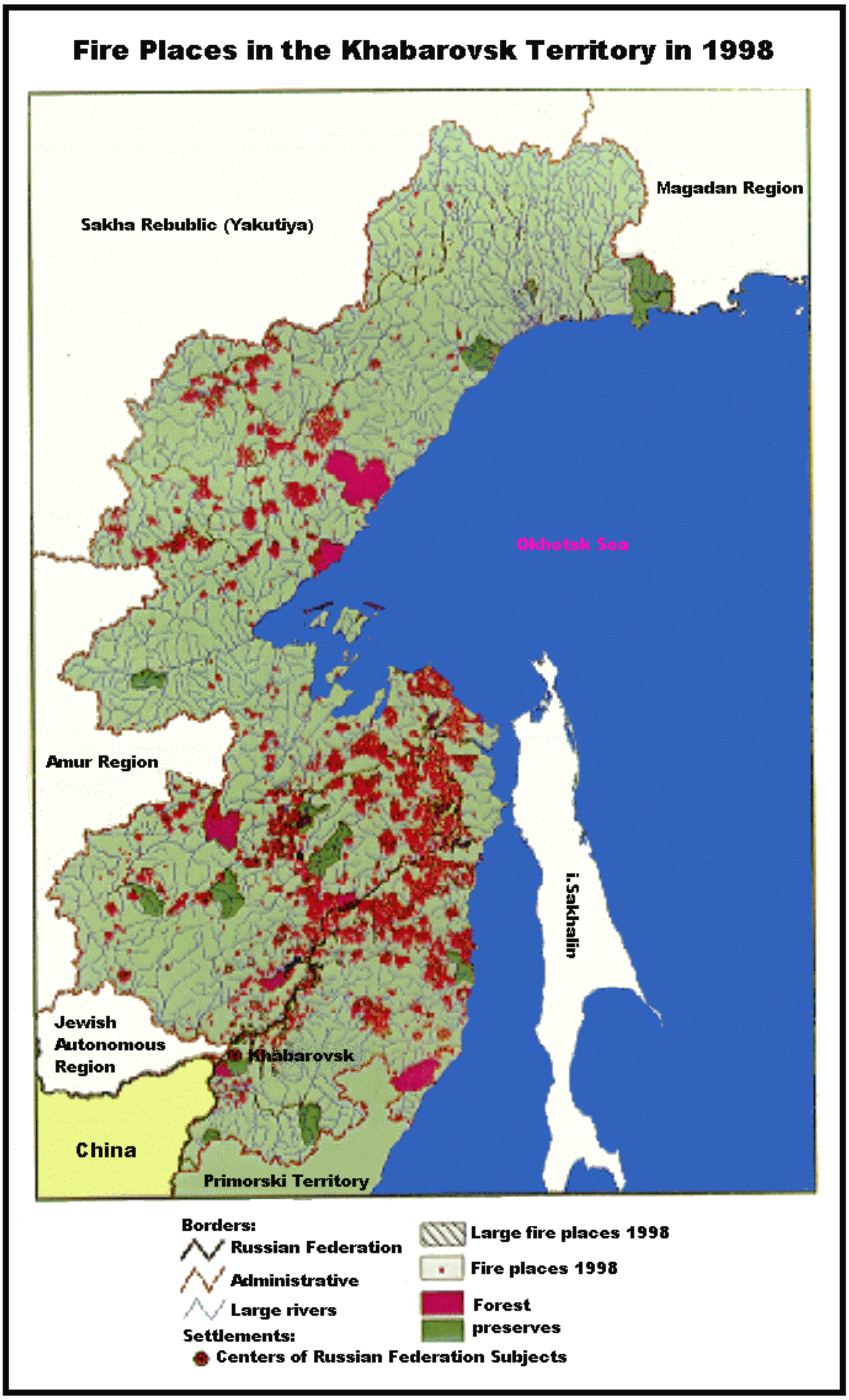

Fig.1. Forest fire map of Low Priamurya region at the end of the 1998 fire season. This fire map was digitized with the assistance of the Amur Design Office of the Russian Branch of the World Wide Fund for Nature (WWF).

Tab.2. Forest area burned by wildfires in Khabarovsk Territory in 1998

No.	Name of Forest Enterprise	Size of Forest (ha)	Area burned in 1998	
			ha	%
1	Amgunski	59,508	70,252	6.6
2	Avanski	28,2562	154	0.1
3	Ayanski	15,907,620	254,000	1.6
4	Badzhalski	1,110,236	22,168	2.0
5	Bikinski	159,289	1,090	0.7
6	Bystrinski	635,829	182,499	28.7
7	Bolonski	606,652	19,733	3.3
8	Vysokogornyi	923,329	161,019	17.4
9	Gorinski	761,670	19,251	2.5
10	Gurski	691,905	38,830	5.6
11	De-Kastrinski	462,912	135,816	29.3
12	Innokentevski	478,530	526	0.1
13	Kerbinski	2,895,868	114,668	4.0
14	Kizinski	219,215	5705	2.6
15	Komsomolski	344,097	16,660	4.8
16	Kur-Urmiyski	1,063,573	1,169	0.1
17	Lazarevski	440,233	12,786	2.9
18	Litovski	462,370	487	0.1
19	Mukhenski	649,909	6,723	1.0
20	Nanaiski	1,266,985	187,046	14.8
21	Nikolaevski	1,248,183	161,874	13.0
22	N.Tambovski	460,243	40,646	8.8
23	Oborski	326,526	229	0.1
24	Okhotski	15,825,976	1,100	-
25	Padalinski	197,806	16,466	8.3
26	Prigranichnyi	72,673	-	-
27	Severnyi	919,180	29,087	3.2
28	Sidinski	114,830	6,887	6.0
29	Sovetski	1,240,770	35,825	2.9
30	Solnechnyi	534,870	18,470	3.5
31	Cukpaiski	1,171,440	1,077	0.1
32	Takhtinski	577,613	93,394	16.2
33	Tyrminski	1,836,091	17,944	1.0
34	Tumninski	663,875	13,3083	20.0
35	Ukturski	802,630	91,111	11.4
36	Ulchiski	1,466,411	358,026	24.4
37	Ulikanski	1,180,271	1,196	0.1
38	Urgalski	3,315,574	66,687	2.0
39	Khorski	951,134	48	-
40	Khabarovski	77,476	1,300	1.7
41	Chumikanski	9,405,705	1,982	-
42	Evoronski	788,064	62,515	7.9
43	Selection center	13,004	-	-
44	Vyazemski	54,377	7	-
	Total	**73,667,014**	**2,389,536**	**3.24**

2.2. Economic

To put out forest fires effectively, the high material maintenance of all forest fire services must be ensured and requires adequate financial support. The continuous decline of budgets which are available for fire protection

The situation of the 1998 was even more complicated because in addition to low provision of finances and technical means there was also no means for preparation of the fire season. Consequently the forest fire equipment was not ready for operations and there were difficulties in providing fuel reserves, food supply and training of forest fire teams.

2.3. Social

Alongside with the natural factor - the extremely dry season - a second factor which caused the extreme fire conditions in the forests of the Kray is anthropogenic. The majority of forest fires is caused by humans and significantly contribute to mass fire situations. Multi-year statistics testify that 9 of 10 fires are caused by human activity. On holidays the amount of fire starts makes up to 40% of the total weekly fires. Up to 93% of all fires burned in a 10-kilometer zone around the settlements and 3-kilometer strips along the roads most visited by the population.

During the current year, in connection with an economic crisis and unemployment, many inhabitants of settlements and townspeople made their way into the forest on various crafts. As a rule, they these people are inexperienced forest users and carelessly cause the outbreak of forest fires. In addition arson was another major cause of wildfires in connection with increasing illegal logging and high competition between forest users.

2.4 Administrative Organization

Experience of 1988 shows that the system of the fire fighting organization which existed in the USSR as a whole was able to control extreme fire situations.

In 1998 alongside with insufficiency of financial and material means the essential administrative and technical problems, concerning the detection and control of fires appeared in connection with the disintegration of the old social and economic system. This was especially shown with regards to mobilization and attraction of the population to fire fighting.

As a whole, from mid May till 15 July 1998 when about 30-40 fires were burning daily, forest fire teams of forest enterprises, the Far East Air Base and timber industry enterprises were involved the fire-fighting with the mobilization of 44 stations with forest fire equipment and fire chemicals and about 350 firemen, 290 personnel of the aerial fire service, bulldozers and other machines.

Practically all state forest protection service was involved in organization of fire fighting works, control of observance of the fire prevention rules, work on check posts. 18 caterpillar all-terrain vehicles were bought, converted and sent to forest enterprises by Forest Management.

The accepted measures allowed forest guarding to cope with fires independently during two months. For that period of time 480 forest fires were put out, and the area affected by fires was 80,000 ha. The average area per fire was 165 ha, thus during the first two days 65 % of all fires were put out.

However, from the middle of July the fire situation in Kray was very complicated due to the anomalous dry weather and the continuous smoke cover of territory. On 17 July 1998 the state of forest fire emergency was declared and the free access in the forest was closed for the population and transport.

To put out the fires all forces and means of forest management and the air base were involved, the regional reserves of manual fire-prevention stock and field property for 1050 persons were opened. All reserve of fire prevention property and month store of a food supply for 500 persons were used up. The month store of food supply for 1000 persons, 1000 tons of fuel and lubricant supply , and 33.0 million rubles. were assigned for fire fighting. In addition the forces of the Regional Department of Disaster Management (EMERCOM of Russia) with up to 120 persons and 25 technical units were involved. The Ministry of Defense contributed up to 360 persons and 96 technical units, and the Ministry of Internal Affairs provided 220 persons and 25 technical units. From other regions of the country 140 persons of the Aerial Fire Service were directed to the Kray. In the Kray a fire retardant airplane and two amphibious airplanes BE-12P which made 95 drops of water on fires (about 550 tones of water) were put into operation.

The accepted measures allowed to stop fire spreading close to settlements, industrial and defense objects, and to prevent human victims. During the most dangerous days more than 100 tractors, 50 all-terrain vehicles, 30 fire engines and other machinery, up to 2000 persons and 500 units of technical units, including 150 bulldozers were involved in fire fighting. Under conditions of strong smoke cover, when the use of aircraft was practically impossible, the satellite information greatly helped the forest fire services. Under extreme conditions it gave the opportunity to detect fires and to direct the forest fire units. However, under the extremely dry conditions it was impossible to stop the intense and fast spreading fires, especially in remote regions where they transformed in large fires with individual sizes of up to 25-30,000 ha and more.

3. Ecological and Economic Estimation of the Forest Fire Damages

The estimation of forest fire damage bears a lot of methodical complexities therefore there are no universally standardized methods of damage assessment. We estimated the fire damage according to *The Express Methods of an Ecological-Economic Evaluation of Fire Damage*, developed in 1977 by the Far East Research Institute, Khabarovsk, and the *Instructions for Fire Damage Determination*, ratified by the Federal Forestry Service of Russia (Order No. 53 03.04.98).

Thus, the damage estimates include not only the direct loss of marketable resources, but also equivalent environmental losses with regard to forest ecosystem formation and functions. As a result the general fire damage of 1998 in the Khabarovsk Territory were in the range of 4.5 to 6.0 billion rubles (equivalent to ca. $US 1.0 billion). This damage considers the state of wood damage for the first year. Taking into account the dynamics of tree mortality and an expected increase of damages up to 2-3 times in the next three years the losses will increase to ca. 8-9 billion rubles. The increase of wood losses during the next 2-3 years will take place due to gradually accelerating mortality of fire-damaged trees and the inevitable intensive outbreak of insects and diseases, particularly wood-boring and bark beetles, fungi).

It is important to note, that significant tree mortality was due to the long-lasting drought which resulted in high-intensity stand replacement fires, burning of the humus/litter layer down to the mineral soil, and the development of crown fires in fir stands and peat forests (organic *Sphagnum* terrain). In the latter two forest types the tree mortality was complete (100 %). Forests burned by surface fires will undergo an increase of mortality during the next two years and reach more than 90% of the standing volume. Out of the total damaged forest no more than 40 million m^3 of timber can be immediately salvaged. Considering the restricted transport availability and potential opportunity of development for the next 3 years about 15 million m^3 can be salvaged.

Except the direct losses of arboreal raw resources the significant losses of animal resources are doubtless. According to data of All-Russian Research Institute of Hunting the loss of squirrels, stoats and musk deer reaches 70-80 %, and roe deer, red deer, and wild boar will suffer losses of to 15-25 %. The direct damage of the hunting economy in 1998 reached about 70 million rubles.

The fires unconditionally influenced biodiversity. We believe that zoo-biodiversity was damaged essentially and in same places irreversibly, not only due to direct mortality or migration from the territory affected by fire, but also due to the destruction of food supply. For example, the depression of mouse rodents is inevitable because of (a) the loss of a food supply for predators, and (b) the loss of the forest production agents. It is possible to expect also, that at the first stage there will be an intensive change of the composition of the entomofauna due to the outbreak of secondary pests and fungal flora. At present it is impossible to evaluate everything. We also believe that the fires were fatal for many populations of animals, including the spawning of salmon in the Amur river.

The complete loss of forest production capacity of a part of forest lands can be referred to direct losses in forestry and indirect results of fires. About 40 % of the burned-over land area are on the territory of traditional aboriginal minorities of the Far North which completely lost the traditional resource base. The influence of fires also reached the vast territories Zabaikalia and Yakutia which were affected by extremely high smoke pollution involving increased human morbidity and decrease of photosynthetically active radiation. The area in which bio-production processes were affected by the indirect effects of fire is in the magnitude of 100 million ha.

On an area of 1.5 million ha of the burned forest 60 % of the standing trees are dead and 40 % damaged by fires, i.e., the loss of live phytomass (only arboreal) is more than 100 million m^3. More than 900,000 ha completely lost their carbon deposition function.

As a result of a fire there was single carbon emission of about 60 million t. And the emission is not compensated by photosynthetic activity due to destruction of stand. The regeneration of this function will be very slow in accordance with forest regeneration. Due to complete humus combustion and deep burn-out of soil ca. 200-300,000 ha of forests are transformed and the regeneration and carbon sequestration function is destroyed. It is also important to note that the processes of post-fire decomposition (tree mortality, etc.) will stimulate carbon emission from 3 up to 10 t/ha of carbon annually. Since the ability of a alive forest to act as a sink of 0.6-0.8 t/ha of carbon the fire-affected sites will remain to be carbon sources for the next decade.

The dynamics of the decomposition of fire-damaged trees show that burned trunks are gradually destroyed over a rather long time period (a decade and more) and remain standing even on mountain slopes. Remaining organic materials protect the soil after fire, but such sites become susceptible to a second fire and represent a major problem for forest restoration works.

4. Carbon Emission from Forest Fires

The influence of forest fires on carbon flux to the atmosphere is determined by two basic processes, (a) the physico-chemical process of releasing carbon in the form of gaseous compounds and aerosols by combustion, and (b) the biological process of slow release of carbon as a result of biological destruction and decomposition of plants killed by fire but not consumed (post-fire emission); this process may last up to several decades.

In order to assess the carbon emission as a result of forest fires it is necessary to know the phytomass consumed by fire and the amount of dead phytomass remaining on site after the fire.

Basic data

I. General: Forested area affected by fire in 1998
Total area burned 2,201,800 ha thereof:
surface fires: 1,997,600 ha (88 %)
crown fires: 242,200 (11 %)
peat fires: 22,600 ha (1 %).

II. Phytomass of the burnt organic material under different kinds of fires (t/ha dry weight)
surface fire: 12 t/ha
crown fire: 30 t/ha
peat fire: 120 t/ha

III. Phytomass of tree dead organic matter in fire-damaged stands (t/ha dry weight)
after surface fire: 13.0
after crown fire: 51.0
after peat fire: 33.0

Estimation of fire carbon emission

The release of carbon from fire is estimated using the formula:

$$G = k\,M, \quad t$$

Where

$k = 0.5$ - constant quotient representing the average content of carbon in forest fuels (FF);
M - mass of burnt FF (t)

The total mass of burnt FF is determined by summarizing the burnt fuel loads from all fire types. The burnt mass is determined as product of the area affected by fire and the burnt mass per ha.

Hence, at mass: $M = 1937.6 \times 12 + 242.2 \times 30 + 22 \times 120 = 33{,}157{,}000$ t the fire carbon emission will be:

$$G = 0.5 \times 33{,}157{,}000 = 16{,}578{,}500 \text{ t}$$

Evaluation of post-fire carbon emissions

The scales of carbon emission after fire estimate under the formula:

$$R = k\tau \frac{P}{T}, t$$

Where
k = 0.5 - quotient of conversion of organic substance mass into carbon
τ = 25 - duration of forest regeneration period of burnt-out areas (years)
T = 10 - duration of destruction period of dead trees (years)
P = mass (dry weight) of annual tree mortality after fire (t)

The mass of annual tree mortality is determined by the sum of phytomass of dead trees from all types of fires. The mass of tree mortality according to the fire type is equal to the product of the area affected by fire and the dry weight of dead trees per ha, and will be equal:

$$P = 1937.6 \times 13 + 242.8 \times 51 + 22 \times 33 = 38,298,000 \text{ ha}$$

and emission after fire:

$$R = 0.5 \times 25 \times 38,298,000: 10 = 47,872,500 \text{ t}$$

Thus, the total carbon emissions of forest fires are:

$$S = 16,578,5 + 47,872,500 = 64,451,000 \text{ t}$$

5. Forecast of Long-Term Consequences After Fire

A prediction of the long-term consequences of catastrophic fires is based on studies of post-fire dynamic processes which were conducted over many years. Following possible negative transformations can be expected:

1. Change of the structure of forest lands and the state of biotopes and habitats. About 30 % of the burned area will loose its forest character for a rather long period and will turn in moors, stone-detritus, grass-shrubs and shrub waste lands within the next 20-30 years. The regeneration of forests on the remaining area (70 %) in the average will go through a reproduction period of 15 to 20 years. The possible pathways will be as follows: will take place about 10 % of the forest lands will be regenerated naturally by coniferous species (mainly by larch); 50 % will be regenerated by soft-leaved species with regeneration of coniferous (basic species) within the next 60-80 years.
2. The ecosystem productivity, particularly the arboreal biomass, will decrease as compared with the initial condition at a minimum by 30%.
3. Increase of fuel accumulation due collapsing trees and rapid spread of grass will increase the wildfire potential. A recurrence of fires in intervals of 5 to 8 years is predicted.
4. The loss of forest in water catchment basins up to the limits of critical cover (50-70 %) will result in essential or irreversible transformations of hydrothermal regimes with consequences on and possible losses of spawning places of salmon and other valuable fish species.
5. General impoverishment of biodiversity will take place due to the direct destruction of unique and rare flora and fauna on burned-over areas passed and subsequent impoverishment of the composition of the post-fire phytocenoses.
6. The quality and topology of distribution of food resources for wildlife will be changed and will have long-term consequences on population dynamics. The depression of wildlife populations will also negatively affect forest utilization.

6. Global Consequences of Catastrophic Fires

There is no doubt that a regional catastrophe of such scale essentially influences global ecological, social and economic processes. However, the role and degree of these consequences, and also the threshold sizes of the planetary significance of regional stresses, practically are not yet investigated.

In the case of the 1998 fire disasters in the Far East of Russia the following impacts must be noted which have transboundary impacts or are of global significance: (a) during almost the whole vegetative period of 1998 a dense near-ground smoke layer covered a large territory of more than 100 million ha, including a parts of China and North Korea, with climatic effects being similar to a "nuclear winter"; (b) negative impact on the carbon pool; (c) impoverishment of biodiversity and number of populations of migratory species (both land and water); (d) transport of large amounts of ash into the Okhotsk Sea and the Japanese Sea; (e) influence on variability of climate parameters in the Northeastern part of the Asian continent; (f) negative influence on wood resources and trade associated with negative socio-economic impacts in countries of the Asia-Pacific Region; (g) loss of natural heritage sites of international significance.

7. Measures of Rehabilitation and Damage Control in Fire-Affected Forest Lands

From the strategic point of view of fire disaster mitigation and rehabilitation of forest lands it is necessary to:

1. Concentrate first of all efforts not so much on reforestation, as an avoidance of the following catastrophe. With that end in view it is required to
2. Reorganize the fire management system;
    - provide the fire services, the forest service and other agencies involved in fire prevention and the forest enterprises with modern state-of-the-art fire fighting equipment;
    - carry out fire-prevention measures as integrated element of forestry in accordance with scientific norms;
    - improve airborne forest fire monitoring and ground-based fire detection and patrolling;
    - increase the regular budgets for fire prevention measures.
3. Urgently speed up salvage logging operation in burned-over forests;
4. Utilize to the full extent the regeneration potential from unburned forest fragments within the next five years;
5. Establish plantations only in accessible sites by using fast-growing species in order to speed up carbon sequestration;
6. Concentrate and prioritize planning and implementation of forest cultures in protection forests in water catchment regions and unburned forest fragments with a high protective value for habitat rehabilitation of rare and the most valuable wildlife animal species.
7. Realize biotechnical measures for the rehabilitation of fire-affected habitats and the regeneration of populations of rare and valuable animals.

