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# MULTIPLE-USE FOREST MANAGEMENT

# THE PHILIPPINES

## FIRE MANAGEMENT

UNITED NATIONS DEVELOPMENT PROGRAMME

FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS , ROME 1985

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# MULTIPLE-USE FOREST MANAGEMENT

# T H E  P H I L I P P I N E S

## FIRE MANAGEMENT

Report prepared for
the Government of the Philippines
by
the Food and Agriculture Organization of the United Nations
acting as executing agency for
the United Nations Development Programme

based on the work of

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Forest Management Consultant

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## ABSTRACT

Within the mountainous pine forests of the Philippines frequent man-caused wildfires are resulting in deterioration of the vegetation, soil degradation, erosion and the predisposition of pines to bark beetle infestation. The fires lead to an overall selection of fire-tolerant plant species and are the main impediment to the reforestation of grasslands, both in upland and lowland areas.

The evaluation of former UNDP/FAO assisted projects on Multiple-use Forest Management pointed out that the most critical factor of all - fire prevention and control - had greatly been neglected during the past. Therefore the Multiple-use Forest Management Project was rephased into 1984 by providing a consultancy in fire management to support the national Fire Control Programme.

The report shows that the Bureau of Forest Development has put a lot of efforts into the planning and organization of forest fire control. Despite these improvements, the implementation of the programme is stagnating due to lack of adequate funding for procuring equipment and carrying out fire prevention measures.

Forest fire research as a basic component of the ecological, technical and socio-economical aspects in the fire management planning has not been subsidized during the past.

Relying on investigations and experiments carried out during the project, the report emphasizes the need of strengthening fire research to obtain detailed informations on the effects of both wildfires and prescribed fires. It also recommends to procure the most urgently needed appropriate fire fighting equipment and personnel safety outfit. A follow-up programme to provide further assistance is highly recommended.

The Food and Agriculture Organization is greatly indebted to all those who assisted in the implementation of the project by providing information, advice and facilities.

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# LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| ASEAN | - | Association of South East Asian Nations |
| BFD | - | Bureau of Forest Development |
| CSIRO | - | Commonwealth Scientific and Industrial Research Organization |
| ECE | - | Economy Commission for Europe |
| FCC | - | Fire Control Center |
| FORI | - | Forest Research Institute |
| ICONA | - | Instituto Nacional para la Conservacion de la Naturaleza (Ministerio de Agricultura, Spain) |
| IUFRO | - | International Union of Forestry Research Organizations |
| MAF | - | Ministry of Agriculture and Food |
| MNR | - | Ministry of Natural Resources |
| MUFM | - | Multiple-use Forest Management |
| NEDA | - | National Economic and Development Authority |
| NRD | - | Natural Resources District |
| PAF | - | Philippine Air Force |
| TCP | - | FAO Technical Cooperation Programme |
| UP | - | University of the Philippines |

# GLOSSARY

| | | |
|---|---|---|
| AERIAL FUELS | - | The standing and supported forest combustibles not in direct contact with the ground and consisting mainly of foliage, twigs, branches, stems and vines. |
| CONTROL LINE | - | A comprehensive term for all the constructed or natural fire barriers and treated fire edges used to control a fire. |
| DISPATCHER | - | A person employed to receive reports of discovery and status of fires, confirm their location, take action promptly to provide the firefighters and equipment likely to be needed for control in first attack, and send them to the proper place, and to support them as needed. |
| DRAPED FUELS | - | Needles, leaves and twigs that have fallen from tree branches and have lodged on lower branches or brush. A part of aerial fuels. |
| DRIP TORCH | - | A hand-held apparatus for igniting prescribed fires or backfires by dripping flaming fuel on the material to be burned. |
| FIREBREAK | - | Any natural or constructed discontinuity in a fuelbed utilized to segregate, stop and control the spread of fire or to provide a control line from which to suppress a fire. |
| FIRE CLIMAX | - | A plant community maintained by regular fires. |
| FIRE DANGER RATING | - | A fire management system that integrates the effects of selected fire danger factors into one or more qualitative or numerical indices of current protection needs. |

| | | |
|---|---|---|
| FIRE LINE | - | A loose term for any cleared strip used in control of a fire. |
| FIRE MANAGEMENT | - | All activities required for the protection of burnable forest values from fire and the use of fire to meet land management goals and objectives. |
| FUELBREAK | - | Generally wide (20-300 m) strips of land on which the native vegetation has been permanently modified so that fires burning into them can more readily controlled. Fuelbreaks have the advantages of preventing erosion, offering a safe place for firefighter to work, low maintenance and a pleasing appearance. |
| FUEL MANAGEMENT | - | The act of practice of controlling the flammability and reducing the resistance to control of forest fuels through mechanical, chemical, biological or manual means, or by fire, in support of land management objectives. |
| GREENBELT | - | An irrigated, landscaped, and regularly maintained fuelbreak, usually put to some additional use. |
| MUTUAL THREAT ZONE | - | A geographical area between two or more jurisdictions into which those agencies would respond to initial attack. |
| PREATTACK PLANNING | - | Within designated blocks of land, planning the locations of fire lines, base camps, water supply sources, helispots, etc; planning transportation systems, probable rates of travel, and constraints of travel on various types of attack units; and determining what types of attack units likely would be needed to construct particular fire lines, their probable rate of line construction, topographic constraints of line construction, etc. |

| | | |
|---|---|---|
| PRESCRIBED BURNING | - | Controlled application of fire to wildland fuels in either their natural or modified state, under specific environmental conditions which allow the fire to be confined to a predetermined area and at the same time to produce the intensity of heat and rate of spread required to attain planned resource management objectives. |
| VALUES-AT-RISK | - | Any or all of the natural resources or improvements which may be jeopardized if a fire occurs. |
| WILDFIRE | - | Any fire occuring on wildland except a fire under prescription. |

The terms of this glossary correspond to the draft Wildland Fire Management Terminology (source document for the english language version of a multilingual fire terminology) being prepared for FAO publication (Lyon, 1984).

# 1. INTRODUCTION

## 1.1 PROJECT BACKGROUND

Multiple-use forest management (MUFM) is the coordinated management of all the various resources of the forests and forest lands, so that they are used in the combination that best contributes to the long-term socio-economic development of the country, without impairing the productive capacity of the lands.

The need for improved and better coordinated forest management in the Philippines was realized during the nineteen-sixties, when it became apparent that the forests were being seriously depleted by over-exploitation of timber, shifting cultivation, fire and other harmful influences. UNDP/FAO was therefore requested to provide forestry assistance. Project PHI 65/5/6 (Demonstration and Training in Forest, Forest Range and Watershed Management) was operational from 1966 to 1970. A further UNDP/FAO project PHI 72/006 (Training and Research in Multiple-use Forest Management) functioned from 1973 until 1978. In addition to this, project PHI 77/011 provided further assistance in developing organizational structure and procedures for planning and implementing MUFM on national forest lands; it was operational between 1978 and 1983.

Both the PHI 77/011 Terminal Report (FAO, 1983a) and the Evaluation Report (FAO, 1983b) recognized that fires are the major cause of the forest soil degradation and erosion as well as the predisposition of pines to infestation by bark beetles. The findings stated that integrated fire management aspects as part of MUFM had greatly been neglected during the past.

Therefore both reports emphasized to give absolute priority to the protection of forests against wildfires. In this regard, the Evaluation Report recommended that a foreign-assisted fire protection specialist should be recruited for a minimum of 18 months; it also stated that associated consultancies and financing for equipment purchases might subsequently be required.

The Bureau of Forest Development (BFD) also recognized the necessity of strengthened forest fire prevention and control by setting up a Five Year Fire Control Program (BFD, 1981); it was intended to start the implementation of this program by October 1984 (see para 2.2.1).

## 1.2 OUTLINE OF OFFICIAL ARRANGEMENTS

The recommendations of the evaluation mission to provide the BFD with the services of a fire management consultant were supported by FAO in November 1983. In February 1984, the Government of the Philippines through BFD and NEDA endorsed this proposal and agreed to rephase PHI 77/011 into 1984.

The UNDP/FAO inputs consisted of the services of a consultant (3 m/m). The consultancy was initiated in November 1984, thus coinciding with the beginning of the dry/fire season, and was operational until end of January 1985.