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Forest Fire Problems in 1999 in the Russian Federation

Forest fire control on 1.111 billion ha of the Forest Fund under management of the Federal Forest Service of the Russian Federation is provided by the following ways:

- Ground-based fire protection service in collaboration with making use of aerial patrolling - 10.5 %
- Ground-based fire protection service - 16.4 %
- Aerial fire protection service through *Avialesookhrana* - 47.2 %
- Unprotected forest and other land - 25.9 %

The forest fire season of 1999 in Russian Federation broke a record by number of forest fires – over 31,000. According to the official statistics forest fires burnt 960,000 ha including 680,000 ha forest area. The majority of forest fires burned as surface fires: Crown fires affected on 65,000 ha. A total of 742 fires exceeded 200 ha and were included in the category of large fires (note: in areas under aerial fire protection a fire >200 ha is defines as a large fire, on territory protected by ground forces a large fire is declared when exceeding 25 ha). The total damage from forest fires in 1999 accounted for 1.8 billion rubles (about $US 70 million). Fires destroyed 21.5 million m^3 of standing forest and 81,000 ha of young forest. The main causes of forest fires in 1999 (on average in Russia):

- Local population - 69 %
- Lightning - 13 %
- Agricultural burning - 4 %
- Forest logging - 1%
- Unknown causes - 13 %

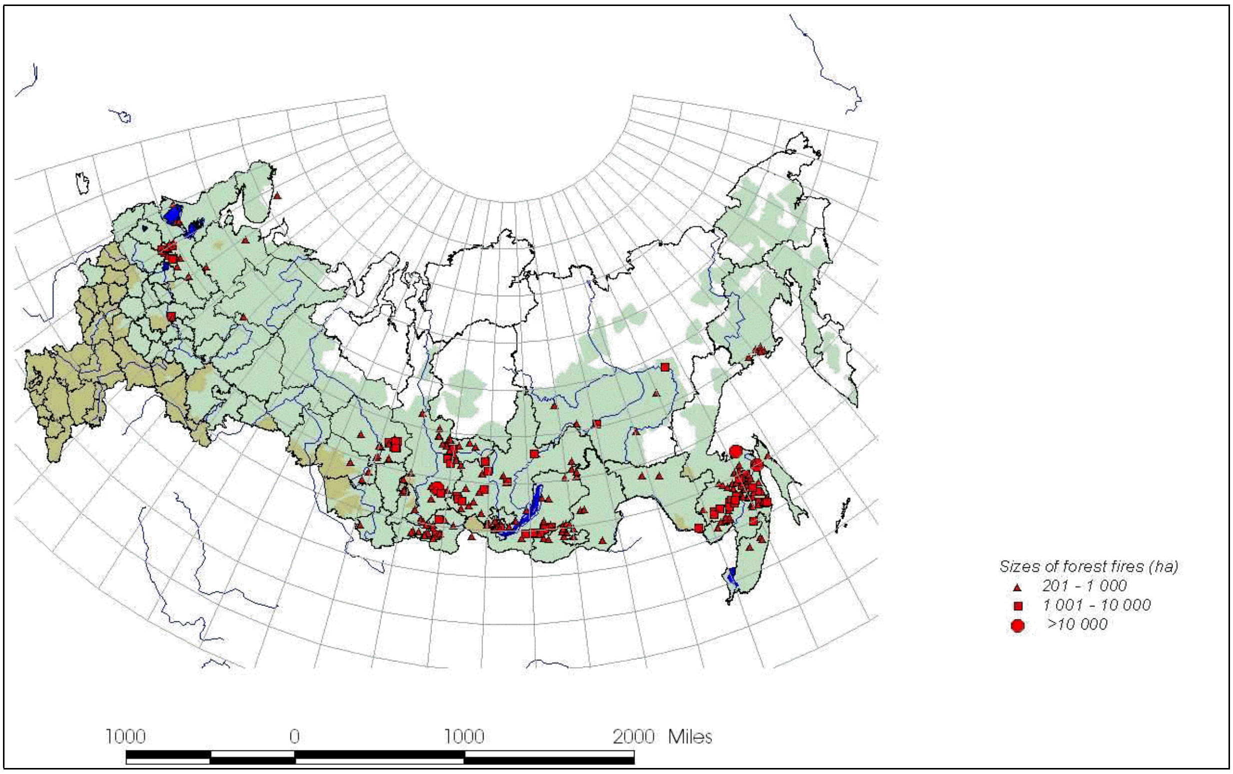

Fig.1. Map of large forest fires (>200 ha) in the territory of the Russian Federation during the fire season of 1999

The most severe fires were recorded in Altai, Khabarovsk, Krasnoyarsk areas, Irkutsk, Chita and Navosibirsk regions, Karelia and Buryatia republics as well as in the Central European regions Moscow, Leningrad, Vologda, Novgorod and Tver.

Over 49 % forest fires were detected and over 6,000 fires suppressed with the help of the aerial forest fire control service. Rapid response teams suppressed 39.2 % of all fires on the first day of fire start.

In comparison with 1980 the number of smokejumpers and helirappelers was considerably reduced, but in the course of the last two years that number was stabilized and is keeping now on the level of 3,900 firefighters. During the 1999 fire season this staff suppressed 2,551 fires covering 41,100 ha without involving additional resources. The positive role in that played active maneuvering with the crews of 933 specialists (smokejumpers and helirappelers) who were moved from one region to another one for rendering support in fire fighting.

During the last season activity of aviation was rather improved. At present time the park of Avialesookhrana's own aviation includes 93 aircraft (22 helicopters, 7 transport planes, 3 amphibian planes and 61 AN-2 - the *work horses* of the Russian fire protection air wing). While the total flight time of aviation spent on forest protection equalled 37,400 hours, over 9,000 hours (24%) were flown by *Avialesookhrana*'s aircraft. The availability of own aviation notably increased operational efficiency, provided support for decisions and speeded fast response to fires because critical time was saved for numerous bureaucratic procedures connected with leasing planes and helicopters.

The government of the Russian Federation approved the Federal Programme *Forest Fire Protection for 1999 to 2005*. The aim of this programme is to increase effectiveness of forest fire protection. The programme maps out in the first place to provide financing for:

* operative detection and suppression of fires;
* material and technical supply of forest fire fighting;
* forest fire prevention activities; and
* development of an integrated system of forest fire monitoring.

For raising the effectiveness of management decisions on federal and regional levels it is foreseen to create an automatized information management system and technical facilities as well as means of information support for forest fire protection. More attention is paid to reception and use of satellite information for estimation and forecast of fire danger and for forest fire monitoring. It is also foreseen to provide financing from the state budget for development and purchases of new aviation technologies. The development of new technologies for airborne fire suppression will receive highest priority. First of all these are new amphibian planes BE 200P, which now are undergoing tests and be fully operational within the next 2-3 years. Modernized water-dropping systems with the use of elastic suspension for helicopters (helibuckets) of different carrying capacity will be developed.

The specific features of new and improved additives for fire-fighting (retardants) will be micro-volumetrically additions of thickeners (0.1-0.3% volume) on a polymeric base, as well as moisteners (wetting agents) and foams to be injected in tanks of fixed-wing aircraft and helicopters. Accordance to calculations by Russian scientists the introduction of the above-mentioned innovations will increase the effectiveness of forest fire suppression more than twice.

During last years in forestry of Russia more and more attention is paid to preventive measures against forest fires. Russian scientists have developed recommendations for controlled preventive burning (prescribed burning) in forests of Siberia. Today such burning operations are conducted on several hundreds of thousands hectars in the *Taiga* forests of Siberia and the Far East. Russian scientists and fire managers are adopting the experience of their colleagues from the United States who have been engaged in that problem for longer time.

I would like to come back to my earlier proposal published in IFFN No. 16 (January 1997) where I discussed the necessity for the creation of international forest fire centers under the auspices of the United Nations. Our present life will force us adopt such a decision by all means. Forest fires are on the offensive. The mankind can and have to foresee this threat and react accordingly.

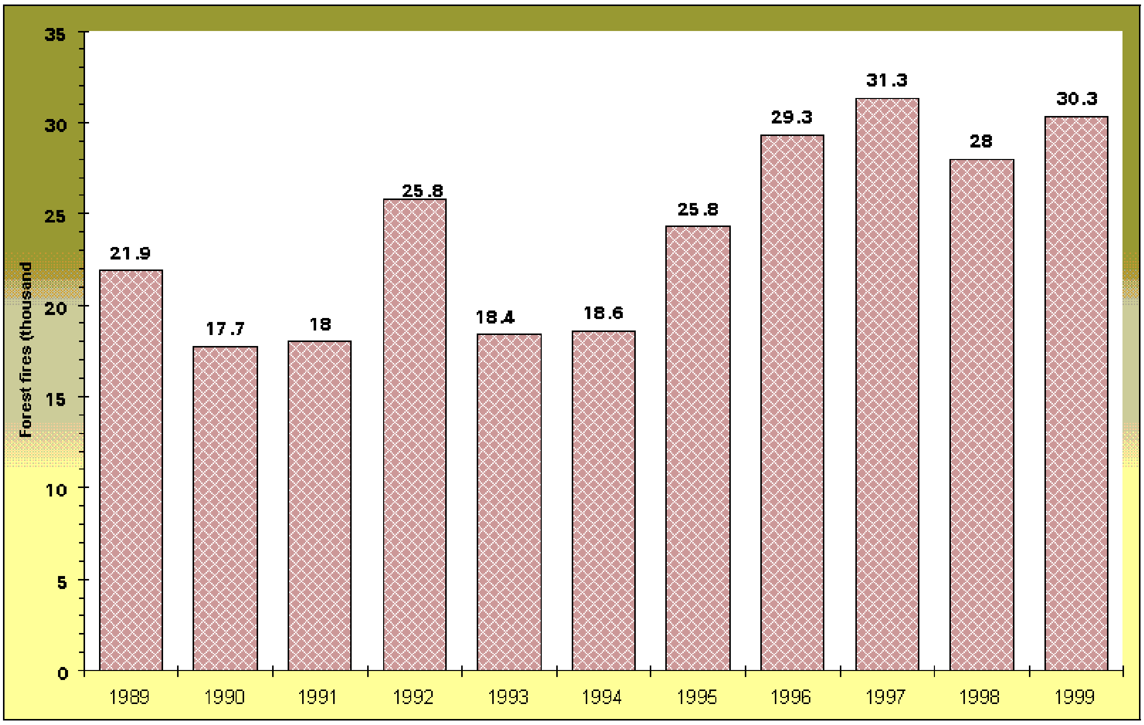

Fig.2. Number of forest fires burning in the Russian Federation during the period 1989-1999

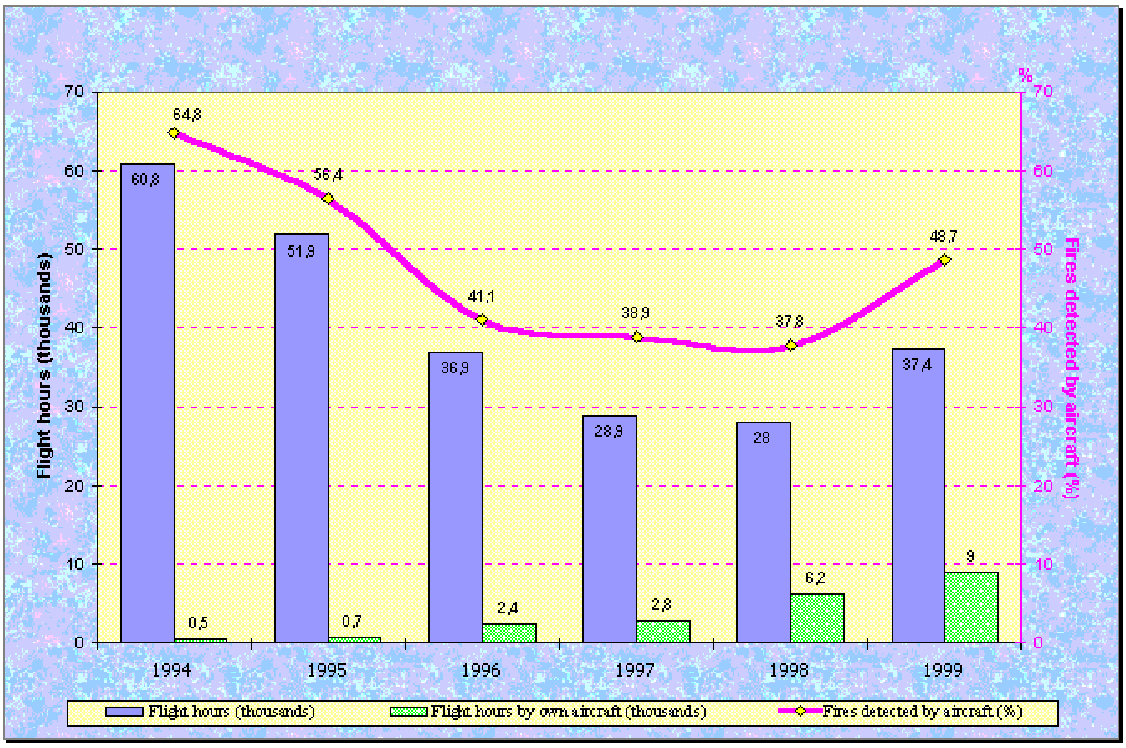

Fig.3. Flight hours and fires detected by aircraft in the Russian Federation between 1994 and 1999. The green bars show the flight hours by aircraft belonging to the Aerial Fire Protection Service Avialesookhrana, Federal Forest Service of Russia.

One hundred of well trained specialists in firefighting are able to render considerable real help in the most complicated situations at any point of our globe. In Russia it is quite possible to form 1-2 crews of well trained smokejumpers and helirappelers consisting of 20 persons who are capable in mastering all methods of fire-fighting.

It seems that we are on the right way now. At the next meeting of the UN-ECE/FAO/ILO Team of Specialists on Forest Fire in June 2000 we will also host a planning meeting of the United Nations International Search and Rescue Advisory Group (INSARAG). The regional INSARAG Europe-Africa group decided in December 1999 to create an international INSARAG Wildland Fire Response Group. Together with an international Russian-German aircraft conversion consortium we may soon be able to realize the establishment of an international fire brigade. While this idea has found a pretty enthusiastic consensus within a small group of international fire advisors, we would greatly appreciate to receive comments from other fire specialists throughout the world. So, please do not hesitate to communicate with me and the coordinating body of the UN Fire Team and the INSARAG Wildland Fire Group (through the Global Fire Monitoring Center).

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SPAIN

Forest Fires in 1999

Fire Effects

Every time we establish the balance of a fire season we remember the terrible year 1994, when 435,000 ha (250,000 ha forested) were blackened by wildfires. On the contrary the year 1999 was again a less than the average season (Tab.1). In fact the burned surface was reduced to 50% of 1998 burned surface.

The number of fires was also less than the average, but 63.5% were registered in the Northwest - as usual.

Most of the brushland and grassland burned areas were registered also at the Northwest (64%), although the forested area burned was approximately one third in every of the three main regions (Northwest 37.3%; Mediterranean 32.9%; Continental 29.3%). In the Canary Islands only 177 ha were burned.

This distribution is related to the main fire causes, which at the Northwest are traditional rural burnings in most cases.

A new preventive initiative has started in the Northwest: Three Integral Prevention Crews (IPC) (EPRIF in Spanish) have been created to operate in three provinces with the highest number of rural fires. They will work between November 1999 and April 2000. Their missions will be:

- investigation of fire causes
- sensitization of the rural population
- organization of prescribed burnings

Their task includes training of the local foresters in those techniques. These IPC will be supported also by the winter Campaign of Rural Sensitization which is performing a theatre play in the small villages, showing to the local people the negative consequences of forest fires for them.

Among those negative consequences the victims by fire are mentioned. In 1999 four forest firefighters were surrounded and killed by fire in Huelva on 30 June. Another firefighter was burned in Cuenca on 26 August 1999. The pilot of a Dromader airtanker crashed in Navarra on 26 July 1999.

Tab.1. Wildland fire statistcs of Spain: Comparison of the 1999 fire season with the average statistical data for the period 1994-98

	AVERAGE 1994-98	**1999**
Number of Fires (<1 ha)	12,769	11,866
Number of Fires (>1 ha)	7,775	5,613
Number of Large Fires (>500 ha)	32	14
Burned Surfaces (ha)		
* Forested	72,827	21,804
* Brushland and grassland	97,230	45,597
* Total	170,057	67,401
Burned surface as percentage of the national woodland area	0.7	0.3

Fire Management

Available resources in 1999 have been rather similar to those in 1998 (see IFFN issues of January 1998 and March 1999).

New improvements were the following:

* Current use of NOAA images to calculate a Danger Index (Greenness Index) developed by the University of Valladolid. This Index gives not only an appraisal of the photosinthetic activity (humidity inside the vegetation) but also an estimation of the biomass accumulation, prone to burn after drought.
* Current use of an infrared airborne camera at the same time as video cameras to detect hot points in the fire perimeter.
* General use of the specific investigation techniques of fire causes by forestry and police agencies, reducing the number of unknown causes to 15%.
* Installation of INMARSAT receivers in 10 of our Canadair CL-215 T. They are also in operation in our 5 CL-215 and will be installed during 2000 in the remaining 5 CL-215T. This is a very useful tool to manage the state fleet of amphibious aircrafts, sending and receiving messages in every place of the country.

All the other aircrafts (fixed wing and helicopters) classified like “Resources for National Coverage” (MCN in Spanish) are equipped with satellite remote control to know their position in every moment at the National Operations Centre.

International Cooperation

Two International Courses were given:

* Advanced Course on Forest Fire Protection, for Latin American experts (Valsaín, September 1999), funded by the Spanish Agency for International Cooperation and the Ministry of Environment
* International Course on Forest Fire Protection for Mediterranean experts (Zaragoza, October 1999), organized by the CIHEAM.

Tab.2. Large fires (>500 ha) in Spain during the 1999 fire season

Date	Location	WOODLAND Surface Burned (ha)
22/2	San Justo (Zamora)	656
17/3	Molezuelas (Zamora)	500
21/3	Lubián (Zamora)	2,500
29/6	Tábara (Zamora)	657
10/7	Ibias (Asturias)	452
11/7	Argamasilla (Ciudad Real)	800
15/7	Lerada (Salamanca)	755
17/7	Verín (Orense)	687
30/7	Descargargmaría (Cáceres)	823
5/8	Turre (Almería)	967
15/8	Enguera (Valencia)	3,197
17/8	Otivar (Granada)	2,148
28/8	El Escorial (Madrid)	450
26/8	Peñera (Salamanca)	680
1/9	Mombeltrán (Avila)	348
2/9	Alfoz de Bricia (Burgos)	985
8/10	Artá (Baleares)	910

Conclusions

In 1999 the Severity Index of Spain (burned surface as a percentage of the national woodland area) was again the lowest (0.3%) among the European Union Mediteranean countries.

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SOUTH AFRICA

Fires in the Southern Cape Peninsula, Western Cape Province, South Africa January 2000

Introduction

This paper describes the fires that occurred in the southern Cape Peninsula from January 16 to 20 January 2000. It is not a comprehensive analysis and its scope is limited. We have combined first-hand observations, media accounts, and official statements to create a description of the fires. In addition, we have used 30 years of fire management experience in California and the Northwest United States to indicate where similar problems and solutions exist.

Summary

For Cape Town and the surrounding area, it was an extraordinary week. Every day the newspaper headlines shouted in gigantic block letters: *Hout Bay Wildfire*, *Mountains of Fire*, and *Burning Shores*. The fires were so intense and extensive, that the shores did actually burn. It was a-once-in-a-century event that left a large percentage of natural vegetation burnt, homes destroyed, meager firefighting resources exhausted, and the public demanding answers. For us, new arrivals to South Africa, it brought back childhood memories of sitting on the roofs of our Southern California homes on warm evenings watching fire burn through the chaparral-covered hills. Ironically, it would later be us on those hills fighting the fires.

A few available figures help complete the image of the week:

- Fires in the South Peninsula Municipality burnt over 8,000 ha, 20% of the natural vegetation
- Other fires in the province burned over 10,000 ha and were especially damaging to vineyards in the Stellenbosch area, the farming region around Tulbagh, and the West Coast National Park
- The total cost of the suppression effort so far is estimated at $US 3 million
- The insurance industry expects over $US 1/2 billion in damage claims
- The Cape Metropolitan area was declared a disaster area
- Over 70 houses were damaged or destroyed
- Over 200 shacks were razed near in informal settlement areas east of Cape Town
- More than 1,200 firefighters, including members of the police, defence force, metro emergency services, local municipality, professional firefighting organizations, and volunteers fought the fire

Location

The Cape Peninsula has a 50-kilometer chain of rugged mountains, broken by small coastal valleys. These mountains, composed of pale sandstone, extend southwards from Table Mountain hovering over downtown Cape Town towards Cape Point at the tip of the peninsula. The Cape Peninsula National Park encompasses the major mountain ranges on the Peninsula.