## 1.3 OBJECTIVES OF THE PROJECT

The government has placed high priority on the rehabilitation, management and protection of the national forest resources, following the concepts of multiple-use and sustained yield principles. Since wildfires are the cause of serious destruction of the mountainous forests (deterioration of soil and vegetation, predisposition of

pine stands to bark beetle infestation), the project was designed to assist in this endeavour by advising the BFD on fire management. Special attention was given to:

a) The establishment and operation of a Fire Control Center
b) Coordination between the Center and other BFD units and other Government Agencies concerned with the prevention and control of fires
c) Fire prevention
d) Prescribed burning
e) Fire hazard determination
f) Detection and reporting of fires
g) Fire fighting, including the use of aircraft
h) Post-fire reporting and evaluation
i) Fire economics
j) Research
k) Equipment, tools and materials

# 2. RESULTS AND CONCLUSIONS

## 2.1 GENERAL FIRE HAZARD

### 2.1.1 Definition of fire problem areas

The wildfire problem area in the Philippines is largely confined to the Island of Luzon. As a result of climate, topography, vegetation cover and land-use practices the most extensive problem exists in the Central Cordillera, the Zambales and Carabello mountains and the surrounding foothills and lowlands. A pronounced dry season of 4 - 6 months is characteristic in this area (Tab. 1), whereas the other parts of the Philippine islands have a partial dry season or well-balanced distribution of rainfall throughout the whole year. The drought period starts in November, and the fire season reaches a peak in March and April.

The generally steep terrain leads to extreme wildfire behaviour due to exposition, low soil moisture content and the increased spread of fires on slopes (Tab. 2). Limited accessibility to the mountainous land is the most important impediment to fire-control activities; due to lack of forest roads or foot trails in many forested areas, firefighters need a travel time up to several hours to arrive at the wildfire scene. Therefore many fires are contained by natural boundaries as wet gullies, sharp ridges or the tropical montane broadleaf forests ("mossy" or "oak" forests) in higher elevations.

Three main fire-prone vegetation types are to be distinguished:

(a) Pine forests

The natural distribution of the Benguet Pine (Pinus kesiya Royle ex Gordon) in the Luzon island mountains is

the Central Cordillera within the altitudinal range of 750 to 2 450 m. The pine is also found between 600 and 1 400 m on the spurs and ridges of the Carabello mountains, and a small provenance occurs in the Zambales mountains at altitudes from 450 to 1 400 m (Armitage et al., 1980). Some recent plantations have been established below the natural elevation boundaries; the high temperatures at the lower altitudes contribute substantially to the severe water deficit during the dry season. Natural pine forests and second growth stands are predominating on the steep slopes.

Most of these pine forests are influenced by man-caused fires since centuries. Thus, they do not represent the natural potential vegetation cover which presumably would contain a wider variety of understorey and co-dominant broadleaf species. Kowal (1966) indicated that there are two easily recognizable types of borders between montane and pine forests:

(i) Pine forest advancing: When fires are fairly frequent each fire injures or kills plants at the edge of the non-flammable montane forest. As a result the pine forest advances very slowly into the montane forest.

(ii) Montane forest advancing: When fires are infrequent or not severe the montane forest slowly advances into the pine forest in the form of a dense undergrowth.

On gentle slopes and along streams the montane forest was able to survive the effects of cutting and burning but steeper slopes were rapidly colonized by pines (Whitford, 1911).

Pinus kesiya forms extensive, more or less even-aged stands which, at higher elevations above 1 500 m, may

be densely stocked but which become more open at lower altitudes. In most of the forests there are only two strata, the pine layer and the herbaceous layer. The tree layer consists exclusively of pine and is associated with a herbaceous layer dominated by grasses and bracken fern (Pteridum aquilinum). The most important fire-tolerant grasses are Themeda triandra, Imperata cylindrica and Miscanthus sinensis.

During the dry season the cured grass and the highly flammable pine litter are favouring the spread of surface fires which tend to kill pine saplings and other fire-sensitive vegetation (Lizardo and Caleda, 1959; Cooling, 1967). On the other hand pine seedlings become easily established on the exposed mineral soil, and a short-term fire exclusion leads to successful regeneration of pine stands.

Long-term fire exclusion allows the re-establishment of the fire-sensitive vegetation as understory and as co-dominants in the overstory. Due to the high fuel load and its spacial distribution, wildfires tend to be of extreme intensity causing the complete combustion of organic matter on the fire-affected sites.

(b) Open grasslands

The open grassland is widely distributed in the interface between agricultural and forested land. It is mainly found on lower elevations like the foothills of the Central Cordillera and the Zambales mountains. Predominating elements are fire-adapted grasses like T. triandra, I. cylindrica, M.sinensis, Saccharum spontaneum, Cappilipodium malabricum, and others. In some places scattered brushes and low trees are occuring. Observations have shown that these brushes and trees like Pilostigma malabricum, Antidesma frutescens and the rain forest relic Syzygium cumini are

characterized by a thick bark providing protection from influence of periodic fires.

Altogether long-term fire selection has led to the formation of fire-climax savannas similar to those being found in South America or Africa. Remnants of dipterocarp forests are occuring only in small patches in the gullies, if at all. There are no distinct boundaries between pure grasslands, the fire savannas and the pine lands. Therefore a grassland fire may easily spread into the forested land.

(c) Dipterocarp forest

The untouched dipterocarp forest is characterized by a great variety of species forming the overstory and a dense understory of climbing and succulent plants. Fire is uncommon in the virgin dipterocarp forest except in the transition zone to the kaingin and grass lands. However, after being altered by forest management practices, this forest type can also be affected by fire during prolonged and extreme drought periods. Fires are carried then by invaded grasses and sun-exposed surface-fuels and may ignite large-volume fuels which burn hotter and are more difficult to control.

However, it must be recognized that extreme dry summers occuring in long intervals may even dry out the moist dipterocarp forests of the southern islands. The extreme 1982-1983 drought within the South Asian region (as well as in Australia) caused disastrous wildfires in the dipterocarp forests of Mindanao and the neighbouring island of Borneo; here a total of 3.5 mio ha burned dipterocarp forest was reported.

Despite of this occasional fire hazard in virgin and secondary dipterocarp forests, the findings of this report refer only to the Luzon pine forests and the adjoining grasslands - regardless of administrative boundaries.

Nevertheless, in future more attention should be paid to this problem especially considering the increased influence of man on the last untouched tropical rainforests in the region.

2.1.2 Fire occurence, causes of fire and fire history

Recent fire statistics of Region 1 are summarized in Tab. 3. The 1979-1983 period shows an annual average of 275 fires on 7 215 ha forested and non-forested land. The specification of the 1982-1983 data show that the portion of forest land varies between 56% and 93% respectively. According to the preliminary data of 1984 an expressed decrease in both number of fires and burnt area is to be expected (62 fires on 1 383 ha). This may not only reflect the last years generally moist weather pattern, but also the consequences of improved fire control activities.

However, these data do not show the damage or value of losses caused by forest fires. Depending on fire intensity, stand age and stand composition, some forest fires cause little damage or may even have beneficial effects. Only recently attempts have been made to assess the degree of damage by surveying the burned area in the year following the fire.

Almost all fires are caused by man. Lightning storms are frequent and numerous lightning-struck trees have been noted in the higher elevations. But most lightning storms are accompanied by rain, and the fires will be extinguished before spreading. In the low grasslands few fires have been reported to be started by lightning.

As it is shown in Tab. 4 most fires are caused by range burning and kaingin. Apart from carelessness, the deliberate starting of fires by workers who have been laid off, or remain unpaid for long periods, and by others who

have grievances, is a common form of protest. The smaller amount refers to smoking, hunting or torches. This data still reflect the historical role of fire in this country. Fire has been used as a cultural tool, beginning with the early colonization of the island. Over centuries escaped kaingin fires, debris burning, pasture and hunting ground improvement-fires as well as fires caused by the traditional use of lightwood torches have permanently influenced the formation of pine forests and grasslands.

Many grasslands and some forested areas are probably burned over every year without being recorded in the fire reports. The reconstruction of the frequency of these periodic light surface fires is impossible. But investigations of fire scars carried out during the consultancy have shown that intense forest fires are occuring at least every 10 - 20 years.

2.1.3 Ecological impact of wildland fires

The long-term influence of fire has resulted in large-scale deforestation and selection of fire resistant/ tolerant plant communities. Coupled with the pronounced dry season, soil erosion is a most serious consequence resulting in damaging floods, siltation of reservoirs, river beds, irrigation canals and lowland agricultural fields. Besides the immediate damage of valuable pine stands, fire may also induce secondary pests. Recent reports point out that fire affected pine stands are severely attacked by Ips calligraphus Germar (FAO, 1982). This bark beetle is not an indigenous species in the Philippines; most likely it has been introduced from North America. It is mentioned that direct and indirect effects of fire have a considerable effect on tree's physiology and therefore increases its susceptibility to insect attack.