Hout Bay, a small coastal community about 20 kilometres south of Cape Town, is surrounded by mountains: Table Mountain to the north, the peaks of Vlakkenberg and Constantiaberg to the east, and Chapman's Peak to the south. The mountains are steep and rugged, abruptly dropping in dramatic fashion into the ocean along Chapman's Peak Drive, which connects Hout Bay to the southern peninsula. Silvermine Reserve, where the first major fire started, lies behind Constantiaberg to the east of Hout Bay.

Simon's Town, site of the second major fire, sits more than halfway down the Cape Peninsula on the more sheltered east side overlooking False Bay. This area lacks the drama of the more mountainous northern half of the peninsula. A smaller, less rugged central mountain range drops down to the coastal roads on either side of the peninsula; these two roads are the only access in and out of the peninsula for coastal communities.

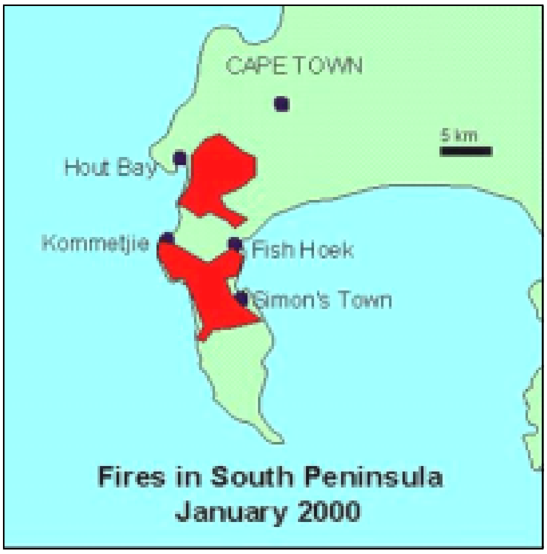

Fig.1. Fires in South Peninsula during January 2000

Environmental Conditions

Vegetation

The Cape floral kingdom is the richest of the world's six floral kingdoms, with a species density unmatched anywhere else on earth. Over 2,600 species of flowering plants grow in this area. The predominant vegetation type in the Western Cape is mountain *fynbos* ('fine bush', derived from fine leaves of *ericas* that typify this vegetation), growing on well-leached, infertile soils derived from sandstone and in some cases, granite and shale. Fynbos consists mainly of knee-high heaths and reeds, interspersed with taller *proteas*.

The greatest threat to mountain fynbos comes from over 300 alien species that have been introduced to the Peninsula. Some of these invasive plants, such as pines and eucalyptus, produce more than 300 percent more heat output than natural fynbos during fires.

Fire is the lifeblood of natural fynbos vegetation, which must be burned between six and 45 years, depending on fuel load, in order to sustain its plant species. Almost all fynbos plants are dependent on fire for successful reproduction.

Many fynbos species store their fruit in fire-safe cones and only release seeds after a fire. By waiting for fires to release their seeds, fynbos plants ensure that more seeds will germinate and survive with less competition from adult plants and grazing rodents. Ash provides a rich mixture of nutrients for the seedlings to grow in. Some fynbos also resprout from buds that are protected from fires by soil or thick bark.

Fynbos is susceptible to frequent and /or exceptionally hot fires, which can burn off all available nutrients with devastating consequences. Many fynbos plants are composed of fine branches that make effective kindling, and they also accumulate dead plant material in their canopies instead of shedding it. A few fynbos plants even contain oils in their leaves, making them highly flammable. During the hot summer months, when strong southeasterly winds blow, the fynbos is a tinderbox waiting to explode.

Weather

The Western Cape enjoys a Mediterranean-type climate: warm, dry summers and wet, temperate winters. Rainfall, varying from 200 to over 2,000 mm per year, falls mainly during the winter months. Strong southeasterly winds, known as the *Cape Doctor*, blow primarily during the summer months, from November to February, and sometimes bring clouds of mist which envelop the surrounding mountain summits. The blanket of mist that flows over Table Mountain is referred to as the *tablecloth*. Summer temperatures rarely rise above 26°C.

The month of December had been one the driest on record and many municipalities had instituted water conservation measures. The week leading up to the fires was characterized by five days of near gale force southeast winds and high temperatures. On the second day of the fire, the high temperature was 41°C, close to the all-time record for Cape Town.

Chronology of Events

Saturday 15 January

Due to dry and windy conditions, fires began to spring up in the Cape metropolitan area. Over 120 fires were reported by the end of the weekend.

Sunday 16 January

A fire started in the early afternoon along Old Cape Way in the Silvermine area and quickly spread up the slope into the Silvermine Reserve. By mid-afternoon, following the wind's path, it reached the saddle next to Constantiaberg above Hout Bay. Pausing only briefly, it made a rapid run toward the community, driven by the gale force wind. Within 40 minutes, it had dropped about 1,000 meters and reached the first houses. Eight houses were damaged or destroyed that first night. The historic Chapman's Peak Hotel and other local businesses were only saved through the efforts of staff and volunteers. Residents were told to evacuate in the upper areas of Hout Bay and others nearby prepared to leave. Residents at the Imizamo Yethu informal settlement camp got ready to fight the fire with buckets of water. Officials and the public seemed to be caught off-guard by the incredible speed and intensity of the fire.

To the south, another fire started at an informal settlement area above Simon's Town and blew over the mountains to the west side of the peninsula where it threatened the communities of Scarborough and Misty Cliffs. During the night, the local fire department started evacuating people, but a two-year-old firebreak helped save houses in the area.

During the night, the Hout Bay fire spread, burning cross-slope, to the north and to the south. Residents in the communities of Hout Bay, Noordhoek, Kommetjie and Scarborough were on standby to evacuate their homes if necessary.

Monday 17 January

On Monday, a combination of high temperatures (35°C), offshore winds, and low humidity caused the major fires in the Western Cape to spread. The northern extent of the Hout Bay fire spread closer to Constantia Nek, the saddle that separates Table Mountain from the southern range of mountains, causing concern about the fire spreading to Table Mountain and populated areas to the east. The southern end of the fire spread to the outskirts of Noordhoek, a small coastal community south of Chapman's Peak, and continued to burn in the Silvermine Reserve, where it had started on Sunday. Two Air Force *Oryx* helicopters dropped water on the Hout Bay fire until they were temporarily diverted to assist with the fire around Scarborough and Kommetjie.

Three helicopters, 40 firefighters and a number of volunteers worked to prevent the fire near Scarborough from burning homes. After a long battle, the flames were contained and none of the houses was damaged. The fire continued to burn into the mountains to the east of Scarborough and Kommetjie, but was no longer threatening any property.

Tuesday 18 January

Fires continued to flare up in the southern Cape Peninsula: Cape Point Nature Reserve, Kommetjie, Scarborough, Hout Bay, and Chapman's Peak. In Noordhoek valley, three Oryx helicopters and two ground crews fought a three-kilometre fire front that moved down from the mountains and threatened houses. Residents used chainsaws to build firebreaks around their houses and moved the many horses in the area to safety.

In the evening, the fire in Hout Bay flared up again and threatened the Mandela Park squatter camp as well as affluent homes on the slopes above the camp. Parts of the camp and some houses were evacuated, though no structures were damaged.

During the night, the area around Noordhoek exploded into flames as the fire burned across the entire length of the valley. Entire areas, including a retirement complex, were evacuated as fires burnt around houses. Residents used spades, buckets, and chainsaws to help firefighters battle the blaze.

Wednesday 19 January

On Wednesday, the temperature around Cape Town soared to 41°C, the hottest day in 34 years. The northern extent of the Hout Bay fire reached Constantia Nek. Major efforts, including water drops by three helicopters, were made to prevent the fire from crossing the road and entering the Table Mountain ecosystem. Around noon, fanned by high winds, the fire flared up and burned down the eastern slopes of the Vlakkenberg into Constantia, burning five houses and threatening the historic Groot Constantia vineyard.

In Simon's Town, over 20 houses were destroyed or damaged as the fire spread right through town. Not far to the south of Simon's Town, tour buses carrying 240 people back from Cape Point were temporarily trapped when the only road was closed by the fire. North of Simon's Town, a fire near De Gama Park caused damage to eight houses.

Fires in other parts of the Western Cape continued to burn. An immense fire about 120 kilometres north of Cape Town burned nearly 6000 hectares in the West Coast National Park. The road from Cape Town to Langebaan near the park was closed. The area north of Stellenbosch sustained substantial damage to its vineyards, with about 20% of the red wine grapes damaged. A large fire was reported near the town of Robertson, about 300 kilometres east of Cape Town.

The Western Cape provincial government declared the Cape Town metropolitan area a disaster area, and Pretoria sent additional helicopters to aid in the firefighting effort. Helicopters had so far dropped 2.6 million litres of water over four days of fires.

Thursday 20 January

Cooler temperatures and calmer winds aided firefighting efforts on the Cape Peninsula. Firefighters from Johannesburg and Pretoria were flown to Cape Town to assist in fighting the fire in the West Coast National Park that continued to burn on Thursday.

The director of the Cape Peninsula National Park reported that the two largest fires were started by people. The Hout Bay fire started next to the road outside Silvermine Reserve by a burning cigarette or match tossed out of a car window (it was presumed). The second fire started in an informal settlement area above Simon's Town.

The Water Affairs and Forestry Minister claimed that alien vegetation, especially on private lands, was to blame for the extent and intensity of the fires.

Observations, Impressions and Potential Areas for Improvement

The purpose of the following section is to compare this fire episode with similar ones in the United States, and to draw some conclusions and solutions that may have relevance in the Western Cape.

Environmental conditions in the Western Cape, including the fires that occur here, are very similar to those in Southern California. The two areas have comparable climate, vegetation (in terms of fire), and topography. In addition, they both have significant urban-fringe problems. In 1970, large fires ravaged Southern California, killing people, destroying hundreds of homes, and damaging valuable watershed. A review by the national, state, and local governments found that the area's emergency-response organizations were deficient in a number of key areas. Lack of coordination among the hundreds of organizations, and use of different methods and terminology were but a few of the many areas that needed to be revised and strengthened.

As a result of the 1970 fires, the U.S. Government provided direction and funding for the *FireScope* Project. The project's goal was to strengthen the capability and capacity of the area's fire protection organizations to deal with fire and other natural disasters. Its success led to increased cooperation, resource sharing, more efficient fire operations, and new fire management technologies. The Cape Peninsula fires were reminiscent of the situation in California in 1970.

Organization and Coordination

There has been some criticism by both the public and local officials of the response and coordination of resources during the first few days of the Cape Peninsula fires. Poor radio communication and failure to establish a coordination center during the early phases of the fire were singled out often. Eventually a joint operations center was established and the National Disaster Center was involved. Later a few officials stated that the coordination of resources needed to be improved and that there was a lack of a disaster management plan. This is not too surprising, given the speed with which the fires escalated and changed direction. In Hout Bay, residents and officials did not initially appreciate how serious the fire was.

Coordination of resources is critical to conducting firefighting operations on this scale. Even in the U.S., a single organization cannot handle large emergencies by itself. Since 1970, cooperation among fire agencies has been strengthened so that they now work together interchangeably or under a single command. Multi-agency cooperation requires a great deal of work before the fire begins as there are barriers to overcome and procedures to work out.

In the U.S., the Incident Command System (ICS) is used as an organizational framework for managing fires and other disasters on the scene. The ICS defines a standard command structure, processes, and terminology for managing small to large incidents. Most emergency response organizations in the U.S. have adopted ICS.

The Multi-Agency Command System (MACS) complements ICS by jointly managing multiple fires. MACS determines priorities and allocation of resources among the various fires through upper level representatives of the involved organizations. ICS and MACS could easily be adapted for use in South Africa.

Firefighting Resources

Lack of resources to fight the fire was an obvious and serious problem. According to accounts, existing fire engines were old and many were out of service. Only 12 of the 15 South Peninsula engines were dispatched, and additional equipment was brought in from Cape Town, the northern suburbs, and eventually the military. In Hout Bay, open fire line adjacent to homes went unattended, most likely due to limited resource availability.

No organized ground crews were observed suppressing fire or constructing fire line. Oryx helicopters (a South African version of the French-made Puma) using Bambi buckets dropped water, often with a spotter helicopter directing them. On the fifth day of the fires, 120 personnel were flown in from Pretoria as backup.

Fig.2. Oryx helicopter dropping water

As a sign of the desperate need for help, a call for volunteers went out the second day of the fires. This eventually created more problems as people coming in from other areas to volunteer added to the traffic clogging the roads. In addition, volunteers without adequate training created a safety issue, and soon the request was scaled back to only locals working in non-fire positions.

There were many accounts of neighbours working together to save houses and businesses, which is not a common occurrence in the U.S. A nearby military base provided equipment and personnel to fight the fire in the West Coast National Park.

There is a need to increase the firefighting capacity and capability in the Western Cape. This includes rapid deployment of equipment and personnel, which is dependent on two essential elements: The first being an adequate supply of resources and the second being a mobilization system that can tap into resources from adjacent organizations, and if necessary, from across the country.

In order to increase the personnel available, a tiered approach, combined with training, could be used. The tiers would be:

* *Full-time Professional Forces.* Consisting of first responders and staff whose job is fire protection these forces would form the core of the system and would provide command and supervisory functions.
* *Reserves.* Trained semi-professionals who are part of full-time organized fire departments or non-fire members of land management organizations who perform fire duties when needed.
* *Military.* Members of the uniformed services who have been trained to perform firefighting duties.
* *Community Assistance Teams.* Organized and trained groups of people from the community who can perform self-help duties and assist their neighbours in the event of an emergency beyond the capacity of local emergency services.
* *Volunteers.* Untrained members of the public who can help in non-firefighting positions.

Fire Tactics

Most firefighting tactics used on the Cape fires were focused on structure protection, and the main fire was left to burn. This was understandable given the extent and intensity of the fire, resource availability, and steep terrain. The water-dropping Oryx helicopters were the primary and most visible means of direct attack on the fire. The helicopters were very well organized and put on impressive displays of accurate water bombing. Their targets were well chosen and indicated a knowledge of fire behaviour. The main problem with this tactic was that, due to conditions, water was ineffective and resulted in only temporarily slowing the spread of the fire. Many times, the helicopters did a good job of knocking down the fire, only to see their work overturned by the fuels quickly drying out and the fire flaring up again after they left to work on another area. Adding a whetting or fire retardant agent to the water drops would improve their effectiveness. For water drops to be effective, quick follow-up from ground crews is essential. In this case, no crews seemed to be available, and even had they been, the situation was usually too dangerous for them. The use of helicopters on fires should be reviewed to ensure that these valuable resources are used in the most effective manner.

Urban Fringe and Increased Human Presence in Natural Areas

The Western Province has a serious urban fringe problem, a disastrous mix of homes located in or adjacent to fire-prone areas of vegetation.

If these fires had occurred in the largely uninhabited range of mountains to the east of Cape Town, they would have received less attention. Instead, these fires burned through what are essentially mountain islands in a sea of populated towns, farms, and vineyards. People with the means are building homes further into the natural areas than ever before. Those without, who have come to the area looking for work, live in "informal settlement" areas of flimsy shacks, often in the middle of the bush. The effects of this are:

* The risk of loss of life and property is greatly increased
* Firefighters are often put in exceptionally dangerous situations as they are forced to protect property
* Fire commanders must shift tactics toward structure protection and away from controlling the main fire
* Potential conflicts with fire management policy, such as prescribed burning, result where public and private lands meet (such as the Cape Peninsula National Park)

The important issue is that the Western Cape is a fire-prone environment and people should learn to live in the urban fringe with this in mind. There was some criticism about the lack of preparation, such as brush clearing, on the part of homeowners. Roofs constructed of tile or metal, which are not flammable, limited the damage and spread of fire in many populated areas. In the U.S., many houses are lost due to wood roofs which easily catch fire brands. Given the same fires in the U.S., the number of houses lost could have easily been doubled.

The US has initiated a program called *Fire Wise* to help homeowners protect their homes through the use of fireproof plantings, fire-resistant construction materials, and other methods.

Fuels Management

The Hout Bay fire burned through an area of fynbos that had not burned in over 30 years, the upper limit of its fire cycle. The ratio of dead to live material was extremely high for fynbos. This contributed to the extreme behaviour observed as the fire moved from the upper reaches of the Silvermine Reserve down to Hout Bay and along Chapman's Peak Drive.

Alien vegetation such as pines, bluegum trees, Australian wattles, myrtles, and hakeas contributed to very high fire line intensities and flame lengths. This created difficulty and danger for fire crews in many areas, especially in the vicinity of Constantia where homes were lost as the fire moved through the crowns of the trees. This fire, the most intense observed, was accompanied by a large convection column.

Solving the fuels management problem in the Western Cape requires an integrated approach among all landowners. First, land management objectives must be set for each area. Once done, a context would be established where compatible fuel management plans could be drawn up. These plans would establish the desired fuel loading, cost benefits, and methods of achievement.

Fire Prevention

The only fire prevention efforts observed were a few fire prevention posters located on forest roads and trailheads. Often the weather bureau would issue fire danger warnings as part of the forecast. There were no special warnings or preventative actions leading up to the fires, even tough the potential for fires was great.

It appears that fire prevention efforts need to be strengthened in the Western Cape. A number of methods can be employed, including more effective signs, special warning messages in the media during dangerous periods, school programs, and community outreach programs. The U.S. has some good examples of fire prevention programs, *Smokey Bear* being the most well known. An effective program in South Africa would need to consider the social context of the fire problem.

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Ecological Requirements for the Maintenance of Western Cape Fynbos Biodiversity and Compromises Recommended to Meet Metropolitan Pressure

Introduction

The *Fynbos* vegetation of the southwestern and southern Cape in South Africa, also described as *evergreen sclerophyllous heathlands and shrublands*, covers 59,282 km^2, or 5.3% of the territory of South Africa. The exclusive area where the fynbos biome is found has a typical winter rainfall in the west, but further to the east spring and autumn peaks characterise the rainfall pattern. The annual rainfall in the area ranges from as low as 200 to over 3000 mm per year, and with such extremes it is clear that the rate of above-ground biomass production in the biome will also vary significantly (Huntley 1984). Kruger (1977) reported fynbos biomass values of between 2000 to 26,000 kg/ha in stands ranging from 2 - 17 years in age, with an average annual biomass production rate of 1000 - 4000 kg/ha. Natural fires in the biome occur within 6 - 40 year rotations (Kruger 1979, Kruger and Bigalke 1984).

In the Western Cape, fynbos shrubland covers the most prominent mountain catchment areas, and are managed for a variety of goals, the most important of which include maintaining sustained yields of high quality streamflow, nature conservation, fire hazard reduction, afforestation, grazing, tourism and recreational opportunity. Many areas are managed for more than one of these goals simultaneously, and as a result the role of fire between communities within the biome will differ significantly (van Wilgen et al. 1990).

During 1999 and 2000 there was a marked increase in the number of fires experienced (as well as size of areas burned-over) throughout the fynbos-covered part of the Cape regions. During Bergwind (Föhn wind-like) conditions in 1998 and 1999 most of some mountain ranges (such as the Outeniquas and Tsitsikamma mountains) were burned by wildfires, including thousands of hectares of adjoining industrial plantations. During mid-summer 1999, and again during January 2000, more mountain catchment areas were burned-over by uncontrolled fire, causing millions of Dollars of damage to urban houses, adjoining vineyards and industrial plantations. Tragically, some human lives were lost in the southern Cape during the 1998 and 1999 fires. The loss in fynbos biodiversity maintenance as a result of these too hot (and in some cases) too frequent fires, will be difficult to quantify, but was substantial.

The question now arises if we can still meet ecological requirements to maintain diversity in the fynbos biome, or whether these goals are now threatened by increased population pressure and access, encroachment of build-up areas (Cape Town and environment in particular), climate change and the spread of alien woody weeds?

Fire Frequency, Season and Intensity

Research achievements in the past now make it possible to determine optimum fire frequencies with an acceptable degree of accuracy, not only considering fuel dynamics, but also maintaining species diversity in the process. Fynbos is rich in species, and has complex requirements for survival. Almost 20% of plant genera are endemic (Bond and Goldblatt 1984), making nature conservation a high priority, and prescribed burning and weed control are important management tools to achieve this.

The optimum fire frequency for fynbos is 10 - 15 years, but fire intensity and season of burn also play an important role to fulfil ecological requirements in the fynbos biome. These requirements vary from region to region, and also with topographical and climate variation. However, these requirements have been published by scientists in the past, and we know what the optimum maintenance requirements are for the biome as a whole (e.g. Bond et al. 1984).

As a result of delays in the prescribed burning programme for various reasons (e.g. public pressure, staff shortages, a high staff turnover, lack staff with prescribed burning experience, weed infestation and urban expansion), fynbos in certain catchments was allowed to become too old, making it therefore impossible to apply fuel reduction by means of prescribed burning because this would now be too hazardous. The accumulation of fuels increased further by the spread of alien weeds such as *Hakea sericae*, *Acacia longifolia* and *Pinus pinaster*, until a situation was reached where serious wildfires just could not be avoided, particularly during abnormal weather conditions as experienced in Southern Africa during recent years.