### 2.1.4 General statement

Both the Multiple-Use Forest Management Project and the bilateral German forestry development project have put a lot of efforts into erosion control, silviculture and agroforestry. Forest fire management as an integrated part of multiple-use forest management has been greatly neglected. Due to lack of activity and experience in this field no fire ecology research has been carried out. Thus, insufficient information is available on the real effects of fire in plant communities and soil deterioration (para 2.4.2.3). The recommendations of MUFM (FAO, 1982; FAO, 1983a) and the BFD's activities to immediately introduce prescribed burning therefore should be based on detailed investigations. However, since a strict policy of total fire exclusion/suppression is unrealistic, the use of fire as a part of integrated fire management has to be taken into consideration. But BFD's future policy should greatly depend on the knowledge gained during the next years operations as well as on fire related research which should be initiated as soon as possible.

## 2.2 FIRE MANAGEMENT ORGANIZATION

### 2.2.1 The Five-Year Forest Fire Control Program

Acting on the order of the President of 30 May 1980 the MNR through BFD in coordination with national and local government and private entities in the pine forest region prepared a Five-Year Forest Fire Control Program (BFD, 1981). This program is designed to "provide effective protection of the pine forest and reduce the wildfire occurence in the region to a tolerable minimum within the next five years". It also aims "to instill and increase individual and communal awareness on forest fire prevention, and achieve support and active involvement by the barangays in fire control activities".

Plans are made to start the implementation of the program by October 1984 relying on a total budget plan of about 1.35 mio $.

In the most critical pine forest region a fire control organization has been established. The organization is headed by the "Baguio - Benguet - Mountain Province Forest Fire Control Council" being responsible for the implementation of the program. In other provinces the Fire Control Program is carried out independently.

Despite of strengthened fire control organization and planning, the implementation of the first phase of the program is restricted due to poor infrastructural facilities. Limited funding in previous years did not allow to procure adequate equipment for transport, communication and other basic tools and materials as well as for fire prevention.

To ensure a realistic approach for improved fire management in the pine region, the findings of this report will try to harmonize with previous plans and strategies as well as with ecological considerations mentioned before.

Thus, the report will not deal with forest fire prevention and control in general, but concentrate on subjects which need improvements in both short-term and long-term plannings. Since the integration of prescribed fire is taken into account and already practised on a small scale, the frame designation of the program should be changed from "Forest Fire Control" to "Forest Fire Management". Actions being mainly related to the public or to the fire suppression itself should maintain designations like "Forest Fire Prevention" or "Wildfire Prevention" or "Forest Fire Control".

2.2.2 Organizational structure

The present fire control organization covering the Baguio City - Benguet and Mountain Province is shown in Fig. 1. Tne structure provides four functional levels. The Forest Fire Control Council acts mainly as a policy-making body, being assisted by the Secretariat. The Task Forces and their attached Barangay Fire Brigades and District Fire Crews perform fire prevention and suppression within their area of jurisdiction.

It is evident that this organizational structure lacks an institution or functional level being responsible for the coordination of fire suppression activities between the task forces, forest districts, government agencies and private entities, and eventually on a supra-regional basis. Even if this duty is presently improvised by the Forest District 1-12, the establishment of a Fire Control Center would be an appropriate instrument for undertaking this function.

2.2.3 Establishment of a Fire Control Center

The following shows a suggested organization. As the organization develops, various modifications will become

apparent and be developed as trained personnel becomes available.

2.2.3.1 Functions of the Fire Control Center

Under the general supervision of the Forest Fire Control Council and the Secretariat the Fire Control Center (FCC) has the following functions:

(i) Coordinate and monitor all forest fire control activities between task forces, government agencies, and licensees within area of jurisdiction

(ii) Act as communication relay station

(iii) Dispatch fire crews and airborne support

(iv) Extend assistance and support outside of area of responsibility if requested

(v) Prepare and monitor preattack plans in cooperation with forest districts

(vi) Suppress forest fires with first attack fire crew based in the FCC

(vii) Introduce new equipment and fire fighting techniques and act as training center for foresters and fire crews in cooperation with task forces and Baguio Forestry Training Center

(viii) Provide local broadcasting stations with forest fire weather/danger forecasts

(ix) Assist Secretariat in collecting and evaluating data and records of the fire control organization

(x) Conduct and supervise prescribed burning experiments and operations

(xi) Cooperate and assist FORI in conducting fire research and experiments

2.2.3.2 Personnel

The personnel of the FCC comprises a permanent staff

and a permanent fire crew. The staff consists of a "Chief Fire Management Officer" and a dispatcher. The fire crew consists of six men, including one foreman. This personnel has the following duties:

(i) Chief Fire Management Officer

This officer has to be a professional forester especially trained abroad, preferably in the U.S.A. Besides supervising the dispatcher and the permanent fire crew, he has to perform all functions assigned to the FCC.

(ii) Dispatcher

This man has to be a technician being trained as radio operator. He is in charge of the radio control in the FCC. His duties are:

- Supervise the radio traffic and in the event of fire, ensure that radio discipline is kept
- Maintain radio communication with fire towers, fire control personnel and other participating bodies
- Keep a record of daily fire danger rating and of forest fire weather reported by the firetowers and the district forest offices
- Keep a record of the exact location of fire crews and equipment being on and off task
- Keep a log of all messages transmitted by radio or telephone
- Plot the position of the fire on the fire control map
- Direct the fire crews and equipment according to the preattack plans
- Keep a record of all fire suppression activities, prescribed burning operations and burning permits on the relevant boards and maps

(iii) Permanent fire crew

The permanent fire crew consists of six young men in good health, including one foreman. During the fire season this crew is based full time in the FCC being prepared for fire control duties. The crew is designed to act as a first attack crew by using the FCC fire truck or the PAF helicopter from the nearby airport. To be prepared as a "hot-shot crew" the men undergo a daily physical fitness training and are supplied with appropriate well-balanced nutrition.

During the off-season the men would be engaged in presuppression type work to expand or improve the present system.

The assignment of a Deputy Fire Management Officer, a Cartographer and an administrative staff member (clerk) should be taken into consideration. All other functions like drivers, toolkeepers and building maintenance have to be performed by the permanent fire crew.

2.2.3.4 Material prerequisites

Following facilities and equipment are essential:

(i) Building

Space for the Operations Center, administration and documentation office, sleeping/resting accomodations, bathroom, kitchen, equipment/ repair store.

(ii) Communication

Radio equipment for HF, VHF and UHF bands and relay stations needed to communicate with task forces, fire crews, cooperating agencies and aircraft. A minimum of two telephone connections,

one with an easy memorizable number to be shown on billboards, etc.

(iii) Maps

- Fire location maps, showing lookout tower positions, navigational aids for helicopter (distance - bearing indicator) and preattack plan symbols
- Fuel maps, showing the type of predominant fuel
- Map showing burning permits/prescribed burning operations and ownership boundaries

(iv) State boards

- Fire-weather state board (last rainfall, temperature, relative humidity, wind speed/ direction)
- Fire danger rating state board
- Prescribed burning/burning permit state board
- Fire crew/equipment deployment state board

(v) Preattack plans

Preattack plans are prepared by the forest districts and licensees for their area of jurisdiction/concession (see para 2.4.5)

(vi) Weather station

Meteograph (temperature, humidity, pressure), maximum-minimum thermometer, wind speed/ direction recorder (with additional indicator for the Center of Operations), rain gauge, instrument shelter. Weather station to be used joint with FORI.

(vii) Field and laboratory instruments

Portable hygrothermograph, hand-held anemometer, fire-weather instrument kits, compass, clinometer, altimeter, stop watch, field balance, laboratory balance, dry oven, photographic equipment.

(viii) Equipment for first attack crew

Additionally to hand-tools the FCC should be equipped with a multi-purpose vehicle for ground transport and initial attack (four wheel drive, truck tool box, slip-on water tank, radio)

(ix) Library

A basic stock of books refering to fire management, fire fighting training, fire weather, prescribed burning, fire ecology, etc. should be available. The center should receive following periodicals from the U.S.A. regularly: "Forest Fire News" and "Fire Management Notes".

## 2.3 FIRE PREVENTION

### 2.3.1 Information and education

Recognizing that fire prevention is the most important aspect of Philippine fire management, the BFD has initiated a well organized information and education campaign carried out by the BFD Forestry Extension Service. It aims to reach different target groups like national and local officials, barangay brigade leaders and forest occupants/users as well as students, school children and the general public.

The campaign material relies mainly on some movies and the cost-free use of broadcast and print media. Most of the movies used by the BFD Extension Service and the Extension Research Center of UP on forest fires and fire fighting are outdated and do not apply to present local circumstances in the Philippines. In the movies available, too little attention is being paid to the consequences of forest fires on agriculture, erosion, floods and availability of water. Due to lack of funding the Task Force on Forestry Information and Extension is not able to produce or procure sufficient supplies of brochures, posters and other printed material. The efficiency of this campaign could easily be increased by better funding.

Only a few billboards alongside roads have been noticed. Since they offer a cheap and effective way to mediate information, the number and distribution of billboards should be increased.