The prescribed burning programme required was further disrupted by the sudden increase in wildfire occurrence, complicating the achievement of ecological goals even further. The intended mosaic of burns, that would have produced vegetation of different ages in plant communities was upset, with some areas burned too frequent or producing a fire of a too high intensity as a result of the added weed biomass. Where weed control measures were intensified, more tons of fuel were added to these systems which were already experiencing high biomass loading as a result of extended age. As a result, extremely high intensity wildfires will burn through these areas, which will trigger the seed beds of most weed species, and ensure that an ever larger alien weed problem than before will develop.

The Solution: Integrated Fire Management with some Compromises

There is no magic solution for the unacceptable status of the fynbos biome at present, but for a start it will help if we accept certain realities which are here to stay. They are:

- We have to live will the population pressure, and subsequent increase in fire hazard, as more and more people will in the future access nature conservation areas, resulting in increased fire hazard.
- Global changes in weather patterns will have to be accepted as a *fait complis*, and planners will have to consider this issue in the future seriously.
- Urban interface problems must be identified, and a plan of action will have to be drawn up by local authorities as a matter of urgency.
- Although the Department of Water Affairs and Forestry has an excellent weed control program going, more consideration should be given to the biomass created in the process (and subsequent fire hazard), particularly along lines with regular public access. This programme should also include regeneration control soon after wildfire.
- Optimum ecological requirements can never be reached, and recent wildfires in the Cape have underlined this. However, we must continue to attempt to come as close as possible to these objectives. Realistic compromises in the ecological burning programme must also be made to reduce the wildfire hazard to acceptable levels.

I would like to suggest the following to reach ecological goals for the fynbos biome in the region:

- Map the status of wildfires (fire perimeters), alien weeds and fynbos vegetation by approx. age for the whole Cape region where fynbos occurs. This should be done as soon as possible, so that future planning can commence. Adjustments in weed control programmes and prescribed burning programmes will also have to be implemented as soon as possible thereafter, as delays could have serious affects on e.g. future weed regeneration control.
- Map and evaluate fire hazard (for the present and over time) by considering the *status quo*, ecological requirements and fuel dynamics (both within fynbos communities and on bordering land).
- Draw up an integrated, regional fire protection plan which includes all the important role players and disciplines (more about this in the next section). Ecological burning programmes must form the core of this plan, but drastic changes in existing fire protection plans and burning programmes may be required.
- Start a public awareness campaign to educate the local population in the role of fire in maintaining the ecological balance, to stamp out (with stricter law inforcement) negligence with fire, weed control on private properties and the protection of dwellings bordering fynbos conservation areas.
- Provide specialised training for selected nature conservation staff in fynbos fuel dynamics, prescribed burning application and integrated fire protection.

Conclusions

The worlds' richests floral kingdom, the Cape Fynbos, needs to be conserved as best as we can. Changes in human population density, weather patterns and land-use, as well as an increase in alien weeds are the reasons why nature conservators are now facing new challenges, particularly after the recent disastrous wildfires.Policy makers, nature conservators, municipal authorities, fire fighting organisations and other land-users such as forest managers and farming representatives, need to sit down and re-think a plan for the future that will be realistic, and satisfying all requirements. This plan will have to be fully integrated, as this is the only way in which all can contribute towards objectives, which all disciplines will understand and apply successfully.

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Strategic Fire Protection for the Cape Peninsula: Now is the Time to Start Right Away!

Background

A large portion of the Cape Peninsula mountain range was devastated by wildfire during January 2000, which included some parts that were seriously alien weed problems occurred. Some properties bordering *Fynbos* areas suffered serious fire damage, and a number of houses completely burned out. It was soon realised that existing fire protection measures (burned, ploughed or hand-prepared fire breaks) could not contain the fires, and that a re-think will be necessary regarding regional fire protection, with all its implications.

The Peninsula's nature conservation, forestry and parks divisions are being controlled by various government, semi-government and private bodies. The overall nature conservation control of most of these areas has recently been placed under the National Parks Board organisation, but a regional strategy regarding integrated fire protection has not yet been implemented, and it is suggested that the time is now ripe to draw up proposals for a fresh fire protection approach.

Methods

First of all It is important that we make sure that we obtain a clear picture of the situation on the ground regarding areas burned, age, structure, and dynamics of the natural vegetation, industrial timber plantations and agricultural land, as well as spread of weeds. Only after this evaluation phase can concrete planning start in earnest. During this so-called *Regional Appreciation Phase* the following is suggested that should be addressed:

Mapping Fire History

The perimeter of all wildfires that occurred between 1995 and February 2000 must be mapped at a 1:20,000 scale, with the assistance of aerial photography and satellite images. The remainder of the area will have to be classified according to vegetation age and degree of weed infestation. The outcome of this exercise will be in the form of a regional map which will feature wildfire history, vegetation classes and existing fire breaks.

Classifying fire hazard categories

The regional map (referred to in the above paragraph) will also have two map overlays which will illustrate external and internal fire hazard. These hazard classes will be developed from a fuel modelling-based classification, which will use a representative fuel classification and external fire hazard features combined, to arrive at a fire hazard classification for both the present (actual) and future (predicted) fire hazard status.

Thereafter, during the *Application Phase*, the following programme will be implemented:

Placing of regional bufferzones

Fuel and wildfire modelling will be used to identify and quantify fire break requirements, and a regional bufferzoning structure will have to be developed to replace outdated and inadequate, existing, fire breaks. The fire hazard evaluation over time (also considering future fuel dynamics) will be used to assist in this decision-making process, and these *fire buffers* will in many cases follow existing strategic protective lines (e.g. public roads, powerlines and other relatively fuel-free areas) over the most suitable topography and land-use areas. These bufferzones will form the main lines of fire protection, and have proved extremely effective in the Mpumalanga Highveld, Northern Kwazulu-Natal Midlands and NE Cape regions (de Ronde, 1995, 1996, 1997, 1998 and 1999). Prescribed burning rotations will have to be considered in most Fynbos found within these zones, as well as inside timber plantations.

Integrating riparian zone management and ecological requirements

The integration of these aspects, as part of an integrated fire protection strategy, will form an important part of the new plan. Sustained water flow will be a priority objective, and in many cases riparian zones can be utilised as part of bufferzoning systems. This will ensure regular rotation burning, which will facilitate maximum water flow requirements. All prescribed burning recommendations will be tested against optimum fire rotations to maintain biodiversity (particularly in Fynbos). The regional bufferzones will be demarcated in such a way that ecologically-sensitive parts of the area are avoided, so that these can still receive their optimum fire treatment in terms of age, season-of-burn and fire intensity applied.

Adapting weed control programmes

As wildfires occur, the weed control programme will have to be adjusted accordingly. Special attention will have to be provided for burned-over areas with heavy weed infestation, to control regeneration after the ash-bed effect in time. The fuel problems created as a result of weed slashing may also have to be attended to by means of special controlled burns before all fuel is cured, to avoid fire of a too high intensity. Timing of these prescribed burns will be crucial, and these prescribed burns will have to be applied by experienced, well-trained fire managers.

Addressing urban interface problems

These will have to be attended to in various ways, as a matter of urgency. To little has been done to avoid and overcome this problem by the local authorities in terms of legislation and public awareness campaigns, and the improvement of *hot spots* on the outskirts of urban areas will have to receive immediate priority attention.

Conclusions

A holistic approach to the fire protection problems of the Cape Peninsula is the only way in which the spiral of wildfires can be challenged. Specialist training will be required to maintain the new strategic fuel management and fire protection goals, and nature conservators, parks officials and foresters involved in the regional plan.

Training courses in fire behaviour prediction, prescribed burning application, smoke management, and the education of the public at large (extension), will be required.

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The Role of Fuel Management and Prescribed Fire in Densely Populated Areas of the Western Cape Region

Introduction

There is no doubt that the use of prescribed fire is the best solution for fuel management application, whether applied in natural fuels (such as *Fynbos* or Montane Grassland) or in manipulated fuel situations (such as Cultivated Agricultural Land or Industrial Timber Plantations). However, in densely populated areas, such as the W. Cape, application of prescribed fire is much more problematic as a result of public resistance against the use of fire, smoke management problems, and build up urban areas bordering conservation areas. These are probably the main causes why prescribed burning programmes in these areas - such as in the Cape Peninsula - soon fall behind schedule and once e.g. the Fynbos becomes too old to burn with an unacceptable degree of safety, Fynbos-covered areas remain unburned in most cases, until burned-over by wildfires.

With predicted climate change, and subsequently more extreme fire weather expected in the future, it is important that we have a serious look at these problems, and find ways to overcome them.

Educating the public

It is extremely important that a thorough extension programme is launched in the Western Cape, targeting the younger generation (at schools and other eductional institutions) and the adult public at large: From the rate payers, to the workers. This programme should make use of all possible media exposure from newspapers to radio and TV, as well as through government institutions in the form of official launches and public debate.

It is important that the public, particularly those living in the Cape Metropole, are educated in the basics of ecological requirements in nature reserves, the role of fire, how to avoid urban interface problems and why prescribed burning is important. Before prescribed burning is applied, the public should also be notified of the intention to apply prescribed burning, again using the media for announcement purposes.

Fuel Management as a Fire Protection Tool

Fuel management should not be restricted to the prescribed burning of fire breaks or bufferzones, but also include fuel reduction measures outside these systems in the form of block burning of Fynbos for ecological requirements, and fuel reduction on agricultural and forestry land in the form of precribed burning (e.g. under the trees in even-aged Pine plantations suitable for this purpose) or slash burning (e.g. in forestry plantations, after clearfelling or on agricultural land to remove pruned material from vineyards or orchards. These prescribed burning programmes are as important as the preparation of fire breaks and regional bufferzones for fire protection.

Weed control measures should be ongoing, on government and on private land the existing weed control programme should continue indefinitely. Legislation must also be provided to force private landowners to keep their land free of exotic weeds.

Training a specialist prescribed burning team

To apply prescribed burning in any form, whether in nature reserves, parks, even-aged plantations or any land where this tool is applied, it is recommended that a specialized prescribed burning team is trained to apply fire protection measures on land controlled by Central or Local Government, or the National Parks Board. The fire manager (or fire boss) in charge of this team should not only be trained in the preparation before burning, burning execution and mopping up after the fire is applied, but also in fire behaviour prediction (with and without computer packages), fire danger rating (according to the new system now being developed by the Department of Water Affairs and Forestry, traffic control and smoke management. He should also be capable of handling media exposure.

The forestry institutions of the Western Cape, such as Safcol (whoever will control these plantations in the future) and the Cape Town Municipal Forestry and Parks Department, should also consider training a specialized team to handle the use of fire within plantation areas. The new integrated approach to fire protection can only be successful if all landowners/managers involved in maintaining the new system are directly participating in the application of this fire protection/fuel management programme.

Summary

In global wildland fire initiatives the role of fire as a fuel management and fire protection tool has been emphasized over and over again (e.g. during the Second International Wildland Fire Conference, held in Vancouver, Canada, 1997). Increased use of this management tool has been recommended, because lack of fire use has been identified as one of the biggest problems in many countries.

South Africa needs some bold decision-making to improve the wildland fire and fire management situation, but I am confident that success can (and will be) achieved.

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A 1999 Fire Season Retrospective
Fire Season Review - Bureau of Land Management
Never Have Seen Anything This Crazy

Tom Warren went on his first wildland fire 15 years ago and has seen more than a fair share of flame on the public rangelands of the western United States since then. But in August of 1999, as he stood on the edge of a northern Nevada wildfire complex that would grow to more than 200,000 acres, the sight was overwhelming. Wildland fire ripped through grasslands, stands of pinyon-juniper and native sagebrush. Flame lengths measured 25 feet high or more. At its peak, the fire raced across the high desert at 40 miles an hour.

It was pretty intense, especially when the wind picked up, says Warren, a rangeland management specialist for the Bureau of Land Management's (BLM) Elko, Nevada, Field Office. It was a persistent, mean fire. Standing there, I thought, 'Never have seen anything this crazy'.

Crazy might be the best single word to describe the 1999 fire season, which was devastating in some areas and did not materialize in places less than a hundred miles away. Another description follows the text of a nursery rhyme: Where it was good, it was very good, and where it was bad, it was horrid.

The Great Basin, and in particular northern Nevada, was one place the fire season was horrid. A low pressure system anchored itself off the northern California coast in early August, spinning inland enough moisture and atmospheric instability to generate a series of thunderstorms through much of the Great Basin. Many of the storms were unaccompanied by moisture and fanned by winds gusting to 50 miles an hour. The result was devastating, a firefighter's nightmare: in the Great Basin alone, stretching roughly from the Sierra Nevada mountains on the California and Nevada border to the Wasatch Range in Utah, more than 1.4 million acres burned in less than a week. It was the worst fire season in the Great Basin in at least 35 years, wildland fire experts say. Nevada experienced some of the toughest rangeland wildfire we've seen in a long time. At one point, 75 percent of all wildland fire-fighting resources in the country were in that state, says Les Rosenkrance, director of BLM's National Office of Fire and Aviation in Boise, Idaho.

Not that all the action took place in Nevada. At opposite ends of the continent, Alaska and Florida experienced unusually severe fire seasons. From mid-June to the end of July, the number of acres burned in Alaska jumped from 50,000 to more than one million. Florida suffered through a year where 341,000 acres were scorched. Even the mid-Atlantic states, not known as a wildland fire hotbed, had their share of blazes.

California also experienced an active season. Stubborn wildfires plagued the state well into the fall, perpetuated by strong winds and almost no precipitation during late summer and early autumn. By the end of the year, about 5.3 acres of land burned in about 79,000 wildland fires across the United States.

Do those figures indicate a disastrous season? Not necessarily. Where fire season was good, it was very good. The Southwest and Pacific Northwest, for example, had light-to-moderate seasons. Colorado, Wyoming, Utah, northern Idaho and Montana had their bouts with wildland fire, but overall, their seasons were tame. The erratic fire season can be blamed primarily on one factor: La Niña, a pool of cool water in the tropical seas of the Pacific. Rick Ochoa, a meteorologist for the National Weather Service in Boise, Idaho, explains. La Niña had a major impact on the fire season, Ochoa says. La Niña usually brings dry winters and springs to the southern tier of states. That's why we've had a very busy fire season from Southern California to Florida. In the Northwest and Rocky Mountain states, La Niña generally brings dry autumns and wet winters. Nevada, California and other parts of the West had a terrible combination of weather: a windy spring, a hot dry summer, dry lightning in August and September, topped off by a warm and dry fall, Ochoa says.

The mountains started out with record-breaking snows in parts of the West, but they also dried out by late summer. Some well-timed rain in September and a little less dry lightning than experienced in Nevada helped keep the lid on fires in the Northwest and Northern Rockies. La Niña is continuing through the winter. We could have an active season in the southern states again next spring, predicts Ochoa.

No matter how many acres burned, the 1999 season will be considered a success in one important respect. The safety record was one of the best in years. The safety of our firefighters and the public is still our paramount concern, says Rosenkrance, of BLM's Office of Fire and Aviation in Boise, Idaho. The fire year started relatively slow, but it ended up a long season for many firefighters. Some of our smokejumpers, for example, made more than 20 jumps, which is an unusually high number. Some of our crews were out for weeks at a time.

When the season wears on, the risk of injury rises, says Rosenkrance. Overall, our safety record was good in a very busy season, he says. To sum it up in one word, I'd say 'congratulations,' to the firefighters.

Another season highlight was the interagency cooperation. BLM firefighters, responsible for most of the public rangelands, were stretched thin, but other agencies stepped in to help out. We couldn't have done it by ourselves. The cooperation from other agencies was tremendous, Rosenkrance says. At one point, when we could see that Nevada was going to get hit hard, we had an additional 300 engines, 40 aircraft and six Type 2 incident teams positioned there to help out. Those crews consisted of people from many agencies. Without that kind of support, the season could have been much worse.

Rosenkrance said that a shortage of trained people is a national concern, as more firefighters near retirement and others participate less in fire because of family and job responsibilities. We need to recruit and train people to meet our future needs. We need a true professional career ladder for firefighters, he said.

Even after the last flame was extinguished, fire season work was far from over. Many fire veterans say that rehabilitating the burn land is even a tougher job over the long haul than fighting fire. It will take years to restore the land, if not decades. To people unfamiliar with the Great Basin, the area may seem a sea of sagebrush and grasses. John C. Fremont described the Great Basin in 1848 as a place of ... no wood, no water, no grass, the gloomy artemisia (big sagebrush) the prevailing shrub ...

In truth, the Great Basin is a place of stark beauty featuring a network of dynamic ecosystems that support a surprising variety of plants and animals. In the last 100 years, the native character of the Great Basin has changed as annual plants, such as cheatgrass, and noxious weeds have overtaken an estimated 17 million acres in the area. Annual grasses and noxious weeds thrive in areas weakened by fire. They also are highly flammable, helping wildfires to spread. So the more wildfires burn, the more annual grasses spread. The more annual grasses spread, the more wildfires burn. The casualties of the cycle are native shrub habitat and the wildlife that depends on it; forage for livestock; local economies that depend on the livestock industry; recreational opportunities; water quality; wild horse habitat; and cultural resources. Also, wildland fires become more frequent and intense, and thus, more dangerous and costly to combat.

Rehabilitation is a tough job requiring long hours and fast work. It essentially boils down to stabilizing soils and keeping the spread of weeds to a minimum. Rehabilitation is also a race against the clock. Tom Warren, like many BLM employees, went almost straight from working on a fire-fighting overhead team to working on a rehabilitation crew. *In rehab, we're trying to beat the first snowfall*, he says.

BLM is attempting to take rehabilitation to a new level in the Great Basin. A team of experts is seeking ways to not only rehabilitate much of the burned area, but also restore it and protect other areas vulnerable to invasive species. *The habitat loss we're facing in the Great Basin isn't a new problem, but it may be the last wake-up call to do something*, says Roy Johnson, the deputy fire program manager at BLM's Office of Fire and Aviation. *The remedies we've used in the past to combat invasive species and restore habitat aren't enough. We need a restoration effort like none before to reverse the downward spiral of Great Basin ecosystem health*, he says.

Before the wildland fires were controlled, teams were on site, evaluating damage and beginning to draw up rehabilitation plans. Back in his office in Elko, Tom Warren reflects on the hectic summer of '99. *Fire can be kind of mean*, he says. *At one point, everywhere we looked, we saw fire and it was roaring. We just wanted to get it out. As tough as the wildland fires were to control, the most important work, rehabilitation and restoration, is still in full stride, and will be for months to come. When we got the fires out, it felt good to get a breather,* Warren says. *Of course now, we have even more work ahead of us.*

In wildland fire, it seems the work never ends. Crazy indeed. Story written by

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RESEARCH & TECHNOLOGY

GERMANY

Autonomous Early Warning System for Forest Fires Tested in Brandenburg (Germany)

Abstract

Forest fires cause significant economic damage and hazard to environment all over the world. Apart from preventive measures, early warning and fast extinction of fires are the only chance to avoid major casualties and damage to nature, especially in regions with dense population. As a common method, trained staff observes the endangered areas. In Germany alone, several hundred observation towers were erected in the forests. The staff works up to 12 hours per day and usually under difficult circumstances (extreme temperatures, isolation, continuous concentration).

To date, all attempts to develop a technical system for this task have failed to outlast the test stage. In most cases the chosen components do not work reliable enough. The Autonomous Early Warning System For Forest Fires AWFS described herein is based on new concepts of hard- and software. It is adapted to the specific conditions in densely wooded regions and detects fire by the trail of smoke.

AWFS consists of a rotating digital camera with a special filter and an innovative electronic system. Thus, an utmost high level of reliability is achieved. The noise is extremely low and allows high radiometric resolution (14bit). Digital data are transmitted from the camera to the computer via optical fibers and get evaluated. The necessary software forms the central component of the system. It recognizes smoke almost in real time by analyzing its typical dynamic and stochastic features. This became possible by modifying know-how gained in space projects. However, only recent development of fast CPUs and high capacity storage media allowed to finally solve complex problems of real-time picture processing at low cost. Warnings are autonomously passed over to a central unit, where an operator will evaluate them. For this purpose, comprehensive and user-optimized software was developed. It visualizes all information necessary for taking further steps and assists in decision-making.

AWFS was installed and tested on three observation towers in Brandenburg, Germany, during the 1999 forest fire season. It became apparent that the main requirement for absolute reliable smoke detection was met. The false alarm rate due to weather and harvest activities commonly remained below 1%, which is well acceptable. Other improvements will be effective soon. The testing forest authority confirmed that the system is mature for service and easy to use. The number of systems will be increased therefore. Moreover, other German states and some European countries are very interested in this technology.

Introduction

The probability of fires in forests and fields is steadily increasing due to climate changes and human activities. In Europe, up to 10,000 km² of vegetation are destroyed by fire every year, and even 20,000 to 90,000 km² in North America. Prognoses presume from the assumption that forest fires including fire clearing in tropical rain forests will halve the world’s forest stand by 2030. Vegetation fires result in high human death toll, speed up the extinction of species and worsen the greenhouse effect. Approximately 20 % of the CO_2 emissions into the atmosphere are released by forest fires, estimated the Enquiry commission "Prevention To Save The Earth Atmosphere” of the German Bundestag in 1990. Germany, too, will be affected by the impacts of global climate change. In Brandenburg and some other German states enormous economic damage is caused by forest fires. For instance, in Brandenburg alone more than 1,000 forest fires are registered every year. 90 % of them are caused by human activities. Large fires cause a total damage of up to 70,000 DM/ha. The annual financial loss caused by forest fires in Germany amounts to a two-digit number of millions. However, preventive and fire extinction measures cost even several times this sum.

In order to minimize damage, forest fires must be recognized as soon as possible (within a few minutes). Therefore, great efforts are made in all respective regions to achieve early recognition. Although numerous technical methods were tested, reliability was in no case sufficient to develop a product suitable for the German market. As an example, infrared sensor systems tested in Spain can only detect the fire itself. However, smoke is the feature relevant for early recognition of fires in densely wooded areas. Optical systems as AWIS in the

Netherlands (Breejen et al. 1998) and Firehawk in South Africa are also in a test phase. But they often imply a high rate of false alarm caused by clouds, light reflection, agricultural activities and industrial plants.

In Canada and Russia an early warning system based on aircraft patrolling is used, which means late recognition of forest fires though and is expensive to operate. Evaluating satellite data is presently not very successful, as spatial and time resolution are not sufficient to allow local prevention. Moreover, clouds obstruct the view very often. However, with the German project BIRD a new generation of imaging infrared sensors for Earth remote sensing objectives including is developed (Briess et al. 1999). A major intention of the BIRD is to demonstrate the scientific and technological value and the technical and programmatic feasibility of fire detection of under low-budget constraints. The start of this small satellite mission is planned for the end of year 2000. Within the European project FUEGO an operational mini satellite constellation is studied (Gonzalo 1996.). It will become operational in 2004 to provide early fire outbreak detection and high resolution fire-line monitoring. Hence to date experienced fire-watchers are employed everywhere in the world to observe endangered forests. In Germany several hundred observation towers are manned during main forest fire season. The fire-watchers observe the forests up to 12 hours per day under utmost difficult circumstances (extreme temperatures, awkward hygiene conditions, isolation, only short breaks from concentration) and report about any smoke formation. Apart from that, authorities usually have to spent large sums on the construction of observation towers, as these edifices need to be built, maintained and operated in accordance with relevant legislation and regulation. As an example, approximately DM 350,000 are required to build one observation tower in Brandenburg.

The pilot project ”Autonomous Early Warning System For Forest Fires“ (AWFS) was ordered and supported by the forest authority of Peitz, Brandenburg, and promoted by the European Union. It comprised installation and testing of a system for the following tasks:

- Observe the forests autonomously and reliably for smoke formation
- Recognize fires early, reduce the risk of human failure and thus minimize damage
- Improve the working conditions of the staff
- Reduce observation costs

A solution for this complex undertaking was found by further developing know-how from unmanned space missions and consistently adapting it to the problem of forest fire recognition.

Technical description of AWFS

According to the forest authority’s specification, an autonomous early warning system for forest fires must meet the following technical requirements:

- Automatically recognize smoke formation of 10 m expansion by daylight within a radius of 10 km and within 10 minutes after becoming visible
- High reliability in respect of fire recognition
- Acceptable rate of false alarm
- Localize the source of the fire
- Easy maintenance
- Autonomous transmission of smoke data to a control center
- Full record-keeping of all events
- Data transmission to control center must enable the operator to independently evaluate the potential hazard

System concept

Principally, there are various methods suitable to recognize vegetation fires, e.g. analyzing picture information provided by digital cameras or by infrared imagers, or detecting emission lines of conflagration gases, or active measurements with Lidar evaluating the laser signal backscattered from smoke particles. To find out which method is suited best, several preliminary tests were performed observing controlled fires with various sensors (CCD-camera, IR-radiometer, IR-spectrometer). We had to take into account our own results as well as experience gained internationally on the field of early forest fire recognition, also given facts on site in Germany, the technical requirements mentioned above and the required user-friendliness and economic efficiency. Bearing all this in mind, we chose a sensor type based on a digital CCD-camera with high resolution. Smoke detection within the visible spectral region is especially important in densely wooded forests, as open flames (which IR-sensors respond to) give alarm too late. Furthermore, cameras provide the operator in the control center with expressive images and hence make it easier for him to evaluate the situation. It was one of the project's main objectives to allow human contribution in a suitable way during the process of evaluating the alarm and selecting the appropriate fire fighting method. For such purpose, the control center is equipped with a number of computer-assisted supports.

Fig.1. Digital CCD-camera

The digital high resolution Frame Transfer CCD-camera with special filter (see Figure 1) scans the forests from the top of the observation tower. AWFS can also be mounted to braced poles of mobile phone providers, high buildings or other suitable locations. The images are resolved with 14 bits and transmitted via optical fibers to the computer unit which is located in the tower too. There they get analyzed by means of specially developed software. If there seems to be a smoke formation, compressed pictures and further details (time, position) are reported via ISDN to the control center, where they are processed in a PC displayed on the screen. The operator receives all information he needs to make decisions. Currently, one control center can support up to 7 towers. In each tower up to 8000 digital images with a data volume of 16 GByte are produced and evaluated every day.

Hardware components installed in the observation tower

The basic components of AWFS are shown in Fig.2. The most distinctive feature of the CCD-camera is its innovative electronic concept of four functional groups: CCD-head, clock-driver, analogue signal chain and controller. The camera is mounted on the very top of the tower by means of a pan and tilt unit (PTU). It takes the camera approximately 10 minutes to come full circle. The controller generates or manages all digital control signals for the CCD transport cycles, analog signal processing and PC-interface. Incoming commands are interpreted and carried out. The video signal is pre-processed in the signal chain on analog basis, then submitted to correlated double sampling, before it runs through further conditioning and multi-level filter. After the signal is digitalized in a 14bit analog-to-digital converter the image data are serialized and transmitted to the controlling PC via optical fibers.

The electronic components are utmost resistant against environmental conditions, stand out for their low energy consumption and extremely low noise. Due to the high radiometric resolution (~16,000 different grey scale values) the camera covers a wide range. Even very structures can be resolved under all sorts of lighting conditions. The 70 mm objective with 10° field of view allows 2 m geometric resolution in 10 km distance. Tests confirmed that the red-free filter increases the contrast between vegetation and smoke, as red light is hardly reflected at all by chlorophyll.

The pan and tilt unit can be positioned with a relative precision of up to 0.2° and with an absolute precision of 1° after being oriented in the landscape by means of GPS-defined land marks. During scanning stage three single images are taken in 1-second intervals for every camera position. Then, full image information is transmitted to a controlling PC at the tower bottom, where the data are evaluated, stored and passed on to an image processing computer. Both computers work with the operating system MS Windows NT.

Moreover, the controlling PC covers the following functions:

* Autonomous control of camera image taking
* Autonomous control of the pan and tilt unit
* Compressing alarm images before transmitting them
* Control of alarm data transmission (time, location of smoke etc.) to the operator in the control center
* Autonomous transmission of sensor unit operating data to the operator (e.g. failure alarm)

Data transmission to the PC in the control center is currently achieved by a wired ISDN-connection. However, it is also possible do use radio transmission or other specific networks.

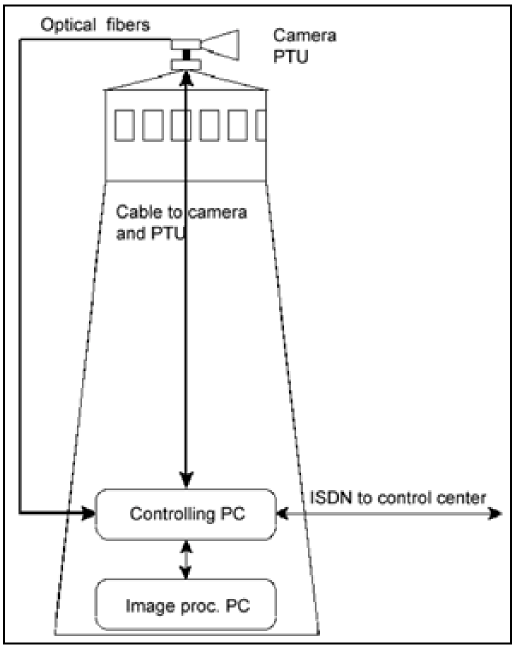

Fig.2. Basic components of AWFS

Image processing software

The image processing computer uses complex algorithms to identify smoke in real time. Simultaneously, it calculates the optimum exposure time and sends it to the controlling PC. The image processing software is the heart of the AWFS. It evaluates in only a few seconds typical features like dynamic and stochastic behaviour. In every camera position several images are taken. First of all, exact matching must be achieved for the images taken from the same camera position, because the towers tend to swing considerably in the wind. Next, the horizon line is determined in the image for orientation purposes. The smoke is identified then by means of dynamic and structural features and by its grey scale value. It is prerequisite to reliable recognition that several features are taken into consideration.

In a first step, typical features of smoke are looked for by analyzing a standard difference image. Wind and thermal convection of hot smoke gases change the grey scale value of smoke areas in the subsequent images. However, other environmental phenomena (e.g. clouds, wind, dust formations, reflections, bird flights, cars) can cause similar effects for short periods of time (in comparison with the time scale of the dynamic behaviour of smoke). Moving objects (cars, planes, birds) can be eliminated by an additional evaluation of the third image, because smoke is quite stationary within the time between first and last image (several seconds). Irrelevant space frequencies are eliminated by band-pass filtering the standard difference image. As the special red filter reduces the green colour of the forest significantly, smoke of wood fire always stands out against the surrounding forest. This fact supports additional suppression of interfering signals (as an example, smoke is easy to distinct from cloud shadow therefore. Finally, adaptable threshold values prompt the decision, whether fire alarm is to be released or not.

In a second step, the texture is evaluated. The respective method is based on the structural analysis of the texture of smoke, which can be clearly discerned from the surrounding structures. It works even without any comparison image and hence does not react to changes in illumination nor to moving objects like vehicles. From mathematical view, the structures are described as stochastic effects superimposed to the average grey scale value. Therefore, it is first necessary to calculate the estimated average grey scale value, so that the stochastic arises from the difference between the original and the estimated image. The mathematical basis is explained by Hetzheim (1999). Typical smoke structures are separated then by means of various procedures. A second image, which is prerequisite to the first step described above, are reused to verify the results.

In accordance with the observed features both methods proceed classing the identified possible smoke areas with probabilities. These are condensed to one total probability then. As an example, the total probability is low, if the identified areas do not overlap and clearly differ in size.

Each of the two methods described above works sufficiently enough to detect smoke on its own, but their simultaneous employment increases the reliability of smoke detection considerably.

Control Center

The control center, too, is equipped with a PC and appropriate software. It deals with the following tasks:

- Control of several camera locations
- Receive alarm images and data
- Visualize alarm images in a suitable way and in correlation with digital maps
- Display a low resolution panorama view of all towers administrated by the center
- Manual area definition in order to permanently mask smoke of irrelevant origin (chimneys, villages, etc.)
- Provide the operator with tools for adequate evaluation of images (zoom, image sequences, filters, facilities to change contrast and brightness)
- Display the bearing lines of alarm messages on digital maps
- Fade-in additional information and data bases in accordance with the user’s requirements

By means of the software developed for the control center, even operators who might not be familiar with modern PC-technology can easily make themselves acquainted with their scope of duties within a few days. Their knowledge about local conditions as well as the information the system provides them with enable them to soon make qualified decisions on initiation of fire fighting activities. Annex 2 shows a possible display variant on the monitor.

3. Results and discussion

Only practical operation can demonstrate the performance of an autonomous early-warning system for forest fires. Therefore, a pilot test was started during the forest fire season 1999, after several tests with controlled fire were made. Supplementary to traditional fire watching methods, AWFS were installed on three observation towers (Kathlow, Reuthen, Jerischke) of the Spree-Neiße district in southern Brandenburg, which is a region with very high forest fire risk. The numerous open pits and power plants in this region with their dust and smoke emissions make the task of fire watching especially difficult. The control center is located at the premises of the local forest authority in Peitz. The test results were monthly evaluated and reported in cooperation with the responsible officers.

Fig.3. Fire detection from Kathlow tower on 8 August 1999

In the test region 16 forest and field fires happened. All these fires were detected and indicated by the AWFS within the set time limit. Despite the approximately 10 min time of revolution, fire indication sometimes (especially during late afternoon) was given even earlier than by the experienced observation tower staff, who obviously suffered from symptoms of tiredness. Figure 3 is an example of automatic smoke detection.

False alarms mean a specific problem. One differentiates between alarm due to irrelevant smoke sources, e.g. chimneys, and proper false alarm. Irrelevant smoke sources are usually stationary objects. Therefore, a facility was created, that allows the operator to permanently mask these sources. The complex image analysis during which various features are evaluated in a multi-step process has been described above and proven to efficiently avoid potential false alarms.

Figure 4 presents the statistical evaluation of the false alarm rates at all three pilot project locations during the period from 16/8/1999 to 18/9/1999 (end of forest fire season). For most days the rate of false alarm is clearly less than 1%. About 230 decisions about smoke formations are to be made hourly by the software on each tower. A rate of 1 % means approximately 2 false alarms per hour, which the operator can easily cope with. However, under certain weather conditions the number of false alarms increases due to light reflection, ascending water vapor (after short but heavy rain) or low clouds. Dust formation as a result of harvest activities can be taken for smoke, too. Even experienced staff has often considerable problems to differentiate properly though. The region around Kathlow has higher rates, which is due to Cottbus city and the Jänschwalde open pit and power plant being in the range of view of the camera. The option to mask such smoke sources was not entirely used yet in the pilot project.

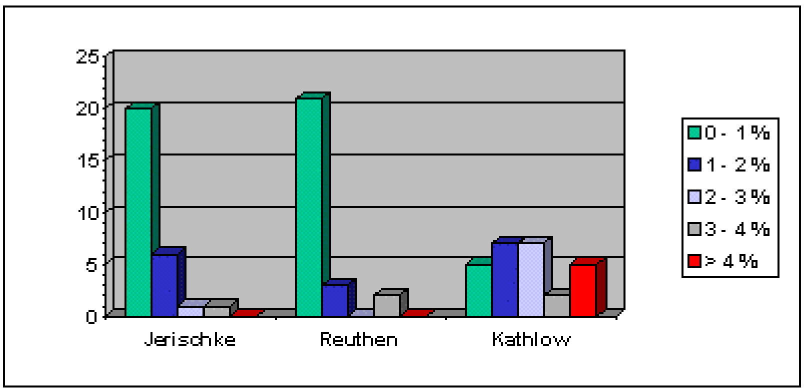

Fig.4. Number of days with different rates of false alarm at the different AWFS locations from 16 August to 18 September 1999

Any problems occurring were continuously evaluated during the test stage and the software improved accordingly. As a result, the user was satisfied with the AWFS.

All in all, AWFS offers the following advantages:

* Reliable and flexible observation of regions with high forest fire risk, prepared for service at any time of the day
* Omission of jobs with difficult working conditions, creation of new jobs in equipment production and maintenance as well as in the control center
* No need for observation towers in forest regions, low costs for installation and maintenance (braced poles of mobile phone providers)

4. Further development

The test-stage turned out to be successful. The experience gained will be considered and evaluated during the next few months. A new generation of AWFS will be developed and tested.

Here are the focal points of future development:

* The computers of several towers will be concluded in a direct network, so they will be able to control the operation of each other (watchdog-system) and hence further increase reliability in service
* High performance PCs will be used, which will lead to lower turn-around times
* False alarm rates will be still reduced by further development and optimization of the software, making use of the comprehensive image data base
* Reliability of smoke detection will be further improved by means of a neuronal algorithms for classification

Due to its universal basic structure, AWFS can be used in other areas as well. The concept of the system (digital camera with high spatial and radiometric resolution, wide range in brightness, real-time image processing, autonomous alarm signal transmission to a control center) and the experience gained so far in detecting complex structures in natural environment are suitable for various observation tasks, e.g. environmental monitoring or security duties. The system can not only observe sensitive areas, but also autonomously give alarm, transfer data to any other place and selectively store images.

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NEWS FROM THE UNITED NATIONS

The WHO - UNEP - WMO Health Guidelines for Vegetation Fire Events

Abstract

As a response to the global recurrence of vegetation fires, WHO, in collaboration with UNEP and WMO has developed the WHO-UNEP-WMO *Health Guidelines for Vegetation Fire Events*. The guidelines are intended to develop the necessary capacity, to give WHO's support to local planning efforts in health, environment and sustainable development; to strengthen the basis for inter-sector action in sustainable development policy and planning, by providing the necessary evidence and guidance; to determine best practices and disseminate such knowledge worldwide; to strengthen the linkages between health, environment and development; to provide ongoing support in the development and implementation of the Regional and National Haze Action Plans. This paper introduces into the objectives, scope and results of the guidelines.

Introduction

Smoke pollution due to vegetation fire events is an important public health issue and involves major risks for the health of the people and the environment. Vegetation fires in Asia, Latin America, Africa, and other parts of the world are recurring phenomena. They often lead to health impacts such as increased mortality, increased hospital admissions due to respiratory and cardiovascular diseases, and increased emergency room and outpatient visits. Smoke from vegetation fires sometimes even overlies urban air pollution, and exposure levels are intermediate between ambient air pollution and indoor air pollution from domestic cooking and heating.

For several months in 1997-98, the smoke disaster in Southeast Asia affected several countries including Brunei Darussalam, Indonesia, Malaysia, Singapore, Philippines, and Thailand, as well as tens of millions of people in the region. Authorities of these countries have taken measures to mitigate smoke effects on population health and to control forest fires. This was particularly the case for Indonesia, which officially requested UN assistance. The fires threatened to evolve into a more complex emergency, through the potential of causing voluntary or planned population movement (evacuation), and through effects on health, economy and security. In such an emergency the development of an early warning system would involve the multidisciplinary collaboration of scientists, technicians and administrators.

As a response to this emergency, the World Health Organization convened a meeting in October 1998 in Lima, Perú, to develop the WHO-UNEP-WMO *Health Guidelines for Vegetation Fire Events* (WHO/UNEP/WMO 1999a) on the basis of background papers written on the involved multidisciplinary issues by several experts. The *Health Guidelines* comprise three separate documents. The *Health Guidelines for Vegetation Fire Events – Guideline document* is a comprehensive handbook with the objective of providing guidance to Governments and authorities from municipalities on the action to be taken in vegetation fire events, when large parts of the population are exposed to smoke from fires. It has to be seen as the main document that summarises the experience and knowledge laid down in the background papers. These background papers are published separately in the document *Health Guidelines for Vegetation Fire Events - Background Papers* (WHO/UNEP/WMO 1999b). A third document entitled *Health Guidelines for Vegetation Fire Events – Teachers' Guide* (WHO/UNEP/WMO 1999c) compiles educational materials that can be used in training courses on the *Health Guidelines* for Vegetation Fire Events.

The WHO-UNEP-WMO Health Guidelines for Vegetation Fire Events (hereafter referred to Health Guidelines) are intended:

- To advise national and international authorities on how to develop and implement an early warning system to protect the health of the population exposed to air pollution caused by vegetation fire events.
- To provide support in capacity building and in the development and implementation of the Regional, National, and Local Haze Action Plans. These plans will be integrated into national sustainable development planning efforts, as parts of the Environmental Action Plans;
- To provide the necessary evidence and guidance on vegetation fires and their health impacts, to strengthen the basis for inter-sector action in sustainable development policy and planning;

* To determine best practices, and disseminate such knowledge worldwide, with the objective of strengthening our understanding of the linkages between health, environment and development.

The Health Guidelines provide decisive recommendations on how to make optimal use of the vast amount of multidisciplinary information that is available worldwide. This information includes knowledge of the global, regional and national extents of vegetation fires obtained by remote sensing techniques and characterises the sources with respect to strength and pollutants. The development of an early warning system is based on ground-base monitoring, space and climate monitoring and modelling. The *Health Guidelines* also provide insight into the acute and chronic health effects of air pollution due to vegetation fires ("biomass burning"), advise on public advisories and mitigation measures, and provide guidance on the methodology for assessing the health impacts of vegetation fires. Important issues are the prevention of future health-affecting events through discussion of land-use and fire policies, and recommendations on scientific work to be performed in the future in order to implement the early warning system.

According to the *Health Guidelines,* fires in forests and other vegetation produce gas and particle emissions that have impacts on the composition of the global atmosphere. These emissions interact with those from fossil-fuel combustion and other technological sources which are the major causes of urban air pollution. Smoke emissions from wildland fires cause visibility problems which may result in accidents and economic losses. Smoke generated by wildland fires may also affect human health and lead to loss of human lives. The development of policies and guidelines for reducing the health impacts of smoke from burning vegetation must be linked with policies which address the smoke problem at its source. Therefore, the *Health Guidelines* help to greatly reduce the burden of excess mortality and preventable disability suffered particularly by the poor. With this in mind, the *Health Guidelines* implement health gains that, in turn, trigger economies to grow and poverty to be cut.