Additionally a nation-wide uniform fire prevention symbol should be created. Like in other countries this symbol could be an animal (U.S.A.: Smokey Bear) which would mainly attract children as the most important basic target. It could also be a general forest fire symbol to be used on all kinds of printed media, signs and billboards.

It has been proposed to use a symbol showing a tree which is green on the left side and flaming red on the right side (see Appendix 2). The introduction of this symbol as an international sign for the european countries has recently been proposed by some ECE/FAO forest fire specialists.

Other initiatives like the "Non Fire Bonus Incentive Plan" of the licensees or the "No Man's Land Policy" of Forest District 1-16 seem to be appropriate provisions of the fire prevention strategy and should be maintained.

2.3.2 Manpower and training

The fire fighters are recruited from barangay fire brigades, the BFD and the licensees. They form a total of 95 suppression crews within the 311 000 ha area of Baguio City - Benguet - Mountain Province. The equipment of the BFD fire crews consists mainly of handtools. Some of the barangay fire brigades have been equipped with handtools by the BFD. BFD is under obligation to train the BFD crews and the barangay brigade leaders, whereas the licensees are responsible for the training of their own crews.

The BFD does not provide funds for full-time employed fire fighters. The suppression crews are mainly recruited from the nurseries. They are prepared for fire suppression duties by fire control exercises and basic training in fire behaviour and suppression. The aspect of safety has greatly been neglected during the past. The fire crews are not equipped with any protective clothing and adequate shoes, helmets, etc. Three casualties during the past fire season evident the need for improvements as a first priority. First aid training should also be a standard part of the fire fighters training. This could probably be obtained by cooperation with the Philippine Red Cross.

A very basic "Fire Fighters Handbook" provides substantial information and drawings on forest fire suppression. However, not every fire crew member is supplied with a copy. It is highly recommended to distribute this kind of manual to every fire fighter or at least to every fire crew.

A more comprehensive textbook should be prepared for the use of suppression crew team leaders, barangay brigade team leaders, forest guards and other cooperating officials involved in fire control operations. It should cover all fire management aspects and background informations and should be written intelligibly to this target group. As an example a textbook prepared for the training of Brazilian forest technicians (Goldammer, 1982) has been presented to the BFD. A more detailed manual on techniques of fire control edited and used by the Spanish Forest Service (ICONA, 1981) has also been handed over to the BFD.

Additional literature for inter-personal seminars and workshops should be procured in the U.S.A. Training programs and guides on fire weather, fire behaviour, fire suppression, prescribed burning etc. have been published by the U.S. Forest Service and can be obtained from this agency. A list of both training brochures and fundamental fire ecology/research literature has been handed over to the BFD.

More emphasis should be given to the qualification of forest protection officers. At the moment no course on fire management is offered at the UP. The report of the Joint Government/UNDP/FAO Evaluation Mission of the MUFM project points out that no fellowship for fire management was granted for training abroad (FAO, 1983). The 60 man-days that had been allocated to a study tour related to fire management represented less than one

percent of the whole training program budget.

To fill this gap one FAO fellowship should be awarded for a Master's degree study in the U.S.A. A minimum requirement for qualification would be an on-the-job-training of six months. The scholar be a young man, and it should be ensured that he will stay on a fire management duty for at least several years and not be posted to other duties after his return. His potential function should be the Chief Fire Management Officer of the FCC.

Seminars like the ASEAN-New Zealand Afforestation Project Workshop on "Fire Control in ASEAN Plantation Management" and "Controlled Burning as a Tool of Plantation Management" (August 1983) should be held repeatedly.

## 2.4 HAZARD REDUCTION AND PREATTACK PLANNING

### 2.4.1 Fuel inventory

As a part of the Fire Control Program the BFD task forces have prepared a "Fire Management Map" on the base of the forest districts. These 1:50 000 scale maps show principle land-use classifications like commercial forest, second growth forest, communal forest land, open land and alienable and disposable land. Additionally, symbols of fire control facilities are marked on the map.

As a first approach to fire management mapping, it contains informations not only on predominating vegetation types but also on social and land-use structure which are of importance for fire hazard determination. Concerning the classification of forested land no distinction is drawn between stand age or stand class, understory/ground cover type and fuel load.