The *Health Guidelines* emphasize that early warning systems of fire and atmospheric pollution are essential components of fire and smoke management. They may involve locally generated indicators, such as fire-weather forecasts and assessment of vegetation dryness. Advanced technologies for detection and monitoring of fires, however, rely on remotely sensed data, evaluation of synoptic weather information, modelling capabilities of fire occurrence and behaviour, and international communication systems. These data are integrated and processed with other relevant information, such as the population at risk, and disseminated in fire information systems.

The *Health Guidelines* are intended to ensure that the health components of Agenda 21 of the United Nations Programme of Action, following the Earth Summit in Rio de Janeiro, are adequately addressed so that health gains trigger economies to grow and, subsequently, poverty to decrease.

Emission, transport of air pollutants and exposure

The *Health Guidelines* have compiled the information on major fire events in the world and their health and economic effects. Wildfires (uncontrolled fires) are common in all vegetation zones. They are mostly caused by negligence and are often associated with escaped land-use fires. Biomass burning is a major contributor of toxic gaseous and particle air pollutants and occurs throughout the world. The nature of biomass burning is such that the combustion is not complete, and as a result a large number of pollutants are emitted. Among the air pollutants emitted from biomass fires are widespread pollutants such as particulate matter, oxides of nitrogen, sulphur dioxide, and carbon monoxide. But unlike some anthropogenic sources, emissions are poorly quantified (also see Goldammer 1999).

After the emission, during transport, the air pollutants undergo transformation processes, which result in physico-chemical changes of the pollutants.

According to the *Health Guidelines*, comprehensive approaches to be standardized for use in dealing with potential risks to public health of emissions from vegetation fires should include:

* Characterization of the magnitude and composition of the emissions and their transformations during transport;
* Quantification of resulting concentrations of ambient air pollutants in populated areas;
* Evaluation of likely exposure scenarios for affected populations (both indoors and outdoors);
* Assessment of consequent health risks posed by such human exposures.

It is pointed out in the *Health Guidelines* that with respect to the exposure to smoke plumes from biomass burning and corresponding health effects, particles receive the most attention of all air pollutants that have potentially detrimental health effects. Very small airborne particles (aerodynamic diameters below 2.5 μm) are considered the most significant pollutants. These particles have a very high probability of deposition in deeper parts of the human respiratory tract, where they may lead to a range of health impacts by virtue of their physical, chemical, toxicological or carcinogenic nature (also see Ward 1999).

Ground-based monitoring

In view of the multidisciplinary approach of the *Health Guidelines*, harmonisation of the various approaches is considered a very important issue. Ground-based air quality monitoring and remote sensing through satellite imagery are necessary to assess air pollutant concentrations of smoke caused by vegetation fires. The *Health Guidelines* give several recommendations with respect to monitoring. Ground-based air quality monitoring should aim to provide information for public health warning and decision making on protective measures, for dispersion model inputs, verification and development, and for human health studies that evaluate effects of smoke. Air quality monitoring should be conducted on a regular basis in major urban and other populated areas likely to be impacted by biomass burning. In addition, stations should be located in rural areas, for background concentration information. Existing networks should be reviewed and the best sites for monitoring smoke and haze episodes identified. Establishment of additional monitoring stations in areas not covered by the existing networks should be considered. The location of the sites should be determined in accordance with existing guidelines. A ground-based network of air samplers is necessary to measure the concentration of aerosols for sizes under 2.5 μm in diameter (for further reference see Grant 1999; Ward 1999).

In measured compounds efforts should be made to separate the contribution of biomass burning from that of other sources. Monitoring of aerosol mass, visibility, meteorological parameters, optical depth and solar radiation are of highest priority. At selected sites, targeted chemical quantities such as carbon monoxide, ozone, nitrogen oxides, sulphur dioxide, carbon dioxide, ultraviolet radiation, aldehydes and other trace pollutants should be measured.

Formulation of uniform protocols for sampling, including temporal resolution and reporting procedures, should be established. The establishment of quality assurance/quality control procedures is essential for obtaining reliable and reproducible results. National and regional databases should be established for use of data before, during and after smoke/haze episodes. These data can be used, for instance, in epidemiological studies, planning for future events and for transport modelling studies. The exchange of validated measurement data should be promoted. The different air pollution indices that are used in regional smoke and haze alerts should be harmonized.

To maximize the usefulness of data collected by different networks, participation should be encouraged in international activities such as the Global Atmosphere Watch programme of the World Meteorological Organization or the Air Management Information System of the World Health Organization.

Satellite data

The Health Guidelines summarise the existing knowledge on satellite imagery and future developments in the field of remote sensing. Satellite data are available for monitoring fires and smoke aerosol, e.g., at the National Aeronautics and Space Administration (NASA) or the National Oceanic and Atmospheric Administration (NOAA) of the United States. Satellite imagery provides information on the dryness of the vegetation, location and size of major fires and smoke plumes, energy released by fires, and air pollutants in the smoke plumes. Additional satellite sensors delivering better data on vegetation fires will be available within the next 1-2 years. With respect to accessibility and evaluation of these data, it is recommended that a centre of excellence in fire and smoke monitoring be established. The centre should be familiar with the technology and software for analysing satellite data. Its responsibilities would be to oversee the regional estimates of fire emissions and to validate the smoke and emission analyses of satellite data. The centre should develop new strategies for fire and smoke detection and advise the international bodies and agencies of its needs. It would also integrate ground-based, aircraft and satellite information. It would work with the regional centres in disseminating information and new technology to the regional centres, as well as co-ordinate the training of technicians to handle new satellite data and software.

It would also be important to establish an indicator for grading the severity of on-going fires. Such an indicator could combine satellite data on the number of active fires per unit area, size of the areas burning, energy released by the fires, the extent the smoke palls and the concentration of pollutants in them. Also recommended is the development of a space fire monitoring system, comprising fire detection satellites and real-time portable receiving hardware, to provide diurnal information on the location of active fires, smoke, and trace gases emitted from the fires. If possible, the information generated by this system should be provided directly from the satellite to local users in near real-time, in a simple and inexpensive manner.

On a regional level there is a need for fire activity centres. These centres would receive the regional satellite data using their own receiving stations, and integrate them both with meteorological information and with ground and aircraft monitoring efforts. The centres would use the data to monitor the development of the fires and smoke and predict the spread of the smoke. The centres are needed since the characteristics and amounty of vegetation burning change from region to region, and since direct reception of the satellite data is essential for real time operation. As there are already WMO centres or representatives with satellite and meteorological capability, they are natural candidates for the location of the regional fire activity centres.

With respect to data availability, it is recommended that NASA and NOAA of the United States and other appropriate agencies be approached to continue placing relevant data such as aerosol and vegetation indexes on the Web. There is a need to develop software packages and instruction material for using satellite data to warn of smoke impacts and to analyse smoke concentrations. Where extensive and intense fire episodes cause severe health problems the reliability of the fire emission estimates should be ensured by continuous validation, using ground based in situ and remote measurements. Such validation will enhance the use of satellite data as input to the simulation model. Once developed, the software packages would also support the determination of environmental hazards for human health.

Atmospheric transport models

With respect to the evaluation of ground-based monitoring data and satellite imagery for the purpose of early warning, the *Health Guidelines* recommend the use of dispersion and trajectory modeling. The distribution and concentrations of fire emissions must be calculated from atmospheric transport models. A description of the spatial and temporal distribution of fire emissions should consider the situation before, during, and after the episode. Defined goals are to be achieved in each of those three stages of the event. It is recommended that the agency capable of carrying out the complete suite of tasks associated with climate monitoring and modelling be identified in each area (further see Garstang 1999; Tapper and Hess 1999).

Mitigation measures

The *Health Guidelines* discuss the various mitigation measures that are appropriate to avoid human health effects. Mitigation measures recommended for acute events include remaining indoors, personal lifestyle modifications, use of air cleaners, use of masks and respirators, outdoor precautionary measures, evacuation to emergency shelters, and school and business activities. To enhance the protection offered by remaining indoors, individuals/building managers should take action to reduce the infiltration of outdoor air. Schools, childcare centres, retirement centres, nursing homes, hospitals and hospices should be especially urged to provide air conditioned rooms to susceptible individuals, and effective filters should be installed and maintained in these rooms. During severe smoke episodes, members of the public should be advised on lifestyle modifications, such as the reduction of physical activities and the restriction of cigarette smoking. Evaluation of the use of portable air cleaners should be conducted and appropriate advice given to the public, to assist them in purchasing models suitable for homes or offices. Advice should be given to the public on specific dust/mask respirator types and their relative utility for filtration of smoke particles, including the proper use and selection of available dust masks/respirators. Precautionary measures should be taken to safeguard the health and safety of workers who must continue to perform outdoor work. For example, employers should provide respirators to workers who must work outdoors during acute emergencies. In severe episodes, susceptible individuals should be allowed free access to air-conditioned emergency shelters (with adequate particle filtration). These could be located inside large commercial buildings, educational facilities or shopping malls.

Health effects

Based on the background papers provided by several authors (Pinto and Grant 1999; Brauer 1999; Malilay 1999; Mannino 1999) the *Health Guidelines* summarize the existing information on the health effects of smoke generated by biomass burning ("biomass smoke"). In addition, the results of several case studies were evaluated (Levine 1999; Kunii 1999; Dawud 1999; Phonboon et al. 1999). The epidemiological studies of indoor and community exposure to biomass smoke indicate a consistent relationship between exposure and increased respiratory symptoms, increased risk of respiratory illness and decreased lung function. A limited number of studies also indicate an association between biomass smoke exposure and visits to emergency departments. Recent assessments of impacts from the 1997-98 Southeast Asian haze episode support an association with increased hospital visits. Studies of the relationship between biomass-smoke air pollution and acute mortality have not been conducted to date. However, as biomass-smoke air pollution mostly consists of fine and ultra-fine particulate matter the new air quality guidelines of the WHO for particulate matter suggest a definite impact on daily mortality, hospital admissions, emergency department visits and outpatient visits.

The health effects of long-term inhalation of smoke generated by burning of plant biomass have been documented in developing countries where women spend many hours cooking over non-vented indoor stoves (also see Brauer 1999). These studies indicate that vegetation fire smoke exposure is associated with the development of chronic lung disease in adults, although these exposures are much higher than would occur as a result of short-term exposure to air pollution associated with vegetation fires. These studies do indicate the serious consequences of exposure to high levels of smoke pollution. The limited data on biomass burning smoke and cancer do not indicate an increased risk even at very high levels of exposure. This evidence includes studies of long-term exposure to high levels of smoke from domestic cooking in developing countries. While biomass burning smoke clearly is potentially carcinogenic, it is much less so than motor vehicle exhaust.

Assessing the health effects of smoke from vegetation fires is a difficult task. Critical factors in ascertaining the health effects of air pollution include: characteristics of the pollutants, population exposure, individual exposure, susceptibility of the exposed individual, potential confounding factors, and the range of health effects being studied. The availability of data on these factors greatly affects the type of study that might be undertaken. Types of study designs in air pollution epidemiology vary widely and include: short-term controlled exposure studies (chamber studies), short-term exposure studies, and long-term exposure studies (also see Mannino 1999). The latter two designs reflect a typical epidemiological approach to the problem of air pollution exposure. Any type of study requires careful planning of the design, implementation and analysis. During an emergency there may be a need to conduct a rapid epidemiological assessment, focusing on the demographics and health concerns of people in the affected community.

An important component of a public health plan to deal with pollution-related exposure is a surveillance system for monitoring respiratory or cardiovascular diseases (also see Mannino 1999). While many countries have such a system in place for infectious diseases, very few have a similar system in place for noninfectious diseases. With the increasing numbers of computerized clinical databases, however, it may be possible to set up a surveillance system for diseases that would be affected by fire-related air pollutants. Before a fire emergency a health department could, potentially, set up a surveillance system looking for chronic cardio-respiratory diseases. If this was in place, changes in these diseases could be assessed during a fire episode. In the absence of such a surveillance system, it is unlikely that any active surveillance would provide reliable information that a public health department could act on. After a fire episode several research designs, as noted above, are available to health departments who want to determine what health effects the fire episode had and who want to use the data to shape future policy.

Public policies

The *Health Guidelines* consider and summarise public policies in various countries (also see Bakar bin Jaafar 1999; Marileo 1999; Johnson 1999; Ooi et al. 1999; Phonboon 1999). In this discussion the policy objectives and policy elements referring to development, assessment and management are described. These elements are ingredients of national haze action plans. The lessons learned from the 1997-98 fires in South-East Asia are important to avoid the recurrence of such an emergency in the future. A number of topics are enumerated in the *Health Guidelines* that need further research.

Policy objectives

With regards to *Policy Objectives*, the elements to be considered are:

* To prevent and control land and forest fires;
* To safeguard public health and safety in such an occurrence;
* To prohibit open burning;
* To introduce and implement ambient air quality guidelines and standards;
* To strengthen control on emissions from mobile and stationary sources.

The elements with respect to *Policy on Development* are:

* To set land use planning based on a sustainable development principle;
* To protect communities and ecosystems at risk from fire and haze effects.

The elements with respect to *Policy on Assessment* include:

* To monitor and report on air quality;
* To develop an effective mechanism for monitoring land and forest fires;
* To develop the capability for detecting and predicting forest fires and haze;
* To monitor the health and environmental impacts of haze.

The *Management Policies* focus on the following aspects:

* To provide the public and the authorities with information on air quality and action to be taken;
* To advise the public on action to be taken for health protection;
* To ensure medical facilities and health supplies for mitigating health impacts;
* To provide support to countries in need and to promote cooperation among countries;
* To minimize haze pollution from fuel burning;
* To strengthen the capabilities of relevant agencies;
* To strengthen interagency cooperation and support.

As the *Health Guidelines* stress, the success of any policy, action plan, or response mechanism will rest on the timely exchange of data, information and experiences among various national, regional, and international authorities or centres of excellence, and on their close co-operation and continuing support. Institutional arrangements at international and regional levels need to be developed and used. Early warning capability is invaluable to national authorities trying to enforce strict controls on both controlled and open burning of vegetation, crops, forest, and any form of biomass or waste (also see Goldammer 1999). During a fire, national authorities should consult competent international bodies for advice. These international bodies should investigate the feasibility of establishing an ongoing panel of experts on haze, whose members are linked via electronic media for the rapid exchange of data and information.

Among the critical components of national governments’ efforts to manage vegetation fires is the education of the population regarding the potential health impacts of air pollution produced in vegetation fires. These education efforts must occur both prior to, and during, fires to keep the population informed.

National Haze Action Plans

The *Health Guidelines* emphasise the necessity of developing National Haze Action Plans to ensure full preparedness of the population for the health impacts of vegetation fire pollution. In each country, a comprehensive National Haze Action Plan should be developed and widely publicized through the media, before the occurrence of any air pollution episode. Based on this action plan, government departments should develop operating procedures and ensure that the population will be aware of any changes made to public services and facilities in an emergency situation. Data on air pollution related illnesses from primary health care providers, hospitals, and mortality registries should be reported periodically. Special educational efforts should be developed for susceptible populations, such as asthmatics, the elderly, and children to ensure that they are adequately prepared for air pollution episodes. Health authorities, via the media, should proactively address frequently asked questions, such as the safety of food and potable water supplies exposed to smoke for prolonged periods.

Lessons learned from the 1997-98 fires

In reviewing the 1997-98 fire and smoke episodes, the Food and Agriculture Organization (FAO) of the United Nations evaluated those public policies which affect forest fires (FAO 1999). The expert consultation concluded that there is a need for reliable national, regional and global systems for fire reporting and for analysis and storage of data. Such data, and information on fire causes and socio-economic and environmental effects, are required as a sound basis for policy making. Linked to these is the requirement for international agreement on terms and definitions, as a basis for information sharing and communication. Information on resource management alternatives and their consequences is essential for involvement of all stakeholders in policy formulation and development.

No single formula can cover the wide range of ecological, socio-economic, and cultural conditions that exist between and within regions, nor cover the different objectives that different societies will decide. Certain broad principles exist, however, that are common to all situations and objectives. These principles include the following (FAO 1999):

- The formulation of national and regional policies specifically addressing forest fires, as an integral component of land-use policies, where they previously did not exist.
- Flexibility in policy implementation, and the capability of reviewing and revising fire-related policies
- Clear and measurable policy objectives and implementation strategies are needed to minimise the many adverse effects of uncontrolled fires, and to maximise the benefits from fire prevention, or from the controlled use of fire. Such objectives and implementation strategies would provide for sustainable land use practices, compatible inter-sector policies, joint fire management responsibilities at the community level, and the participation of the private sector and non-governmental organizations. Decision makers should recognize that sustainable land management may, in many instances, be attained only through the devolution of the control of forest resources, and through the involvement of communities, adjacent to or within the forest, in all aspects of management and fire protection. Land-use policies may also have to consider the need for appropriate incentives and subsidies to promote fire prevention.
- A favourable policy environment must be created for all aspects of systematic fire management (prevention, detection, suppression, prescribed fire, post-fire rehabilitation etc.) and for an appropriate balance among individual system components. Such an environment should attempt to quantify the monetary and non-market values, to emphasise the costs and benefits to society and to decision-makers.
- Policies that tend to increase forest fires must consider public health effects. Policies concerned with maintaining the health of fire-adapted ecosystems may have to balance public health and forest health issues.

The *Health Guidelines* fully support these principles. Continued and improved collaboration and co-ordination are urged among the many organizations involved in forest fire-related activities at global and regional levels. Transboundary or regional agreements for collaboration in fire management need to be developed, with the technical and financial support of international organizations. International organizations, in close collaboration with the fire science community and end-users, are further urged to support the design and implementation of a global fire inventory or reporting system, to increase preparedness and responsiveness to fire outbreaks at national, regional and global levels. International organisations should play a catalytic role in the establishment of networks, to promote the sharing of information and technical co-operation among developing and developed countries. Sufficient resources should be allocated for these purposes.

Accumulated experience should not be neglected, and local indigenous knowledge and customs should be acquired from traditional fire related cultures as a guide for fire management practices and policies. Evaluation systems should be developed to assess fire damage and benefits, and to draw attention to the true costs and benefits of fires. Policies and techniques that aim to increase agricultural productivity, while providing and enforcing disincentives for reckless programmes, will slow forest conversion for unsustainable agriculture and will thus reduce forest fire damage.

Research needs

According to the *Health Guidelines,* some technical aspects may support policy formulation and implementation. They include systematic or integrated fire management; institutional co-operation; restoration/rehabilitation; and technology/research/information. New technologies offer the means to introduce new and more environmentally and socially acceptable land use management policies; particular attention is drawn to “zero-burning” land clearing techniques. Fire research at national and regional levels needs to be strengthened, to support development of fire policies and fire management capabilities, especially related to investigations into socio-economic and cultural aspects of fire outbreaks. Fire research is needed into a number of topics including:

* The development of dedicated space-borne remote sensing technologies for improving decision support in fire management, including technologies for fire detection and early warning;
* Post-fire recovery techniques, fire effects and ecosystem recovery processes;
* The impact of climate change on fire regimes and fire severity;
* The implementation of a global vegetation fire inventory, and the implementation of a center to monitor, archive, and disseminate global fire information, as well as forecast fire and related hazards;
* Special attention to fire-generated radioactive emissions;
* The development of source information for fires in different ecosystems;
* Physical/chemical factors contributing to the changes that occur over time and space during transport;
* Compilation of information pertaining to levels of exposure and fire activity, in conjunction with past fire and smoke episodes;
* Mitigation approaches;
* Health impacts of air pollution due to biomass burning within the general population.

Conclusions

According to the WHO-UNEP-WMO *Health Guidelines* the situation with respect to the occurrence of forest fires, the potential health effects of smoke from vegetation fires, their mitigation and early warning of the populations are to be summarised as follows. Vegetation fires, particularly uncontrolled ones, are a substantial source of air pollution in urban and rural areas. They add to urban and indoor air pollution (from domestic wood and coal burning for cooking and heating). Inhaling the smoke from vegetation fires enhances the risk of acute respiratory infections in childhood, a major killer of young children in developing countries. The health of women is also particularly affected as women are already exposed to high levels of air pollution in the home environment and they suffer more from this additional burden of pollution caused by vegetation fires. Land clearing practices through vegetation fires add to rapid environmental changes and degradation. The use of forest fires for land clearing is also a consequence of poverty. Combating poverty is the central challenge to ensure sustainable development and healthy living conditions. As health is so dependent on environment, there is a need to address the global dimensions of the problem of forest fires.

Vegetation fire events are an important public health issue since they involve major risks for the health of the people and the environment. Because of their nation- and region-wide effects, vegetation fire events can evolve from a sort of “natural” disaster into a more complex emergency because of population movement, and through their effects on the economy and security of the affected countries. In view of the character of a potentially complex emergency from vegetation fire events, the development of an early warning system for such events involves the collaboration of multidisciplinary groups of scientists, technicians and administrators. The Health guidelines provide the knowledge for implementing an early warning system to protect human health from the impacts of smoke and haze from vegetation fires and, therefore, help governments to cope with the recurring events.

The *Health Guidelines* are intended to develop the necessary capacity not only at regional and national levels, but also at local levels. In addition, to give WHO's support to the local health, environmental and sustainable development planning efforts being undertaken. The *Health Guidelines* provide the necessary evidence and guidance for strengthening inter-sector action in sustainable development policy and planning. They aso determine best practices, and disseminate such knowledge worldwide. They strengthen the linkages between health, environment and development; and provide ongoing support in the development and implementation of the Regional and National Haze Action Plans, as part of Environmental Action Plans to be integrated into national sustainable development efforts.

The Health Guidelines for Vegetation Fire Events help to ensure that the health components of Agenda 21 of the United Nations Programme of Action, following the Earth Summit in Rio de Janeiro, are adequately addressed.

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Disclaimer

This paper does not reflect the policy of the World Health Organization. The author alone is responsible for the views expressed in this report.

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The Guidelines, the Background Papers and the Teacher's Guide are also available on the internet: http://www.who.int/peh/air/vegetation_fires.htm

By mid of 2000 the set of guideline documents will be available on CD Rom (English, Spanish, French). Requests may be directed to the author of this paper.

The International Strategy for Disaster Reduction (ISDR)
Building on a ten-year Foundation

Background

Just over ten years ago, the General Assembly of the United Nations declared the 1990's as the International Decade for Natural Disaster Reduction (IDNDR). Its mandate was to initiate and marshal wide-ranging international cooperation on a series of action and awareness programmes aimed at reducing the loss of life, property damage and social and economic disruption caused by natural disasters.

The need to take action was clear. For several years, economic losses stemming from natural disasters had been dramatically increasing, thanks to a combination of several global trends, among them:

- climatic changes, leading to an increase in hydrometeorological hazards worldwide;
- demographic shifts, exposing more and more people to natural hazards;
- a substantial increase in the density - and thus the vulnerability - of the built environment; and
- widespread lack of planning and preventative thinking.

Even if natural hazards can never be eliminated, it was obvious that human decisions and actions could play a critical role in preventing natural hazards from becoming future disasters. The mission of the IDNDR was thus to influence these decisions and help create long-term, pro-active disaster prevention strategies. The scope of the challenge was - and remains - enormous, but during its ten-year life, the IDNDR succeeded in coordinating a new, global approach to improving the resiliency of local communities.

The birth of the International Strategy for Disaster Reduction (ISDR)

As its name implied, the IDNDR officially came to an end in 1999. However, during its ten-year span of activities, it achieved such important successes - especially in terms of forging vital links among the political, scientific and technological communities - that the United Nations created a successor body to carry on its work. This new body of coordinated action programmes, with a small secretariat in Geneva, is ISDR.

The ISDR is therefore a new structure, but one which is based on well-established international disaster prevention networks and working methodologies, not to mention the support and legitimacy of the United Nations. For example, because it works through an inter-agency task force comprising United Nations agencies, various actors within civil society and regional representatives, it can call upon resources from an array of partner institutions, among them:

- the UN system itself
- the education and academic communities
- scientific and technical institutions
- private-sector partners with commercial and/or financial interests
- the media

* various NGO's
* an increasingly wide range of professional disciplines

Strength and Experience

Based on its invaluable experience and expertise built up over ten years, particularly in developing countries, the ISDR is extremely well-placed to foster the multi-disciplinary and inter-sectoral relationships necessary to bring about the all-important shift from the mainly reactive mindset of today to the pro-active mindset of tomorrow, where prevention and risk management are paramount. It has already established a global network of public, private and local community partners with whom it is developing risk prevention strategies, integrating them into long-term sustainable development plans.

An Inter-Agency Task Force has also been established, focusing on overall programme priorities, assessing risk, studying options and, together with political leaders, putting workable disaster prevention and management plans into place.

In addition to the input of experts and the cooperation of political decision-makers, public confidence is also crucial if such prevention plans are to be effective. To this end, the ISDR has established active media contacts and important partnerships with members of the education communities, both vital forces in ensuring that public understanding is enhanced and participation is therefore increased in various local endeavors.

Funding for the ISDR comes exclusively from voluntary and purpose-designated contributions.

Working Together

To fulfil the two overall objectives of the ISDR, namely:

* enabling all communities to become resilient to the effects of natural, technological and environmental hazards, reducing the compound risks they pose to social and economic vulnerabilities within modern societies; and
* proceeding from protection against hazards to the management of risk through the integration of risk prevention into sustainable development

To continue the interagency work with regard to the El Niño phenomenon, and the follow up to the early warning initiatives that led to the Potsdam Conference of 1998.

To implement non operational substantive initiatives in line with the endeavors and priorities of the ISDR.

For a true culture of prevention to take root - in many different regions across the globe, and within the context of many different political, economic and social environments - cooperation and coordination are required among a wide variety of actors, each bringing expertise, knowledge or resources to bear on this huge humanitarian challenge.

Recognizing the need for greater coordinated networking, ISDR warmly extends a hand to all organizations with an interest in improving mankind's ability to manage the hazards and risks inherent in our physical environment. Together, it is possible to improve our understanding of the myriad factors which cause natural disasters to happen, and to change the way we deal with them - before they take place.

Updates from the ISDR Geneva (February-March 2000)

ProVention Consortium Inaugural Meeting

The Deputy to the Under Secretary-General for Humanitarian Affairs, Mrs. Carolyn McAskie, and the Director of the Secretariat of the International Strategy for Disaster Reduction (ISDR), Mr. Philippe Boullé, participated in the inaugural meeting of the ProVention Consortium (Consortium on Natural and Technological Catastrophes) in Washington D.C. The event, held from 2 to 4 February 2000 at the World Bank in Washington DC, marked the official launch of the ProVention Consortium, an important institutional development building on the achievements of the IDNDR and seeking to harness the interests and resources of the private and public sectors, the scientific and technological community, international and non-governmental organisations involved in disaster reduction. The effort represents another global partnership commitment dedicated to reducing the risk and impact of disasters on developing countries. Mrs. McAskie addressed the meeting on the subject of

Strategies within the UN to Reduce Disaster Risk and Vulnerability, and outlined the International Strategy for Disaster Reduction as an inclusive multi-disciplinary and inter-sectoral mechanism. Mr. Boullé attended and is also a member of the Steering Committee of the ProVention Consortium.

The main objectives of the ProVentium Consortium are: to promote a culture of safety among developing countries through education and training; to support public policy to reduce the risk of natural and technological disasters within developing countries; to disseminate information about best practices; to develop governments' ability to minimize disasters and to respond effectively; and to forge links between public and private sectors, between the scientific community and policy makers, between donors and victims. In this regard, the ProVentium Consortium represents an important initiative, because it serves as a forum where the mutual interests of the primary constituencies of the World Bank (including the interests of the public and private sectors of industrialized countries), and of the partners of the ISDR (including scientific and technical institutions, elements of civil society and regional organizations of disaster-prone countries) can meet and complement each others' activities and respective emphasis.

ISDR and the International Council for Science

An initial planning meeting of the reconstituted Special Committee for Disaster Reduction of the International Council for Science (ICSU), the successor body of the ICSU Special Committee for the IDNDR, was convened in Paris, France, from 2 to 4 March 2000. This meeting follows on the activities of the earlier ICSU/IDNDR committee highlighted in the ICSU newsletter "Science International" for December 1999, and included the participation of the ISDR Secretariat and key collaborators in disaster reduction strategy for the future from UNESCO, World Meteorological Organization (WMO), the World Institute for Disaster Risk Management, the World Bank's ProVention Consortium, and representatives of scientific, academic, and engineering organizations. The reformulation of the ICSU Committee is taking its lead from the emphasis given by the ISDR to ensure that the future global strategy is indeed both multi-sectoral and inter-disciplinary in nature, transcending specific institutional interests of United Nations organizations to the larger realm of professional engagement in hazards and risk management practice.

The new Chair of the Committee is Mr. Robert Hamilton, previously the Chair of the IDNDR Scientific and Technical Committee. The recently appointed Executive Director of ICSU, Mr. Lawrence Kohler, expressed the view that the increasing requirement of hazard and risk reduction practices around the world offer significant opportunities for scientific and technical abilities to contribute to both policy development and the application of knowledge through the national organizations and the scientific unions that compose the International Council for Science (ICSU). As the subject is one which affects all countries, it is also important to pay particular attention to transmitting this knowledge and experience with the objective of creating enhanced professional abilities required for more effective risk management within disaster-prone developing countries. The first full meeting of the ICSU Special Committee for Disaster Reduction, with its newly inducted members drawn from different professions and regions from around the world, is expected to be held in the next 4-6 weeks.

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ISDR and the International Fire Community
Transition from the IDNDR Programme to the first Biennium of the ISDR

On 11 December 1987 at its 42nd session, the General Assembly of the United Nations designated the 1990's as the International Decade for Natural Disaster Reduction (IDNDR). The basic idea behind this proclamation of the Decade was and still remains to be the unacceptable and rising levels of losses which disasters continue to incur on the one hand, and the existence, on the other hand, of a wealth of scientific and engineering know-how which could be effectively used to reduce losses resulting from disasters.

The UN World Conference on Natural Disaster Reduction which was part of a mid-term review of Decade activities, was held in Yokohama (Japan), 23-27 May 1994. The UN-FAO/ECE/ILO Team of Specialists on Forest Fire used the opportunity to express its views on global fire to the IDNDR. A brief report to the UN World Conference has been published in IFFN No.11.

In 1997 close links were established between the IDNDR Secretariat in Geneva and UN Fire Team through the Fire Ecology Research Group and the Global Fire Monitoring Center. In July 1997 the UN Fire Team was entrusted with the formation of a Working Group "Fire and Related Environmental Hazards" of the IDNDR Early Warning Programme. The recommendations of the report which was submitted to IDNDR in 1997 were incorporated into the Report of the UN Secretary General "Improved effectiveness of early-warning systems with regard to natural and similar disasters". The IDNDR Fire Working Group contributed to the International IDNDR Conference on Early Warning Systems for the Reduction of Natural Disasters.

During the second half of the IDNDR the Fire Working Group activities and the work of the UN-ECE/FAO/ILO Team of Specialists on Forest Fire were closely linked to a series a projects and programmes. The last summary update of joint activities were published in IFFN No. 19. Between 1997 and the end of IDNDR in 1999 the following activities were accomplished:

International Science and Policy Support during the 1997-98 Fire and Smoke Episode

The team supported the governments of the ASEAN region with advice on measures to be taken to mitigate the consequences of the ongoing and to prevent future negative impacts of fire application and land-use fires on the environment, ecosystems and human health. Several conferences and strategic planning meetings were supported, notably:

* UNEP Meeting "Coordination UN Response to Indonesian Fires" (Geneva, 20-21 April 1998)
* Asia-Pacific Regional Workshop on Transboundary Pollution, Germany-Singapore Environmental Technology Agency (Singapore, 27-28 May 1998)
* WMO Workshop on Regional Transboundary Smoke and Haze in South-East Asia (Singapore, 2-5 June 1998)
* WHO Workshop for the preparation of the "Health Guidelines for Vegetation Fire Events" (Lima, Peru, 6-9 October 1998) and production of the guidelines (publ. in Singapore, December 1999)
* International Cross-Sectoral Forum on Forest Fire Management in South East Asia" (Jakarta, Indonesia, 7-8 December 1998) and the World Bank Workshop on Fire Hazards, Transboundary Haze and Sustainable Forestry in East Asia and the Pacific in South East Asia (Surabaya, Indonesia, 9-12 December 1998)

Implications of the 1997-98 Fire Episode: Collaboration with Agencies and Programmes of the UN and other International Organizations

* Establishment of the Global Fire Monitoring Center (Freiburg/Germany, June 1998)
* UNESCO, the World Bank, and the World Conservation Union (IUCN) are official co-sponsors of the Global Fire Monitoring Center (Dezember 1998 - July 1999)
* Support of the FAO Consultation "Public Policies Affecting Forest Fires" (26-28 October 1998) in preparation of the FAO Conference of the Forest Ministers and the "Rome Declaration on Forestry" (9 March 1999)

* Support of the UNESCO Conference Fires in Mediterranean Forests: Prevention, Suppression, Soil Erosion, Reforestation (Athens, Greece, 3-6 February 1999)
* Organization of the international Workshop Fire on Ice (Khabarovsk, Russian Federation, August 1999) addressing the relationship between climate change, permafrost, forest and fire.
* Begin of the revision of the FAO Multilingual Wildland Fire Management Glossary

Final Phase of IDNDR and Transition to the ISDR

* Participation at the final event of the IDNDR, the Programme Forum (Geneva, 5-9 July 1999). Launch of the proposal on the Creation of an Interagency Task Force on Fire (ITFF) under the umbrella of the ISDR and the UN Interagency Task Force.

Support of the Establishment and Member of the World Bank ProVention Consortium

* Preparation of the World Bank ProVention Consortium (Consortium for Natural and Technical Catastrophes), Paris (1-2 June 1999) and Washington (2-4 February 2000). The GFMC is Associate Member of the ProVention Consortium.

Support of the Establishment and Cooperating Institution of the World Institute for Disaster Risk Management (DRM)

* The GFMC and the UN Fire Team supported the launching of the DRM, a joint venture of the Swiss Federal Institutes of Technology, Swiss Re, the World Bank, and Virginia Tech (Alexandria/Washington, 29 February 2000)

Support of the Establishment and Cooperating Institution of the Committee on Earth Observation Satellites (CEOS)

* Ongoing participation in the CEOS Disaster Management Support Group (DMSP) since 1998
* Active participation in establishing the Global Observation of the Forest Cover (GOFC) Fire subgroup (Ispra, Italy, 3-5 November 1999)

Establishment of a Wildfire Subgroup within the UN International Search and Rescue Advisory Group (INSARAG)

* First preparatory meeting at the INSARAG Europe-Africa Conference (Neuhausen/Stuttgart, Germany, 9-11 December 1999)
* Second preparatory meeting of INSARAG Subgroup Wildfire at BALTEX FIRE 2000 (Kuopio, Finland, 5-9 June 2000)
* Preparation of the INSARAG Europe-Africa Conference (Tunisia, 16-19 November 2000)

Other new Initiatives by the UNECE/IDNDR Fire Group

The Baltic Focus

* First Baltic Conference on Forest Fires (Radom-Katowice, Poland, 5-8 May 1998)

- Baltic Exercise for Fire Information and Resources Exchange 2000 - BALTEX FIRE 2000 (Kuopio, Finland, 5-9 June 2000)

International Coordination and Backstopping Support in a Large Fire Emergency

- For the first time in history it was possible to organize and dispatch a multinational fire emergency team to repsond to a wildfire situation. In February-March 2000 a coalition of fire scientists and fire management specialists from the GFMC, Germany, South Africa, the U.S.A. supported Ethiopia in addressing a large wildfire situation (see Editorial of the issue No. 22 of IFFN). The situation is ongoing at the time of compiling this report (see GFMC website address given below).

References

Documents on these activities are published on the Global Fire Monitoring Center (GFMC) website at: < http://www.uni-freiburg.de/fireglobe >

RECENT PUBLICATIONS

Rainforest Ecosystems of East Kalimantan

Since the late 1960s the Indonesian state of East Kalimantan has witnessed a marked increase in the impact of human activities - chiefly commercial logging and agricultural exploitation. Located on the island of Borneo, East Kalimantan also was subjected to prolonged droughts and extensive wildfires in 1982-83 and 1997-98 that were linked to the EI Niño-Southern Oscillation (ENSO) phenomenon. The changes in the rainforest ecosystem in East Kalimantan during this 15-year cycle of severe ENSO events are the subject of this book. With an eye toward development of rehabilitation techniques for sustainable forest management, the authors examine possible interactive effects of drought, fire, and human impacts on the flora and fauna of the area. The chapters covering fire occurrence and effects are:

- T.Mori: Effects of droughts and forest fires on Dipterocarp forests in East Kalimantan
- P.Matius et al.: Droughts and fire impacts on forest ecosystems
- T.Toma et al.: Dynamics of burned lowland Dipterocarp forest stands in Bukit Soeharto, East Kalimantan
- Y.Kiyono and Hastaniah: Flowering and fruiting phenologies of Dipterocarps in a rainforest in Bukit Soeharto, East Kalimantan
- H.Makihara et al.: The effect of drought and fires on Coleopteran insects in lowland Dipterocarp forests in Bukit Soeharto, East Kalimantan

Additional chapters deal with the impact of traditional slash-and-burn agriculture systems. This book, together with the proceedings of the 3rd International Symposium on Asian Tropical Forest Management (see below) provide the latest state-of-the-art knowledge on fire in tropical lowland rainforest ecosystems of the region.

Guhardja, E., M.Fatawi, M.Sutisna, T.Mori, and S.Ohta (eds.) 2000. Rainforest ecosystems of East Kalimantan. Ecological Studies 140, Springer Verlag, Tokyo, Berlin, Heidelberg, 330 p. (ISBN 4-431-70272-5)

Impacts of Fire and Human Activities on Forest Ecosystems in the Tropics
3rd International Symposium on Asian Tropical Forest Management

Tropical forests are a favourable environment for much of the Earth's plant and animal life, and contribute to stabilizing the global environment. However, despite repeated warnings in recent decades, the tropical forests continue to shrink and suffer further degradation each year. There are two major causes: forest fires and human activity, including unsuitable forestry practices. Forest fires and human activity affect not only the biota of the forest, but also the neighboring aquatic, terrestrial, and atmospheric environments, and it will therefore require the cooperation of many academic disciplines to develop new methods of forest management. Exchange of information on these topics is vital.

This volume is a compilation of the papers presented at the 3rd International Symposium on Asian Tropical Forest Management "Impacts of Fire and Human Activities on Forest Ecosystems in the Tropics". The symposium was held by The Tropical Rain Forest Research Center of Mulawarman University (PUSREHUT-UNMUL) in Samarinda, East Kalimantan, Indonesia, 20-23 September 1999 as an activity of a cooperative research project between Indonesia and Japan. The symposium was supported by the Indonesian Ministry of Education and Culture and by the Japan International Cooperation Agency (JICA). The Fire Ecology Research Group of the Max Planck Institute for Chemistry, Freiburg University, and the Rehabilitation Research Group at the Center for International Forestry Research (CIFOR) kindly collaborated in preparing and conducting the symposium.

Suhartoyo, H. and T. Toma (eds.) 1999. Impacts of fire and human activities on forest ecosystems in the tropics. Proc. Third International Symposium of Tropical Forest Management, Samarinda, 20-23 September 1999. Tropical Forest Research Center Mulawarman University and Japan International Cooperation Agency, Samarinda, Indonesia. PUSREHUT Spec. Pub. No. 8, 630 p.

Fire, Climate Change, and Carbon Cycling in the Boreal Forest

In boreal forests, which contain large amounts of the world's terrestrial organic carbon, fire is a natural and fundamental disturbance regime essential in controlling many ecosystem processes. As a result of predicted climate change in the future, the fire regime and, consequently, the forest cover and carbon storage of boreal regions will undergo dramatic alterations. This volume discusses the direct and indirect mechanisms by which fire and climate interact to influence carbon cycling in North American boreal forests. The first section summarizes the information needed to understand and to manage fire's effects on the ecology of boreal forests and its influence on global climate-change issues. Following chapters discuss in detail the role of fire in the ecology of boreal forests. Subsequent sections present data sets on fire and the distribution of carbon, discuss the use of satellite imagery in monitoring these regions, and discuss approaches to modeling the relevant processes. The book offers the following new results:

* improved estimates of carbon released during fires at a variety of scales, from individual sites to the entire North American boreal forest region
* direct evidence of enhanced soil respiration after fire in Alaskan boreal forests
* studies of the influence of fire on long-term forest-succession patterns
* modeling results of the effects of climate warming on the fire regime
* examples of the use of satellite imagery to monitor surface characteristics important in carbon cycling
* modeling results of how climate change will interact with the fire regime to influence carbon storage

Perspectives on Eurasian and Russian boreal forest fire management policies and research are also included.

Kasischke, E.S., and B.J.Stocks (eds.) 2000. Fire, Climate Change, and Carbon Cycling in the Boreal Forest. Ecological Studies 138, Springer Verlag, New York, Berlin, Heidelberg, 461 p. (ISBN 0-387-98890-4)

Flames in the Rain Forest:
Origins, Impacts and Alternatives to Amazonian Fires

This book is the first comprehensive analysis of fire and its new, disturbing role in the Amazon. The book builds on a 1996 study commissioned by the World Bank that examined the causes of increasing forest clearing and fires at five sites along the Amazon region's arc of deforestation. Written by a team of scientists based at the Woods Hole Research Center (WHRC) and the Instituto de Pesquisa Ambiental da Amazônia (IPAM), and with the collaboration of researchers from diverse institutions and disciplines, this book examines in detail the origins and impacts of Amazonian fires. Practiced by indigenous peoples during millennia fire is an ancient component of the regional landscape. Until recently, its impacts were generally localized. Today, however, fire affects all major ecosystems in the Amazon and releases more than 4% of the total carbon entering the atmosphere worldwide each year.

One of the book's most disturbing findings involves the impacts of so-called forest surface fires such as those that struck Roraima. At first glance, these impacts appear to be small. Surface fires are usually confined to the forest floor, where they consume organic material and underbrush. Yet even such low-intensity fires damage the bark of rainforest trees, which slowly die during the following year. This slow death builds up substantial amounts of fuel on the forest floor, and the gradual open fires during the following year's dry season. These findings suggest that the Roraima fires could be far worse in 1999.

In addition to analyzing the origins and impacts of Amazonian fires, the book explores alternatives that could enhance fire prevention and control. Based on a synthesis of available data on rainfall, soil and land-use practices, the authors present the first predictive model of forest fires in the Amazon. The model, which was used in preparing a World Bank emergency project for fire prevention and control in the region, provided a sobering outlook for the latter half of 1998: about 200,000 km^2 of Amazon forest were under extreme threat of burning. The data used to construct this model were admittedly deficient. For example, the Brazilian Amazon contains 60 weather stations, compared to over 1,000 in the continental United States. With improved data collection, modeling could provide a powerful tool for fire prevention and control in the Amazon.

According to the authors, the key challenge confronting policy alternatives is that many of the benefits of fire prevention and control such as reduced emissions of greenhouse gases, protection of biodiversity, decreased flooding and erosion, and improved air quality-accrue to society as a whole, while the costs are borne entirely by individual landholders. Through enforcement of sensible policies and judicious use of economic incentives, a more balanced distribution of costs and benefits can be achieved. Finally, the authors conclude that Amazonian fires can no longer be treated only during "emergency" years, nor can they be effectively controlled by brigades of publicly financed fire fighters. Instead, fires must now be viewed as an integral part of the Amazonian landscape, and strategies for combating them must begin with the region's local communities - where creative solutions are already being tested.

Nepstad, D.C., A. Moreira, and A..A.Alencar.1999. Flames in the Rain Forest: Origins, Impacts and Alternatives to Amazonian Fires. The Pilot Program to Conserve the Brazilian Rain Forest, Brazilia, Brazil. 190p.

O Megaincêndio do Século - 1998
<The Wildfire of the Century>

This book describes one of the most severe environmental destructions, in a region of Brazil which normally is not subjected to large seasonal wildfires. What happened in the State of *Roraima* in March 1998 was caused primarily by the intense dryness of the region, a consequence of the El Niño-Southern Oscillation (ENSO) phenomenon which caused climatic perturbations all over the globe. In addition, farmers and land owners were not careful enough and continued to practice traditional burnings after the clearing of forests, in spite of the obvious high wildfire risk and the prohibitions by the Federal Government. It is this situation that is described in this book.

The book starts with a general description of how most of the wildfires get started in Brazil. It also highlights the impact on the environment and the atmosphere. It is important to realize that *Roraima is* located outside of the area of Brazil where vegetation fires occur regularly - the *cerrado* (savanna) region in the center of the country. The 1998 wildfires of *Roraim* were a big surprise and a great exception. The geographic region of *Roraima is* described, calling attention to the fact that it is almost entirely situated in the Northern Hemisphere. Chapter 3 describes the meteorology of the region, including information on the climatic phenomenon El Niño. Chapter 4 describes the evolution of the fire event during its most critical phase. How it started and developed during the month of March. The physical damage caused by the wildfire is described, as well as the technical assessment of the size of the burnt area, and in Chapter 6 the heroes and villains of the episode are mentioned. The end of the huge fire is described in Chapter 7. The fire was extinguished not by the firemen, who despite their excellent performance were helpless in view of the magnitude of the fire disaster, but by the natural rains that started to fall by the end of March and beginning of April.

Kirchhoff, V.W.J., and P.A.S. Escada. 1998. O Megaincêndio do Século - 1998. The Wildfire of the Century. TRANSTEC Editorial, Sao José dos Campos, 86 pp. (ISBN 85-85417)

Australian Rainforests - Islands of Green in a Land of Fire

Why do Australian rainforests occur as islands within the vast tracts of Eucalyptus? Why is fire a critical ecological factor in every Australian landscape? What were the consequences of the ice-age colonists' use of fire? In this original and challenging book, David Bowman critically examines all hypotheses that have been advanced to answer these questions. He demonstrates that fire is the most critical factor in controlling the distribution of rainforest throughout Australia. Furthermore, while Aboriginal people used fire to skilfully manage and preserve habitats he concludes that they did not significantly influence the evolution of Australia's unique flora and fauna.

This book is the first comprehensive overview of the diverse literature that attempts to solve the puzzle of the archipelago of rainforest habitats in Australia. It is essential reading for all ecologists, foresters, conservation biologists, and others interested in the biogeography and ecology of Australian rainforests.

Bowman, D.M.J.S. 2000. Australian rainforests - Islands of green in a land of fire. Cambridge University Press. Cambridge, UK, 345 p. (ISBN 0 521 46568 0)

Incendios Históricos. Una Aproximación Multi-Disciplinar
<Historical Forest fires. A Multidisciplinary Approach>

The investigation of historical forests fire is still very little developed in Spain, doubtless by short of responsible datums and extensive statistic series that allow to analyze the phenomenom of forests fire with rigour. In spite of this, every time is higher the importance that it is recognized to the fire in the process of transformation of the rural landscape in Spain during the last centuries.

This book, consequence of a Seminar developed in the International University of Andalusia, mentioned in this Review (International Forest Fire News No. 18), pretends to contribute to the historical knowledge of the forest fire through a multidisciplinary and pluri-regional approach to this phenomenon. The contributions come from Geography, History and Forest Engineering. Respect to regional analysis, it is analyzed Galicia, Andalusia, Mediterranean Regions and Castilla from Spain and Italy as a whole.

The book is completed with another two works. In one of them, Ricardo Vélez studies the evolution of the Spanish policy of fight against the forest fire in the last two centuries, and in the other Stephen Pyne explains the "triangle of fire".

For more information contact:

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Araque Jiménez, E.(comp.) 1999. Incendios históricos. Una aproximación multi-disciplinar <Historical forest fires. A multidisciplinary approach>. International University of Baezas´ Publications, Baeza, Spain (ISNBN 84-922285-3-9).

Protection contre les incendies de forêt: principes et methodes d'action
<Forest Fire Protection: Principles and Methods>

In its Mediterranean Agronomic Institute, Zaragoza (Spain), the *Centre d'Hautes Études Agronomiques Mediterranéens* (CIHEAM) periodically organizes international courses on forest fires for the training of technicians from the Mediterranean Basin. These courses are conducted in collaboration with the General Directorate for Nature Conservation and the FAO Committee *Silva Mediterranea.* This publication presents the core contents of these courses, prepared by the responsible expert, Mr. Ricardo Vélez. The titles of his chapters are (1) Forest fires in the Mediterranean region, (2) Fire prevention, (3) Active fire suppression, (4) Evaluation of losses, and (5) Protection policies against wildfires. In the annexes are included: One example of a national fire protection plan, two diskettes with the BEHAVE programme (for the prediction of fire behaviour) and the PYROSTAT programme for the creation of a forest fire database. In addition a photographic guide of fuel models in a region of Spain is provided. The text is provided in French to be utilized by frankophone technicians attending the courses.

Ricardo Vélez. 1999. Protection contre les incendies de forêt: principes et methodes d'action. Centre d'Hautes Etudes Agronomiques Mediterranéens (CIHEAM), Zaragoza. Options Mediterranéennes, Serie B: Études et Recherches No. 26, 118 p.

MEETINGS PLANNED FOR 2000

RUSSIAN FEDERATION

International Conference "Conjugate Problems of Mechanics and Ecology"
4-9 July 2000, Tomsk

The conference is organized by Tomsk State University, the Centre on Reactive Media Mechanics and Ecology, the Naval Surface Warfare Center, the Novosibirsk State University of Architecture and Civil Engineering, the Siberian Branch of the Council on Combustion of the Russian Academy of Sciences, and the Tomsk Society of Mechanics-scientists and Thermophysicists. The conference will elaborate on the following topics:

- Natural and technogenic catastrophes
- Understanding of accidental explosions in nature and industry
- Predicting motion and distribution of dangerous celestial natural and man-made dangerous objects
- The problem of celestial bodies entering the dense layers of the atmosphere and the methods of changing a flight trajectory
- Mechanisms of thermochemical destruction of celestial bodies in the atmosphere of the planets and the Earth
- Catastrophic floods and ecology of existing water-development works

* Principles, methods and technical facilities of the ecological monitoring of natural complexes and geotechnical systems
* Physico-chemical foundations and control methods of contaminating media and their regeneration
* Forest fires: initiation, spread and ecological impacts
* Methodology of risk-analysis of new technologies for improving the ecological production safety
* The physical and mechanical properties of aerosols and dispersed fluids
* Computer programmes and methods for predicting ecological impacts of catastrophes
* Higher ecological education and social monitoring
* Ecological and social aspects of the collision catastrophe

The working languages of the conference are Russian and English. The Conference program is as follows:

* "Round table" discussions of different aspects of the conference
* Sale-exhibition of computer programs and methods

Sponsors are invited for mutual cooperation and participation in the conference. The program will include the names of the participants and organizations that will support the conference.

To be registered, conference participants are requested to send their preregistration forms to the organizing committee, together with the application and abstracts for foreigners not later than 30 May 2000.

A registration fee of $US400 will be charged for foreign participants. The registration fee will cover the costs of hotel accommodation, all meals, and the conference book proceedings. After the conference (9-10 July 2000) it is planned to conduct aforest fire (surface fire) experiment to investigate fire behaviour and spread and the application of new methods of fighting them. The design of scientific experiments can be expanded in accordance with the interests of new participants.

There will be a special cultural program for the participants of the conference, including excursions over the historical places of Tomsk.

Please request your pre-registration form through the following contact addresses of the Organizing Committee:

Prof. Anatoly Mikhaylovich Grishin
Conference Chair
Centre on Reactive Media Mechanics and Ecology
Tomsk State University
36 Lenin avenue
RUS - Tomsk 634050

Fax: ++7-3822-42-61-95
Tel: ++7-3822-42-61-69
e-mail: fire@fire.tsu.tomsk.su

Dr. Ruth M. Doherty
Conference Co-Chair
Code 90B
Naval Surface Warfare Center
101 Strauss Avenue
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MALAYSIA

XXI IUFRO World Congress "Forests and Society: The Role of Research"
7-12 August 2000, Kuala Lumpur

The next IUFRO World Congress will be held in Malaysia, 7-12 August, 2000. The Congress title is "Forests and Society: The Role of Research". The responsibility for its scientific programme lies with the IUFRO Executive Board, which has established a Congress Scientific Committee (CSC) for this purpose. The practical organisation is in hands of the Congress Organizing Committee (COC) in Malaysia.

A Sub-Plenary "Sustainable Management of Natural Resources: Fire and Forests" will be organized by the IUFRO Fire Group 8.05 (see contact address below) on 8 August 2000. For the detailed poster and oral presentations programme on forest fire: see http://iufro.boku.ac.at/iufro/congress/csc/.

Contact address:

Congress Scientific Committee
IUFRO Secretariat
c/o Federal Forest Research Centre
Seckendorff-Gudent-Weg 8
1131 Vienna
AUSTRIA

Fax: ++43-1-8779355
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General information on the XXI IUFRO World Congress: http://iufro.boku.ac.at/iufro/congress

The congress information package is available on: http://iufro.boku.ac.at/iufro/congress/cip-98.pdf (Acrobat Reader required).

IUFRO Group 8.05 Contacts: http://iufro.boku.ac.at/iufro/iufronet/d8/hp80500.htm

IUFRO XXI World Congress: Sessions of Group 8.05 Forest Fire Research

The programme of scientific meetings of IUFRO Unit 8.05.00 Forest Fire Research is given below (state: 19 October 1999).

Updated programme information is available on-line at: http://iufro.boku.ac.at/iufro/congress/csc/

8 August 1999: Sub-Plenary "Sustainable management of natural resources: Fire and forests"

1. Johann G.Goldammer. The fire and smoke episode of 1997-98 in South East Asia: implications on regional and global fire research programmes.
2. Adriana G. Moreira and Daniel C. Nepstad. Forest fires in tropical America : challenges for research.
3. Brian J. Stocks and Susan G. Conard. Forest fire research in north America and Russia. Past accomplishments and future trends.
4. Ertugrul Bilgili and Johann G.Goldammer. Fire in the Mediterranean basin: towards an interdisciplinary science programme.

Organisers: Johann G. Goldammer and Brian J. Stocks

Posters "Fire weather and behaviour"

1. Bulent Saglam, Ertugrul Bilgili. Fire occurrence in relation to weather conditions
2. Ronaldo Viana Soares. Performance of the Monte Alegre formula on fire danger evaluation in different regions of Brazil
3. Shoji Inoue. An analysis of forest fire behaviour based on estimation of wind direction and wind Velocity at the time of the fire
4. A.P.Sapozhnikov. About necessity of new approach to pyrological estimation of forests
5. A.V.Volokitina, L.Ph.Nozhenkova, M.A.Sofronov, D.I.Nazimova. Prognosis of emergency situations under wildland fires

Posters "Fire effects, ecology and country profiles"

6. K.Owusu-Afriyie et al. Seedling survival, mortality and regeneration after fire in a tropical high forest in Ghana
7. Ranjith B. Mapa. Effect of fire on soil properties in pine and natural forest in Sri Lanka
8. George Mathew, P.Rugmini, C.F.Binoy. Impact of fire on forest insect species diversity. A study in the Silent Valley
9. Andre M. Tandjiekpon. Influence des feux de brousse sur la dynamique des forêts seches. Cas des formations forestièresdegradées du Nord-Benin
10. H.H.Liwangsa et al. Forest plantation fire. The SAFODA experience (Sabah Forestry Development Authority)
11. Ronaldo Viana Soares. Wildfire occurrence in a forest district and other Brazilian protected areas
12. Daniel Otu. Natural regeneration of Tectona grandis and Gmelina arborea after fire in Ikrogon Forest reserve, Cross River State, Nigeria
13. Yamaguchi Tsunashi, Tsuyuki Satoshi, H. Siswanto, and Y.Ruslim. Assessment of forest fire impacts in East Kalimantan using satellite remotely sensed data
14. Angelo M. Carvalho Oliveira, Jaime S. Luis. Growth and development of a maritime pine stand after fire

8 August 2000: Session Forest Fires in Southeast Asia (I)

1. M.Hasmadi Ismail, Kamaruzaman Jusoff. Forest fire. Monitoring and management using satellite remote sensing data (Malaysia)
2. Yousif Ali Hussin, Heri Sunuprapto. Forest fire monitoring and damage assessment using remotely sensed data and GIS. A case study from East Kalimantan, Indonesia
3. Samsudin Musa, S.Ibrahim, I.Harun, R.Barizan, A.Hassan, W.M.Shukri, I.Parian. Haze forest fires and land-use practices. An assessment (Malaysia)
4. Gusti Z.Anshari. A study of fire history and the vegetation change of a lowland, peat swamp forest in the Lake Sentarum wildlife reserve, West Kalimantan, Indonesia
5. Bambang Hero Saharjo. Fire research and society interest as limiting factors in minimizing large forest fires burn in Indonesia

Organisers: Brian Stocks and Johann G. Goldammer

9 August 2000: Forest Fires in Southeast Asia (II) and in Other Tropical Regions

1. Eulis Retnowati. Managing smoke in forestry and crop estate sector in Indonesia
2. A.R.R. Menon and K.J. Martin Lowel. Fire-related regeneration dynamics in the moist deciduous forests of Western Ghats. A case study
3. Paul Kankan. Sustainable management of natural resources: Forest and fire (Ghana)
4. Marcos Pedro Ramos Rodriguez, Ronaldo Viana Soares. History of forest fires in the province of Pinar del Rio, Cuba
5. Lailan Syaufina. The interest of students on forest fire studies (Indonesia)

Organisers: Brian Stocks and Johann G. Goldammer

11 August 2000: Forest Fires in Temperate and Boreal Forests. Scientific Session and Panel Discussion

1. Susan G. Conard, Brian J. Stocks. Fire in temperate and boreal forests. Global change, fire management, and sustainability
2. E.S. Arzybashev. Forest fires in Russia
3. Panel Discussion

Organisers: Brian Stocks and Johann G. Goldammer

FRANCE

Euromediterranean Forest Fire Meetings of the Millenium & Forest Fire Research Special Session
25 - 27 October 2000, Hyères les Palmiers

This Symposium is organized by ENTENTE INTERDEPARTEMENTALE (En vue de la Protection de la Forêt et de l'Environnement contre l'Incendie) Located in Valabre (Bouches du Rhône – France).

The aim of the *Meetings* is to bring together all people concerned by forest firefighting in countries of the Euromediterranean Region, as well as representatives of countries affected by the same risk all over the world.

The ***Meetings*** are mainly addressing:

∗ Decision makers concerning risk management or operational command (elected representatives, public authorities, heads of departments, heads of units…)
∗ Researchers who are expected to propose solutions to meet the operational needs
∗ All people directly or indirectly involved in prevention and suppression activities (firefighters, foresters, aircraft pilots, government officials and public services, members of associations…)
∗ Manufacturers who intend to present any new achievement related to forest and environment fire protection

The Objective is:

∗ from exchanges of views and experience
∗ through the information collected
  - to BLAZE A TRAIL for the decision makers and the operational people to find practical solutions to deal with difficulties in the field, as far as strategy, technology and tools are concerned ;
  - to assess ways and requirements for defining a COHERENT STRATEGY to be shared by all the Mediterranean countries affected by wildfires.

For this purpose, two themes will be developed :

∗ Innovative Processes
∗ Fires on the Urban Interface

The Innovative Processes

Imagination and innovation are the main successful tools to cope with the evolving hazardous aspect of the fire. Innovation is a key element in the improvement of the risk management on field. These innovative processes concern the new strategy, the new methods, the new technologies and the new tools that could influence positively prevention and suppression activities. They are subjects to be discussed, as well as their effects on the existing organizations. Results of such innovative processes will have to be evaluated, especially when we consider constraints of energy and cost. During these *Meetings*, further more than the state of affairs, prior specific topics will have to be targeted and issues will have to be considered in a concise practical manner. In this scope, the following items will be developed:

* identification of « hazard » and risk evaluation
* data processing
* crisis management
* experience feedback
* training of people in charge of the crisis
* concept of innovation : from the idea through its fullfilment

Fires on the Urban Interface

Special attention will be paid to this topic. In most of Mediterranean countries, as in other part of the world, we have to cope with this type of situation. Development of fires on the urban/wildland interface leads to severe effects for the protection of life and property, especially in highly tourist zones. It is a sensitive issue that requires responses regarding the choice of strategy, the security of population, the operational effectiveness and the occupation of the concerned areas. So, it would be interesting to list the innovative responses to deal with this particular risk Various fields will be examined such as self-defence, use of specific fighting resources, or fire protection planning.

The format of the MEETINGS will include:

* A symposium with
    - formal sessions on subjects related to the two main themes
    - workshops to enhance knowledge of the topic
* An exhibition for manufacturers and for any private or public organizations. Opportunities to present their know-how and to display technics and new tools
* areas set for communication purpose (poster presentation, cybercafé…)

What to know about the event:

* more than twenty Euromediterranean countries will attend the meeting
* several hundred participants, researchers and fire experts, are expected
* a hundred exhibition stands have been designed
* this Symposium is being organized under the auspices of the most representative International and European institutions.
* The national Ministries dealing with forest and environment fire protection, are actively participating in the Symposium.
* individual or collective contributions are welcome
* tourist activities are planned for accompanying persons

Forest Fire Research Special Session 2000

On 24 October 2000, a day before the Euromediterranean Wildfire Meetings, the *Centre d'Essais et de Recherche de l'Entente* (CEREN) will organize a Research Special Session in collaboration with the European Commission – DG XII.

The main objective of this session is to present the State-of-the-Art of the forest fire research in various countries in the Mediterranean area and all over the world. Co-ordinators of EU-funded projects will give a presentation of completed or ongoing projects. The second and not least objective is to provide the participants with an opportunity to share expertise and discuss appropriate work to be developed by the researchers to meet the fire fighters requirements.

The programme of the MEETINGS and registration details will be given before 1 April 2000.

Venue: FORUM CASINO in HYÈRES LES PALMIERS

Hyères les Palmiers is a tourist city located in the Var Department (Provence Alpes Côte d'Azur Region / South of France), and is well connected by plane, train and highway . A special arrangement is made with the Secretariat of FORUM CASINO to accomodate participants, and to deal with registration and transportation.

Any further information is available at:

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Comité d'Organisation des Rencontres
Euroméditerranéennes Feux de Forêt 2000
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