Together with the topographic features the description and distinction of these fuel characteristics are important prerequisites for estimating fire behaviour and spread. In accordance with the proposed system of preattack planning (para 2.4.5) the fire management map should be improved on the bases of a topographic map and contain a minimum of following informations on fuel type:

- Forest type (pine, dipterocarp, mossy; virgin, second growth, plantation)
- Age/age class (old growth, year of cutting/ regeneration, year of planting)
- Stocking density (open, middle, dense)
- Ground cover/understory (grass, fern, dense understory)

For the planning and execution of prescribed burning operations more information is needed on the quantity and surface and aerial fuels (para 2.4.2.3). The overloading

of the fuel/preattack block maps with these additional informations should be avoided.

### 2.4.2 Fuel management

Three methods of hazard reduction by means of fuel treatment should be taken into consideration: Timber stand improvement, establishment of fuel breaks and prescribed burning.

#### 2.4.2.1 Timber stand improvement

Timber stand improvement is a basic method in both silviculture and fuel management practices. Rough reduction and thinning of pine stands reduce the competition for minerals/water as well as fire hazrd. Pruning as a means of timber quality improvement will remove ladder fuels (aerial and draped fuels) reducing thus the blow-up, crown scorch and crown fire danger. Consistently the forest residues suitable for breeding material of Ips calligraphus must be removed to prevent bark bettle outbreaks.

#### 2.4.2.2 Establishment of fuel breaks

Since forest accessibility in the mountainous region is largely restricted, fuel break construction seems to be the most appropriate provision to reduce forest fire hazard and to limit the spread of wildfires. The concept of fuel breaks is based on fuel and/or vegetation modification to reduce flammability on strips subdividing areas with nigh fire hazard. On these strips the fire should either stop by itself or be controlled easier, due to reduced intensity and improved accessibility of the forest land. The reduction of flammability can be obtained by different means of fuel treatment or selection of appropriate plants. The principles of fuelbreaks are known in the Philippines and a basic study on different methods of fuelbreak construction has been carried out (Peñafiel and Doctolero, 1978).

However, it seems that the implementation of a great part of fuelbreak and greenbelt construction is limited to strips of small width, mainly alongside roads. Like firebreaks these may be useful to prevent the start of a fire or to confine a low-intensity fire.

The concept of fuel breaks should be extended to remote pine forest areas where the suppression of high intensity wildfires becomes problematic. Hence, the location and the width should be adapted to the topography and the surrounding fuel type. Since the steep mountainous terrain is much dissected, wildfires can easily be controlled in the wet gullies and valleys. Therefore the fuelbreaks should be located on the ridges. Depending on the slope and the dimension of the ridge the width should be between 20 and 100 m.

To avoid diminuition of productive forest land the establishment of "shaded fuelbreaks" should be preferred. Strips of natural pine stands as well as second growth or plantations can be converted into shaded fuel breaks. The spacing should be extended up to 10 x 10 m final stocking, and all trees should be pruned. The slash has to be removed and the grass cover and other understory plants should be treated regularly by mechanical means (motor brush cutter), prescribed burning or grazing (see 2.4.4.3). If pruning is done properly, highly valuable timber can be produced on these sites. This kind of shaded fuel breaks improves accessibility for fire fighters and even for fire trucks and facilitates fire control by reducing fire intensity. If properly maintained it may stop a wildfire by itself.

Other type of fuelbreak construction like greenbelts should be studied. Experiments on using Lantana camara and Tithoria diversifolia show promising results. However, the use of some annual plants as fire retardant species

seems to be contradictory since they start to cure during the last part of the dry season when the wildfire hazard is getting worse.

This also refers to the planting of trees like Gmelina arborea which sheds its leaves during the dry season. The investment of planting Alnus japonica seems to be doubtful since these trees are easily killed by wildfires.

The construction and maintenance of fire breaks by removing organic matter and exposing the mineral soil is very costly and may cause erosion. Since the width of these control lines is limited to some meters, fires may easily break over. Firebreaks are only recommended in flat terrain and low fuel loads like grasslands.

2.4.2.3 Prescribed burning

Prescribed burning of pine stands is already being carried out in a small scale. If properly applied, prescribed burning will reduce fire hazard by removing the pine litter, the herbaceous layer fuels, understory shrubs and trees as well as co-dominating but fire sensitive trees. Like the long-term and overall effects of wildfire influence, the prescribed fire will maintain the pine-grass-association vegetation type.

With regard to long-term development on many sites like gently slopes on higher elevations the pine would play a minor role in an advancing but ecologically more stable montane forest. Concerning erosion control and watershed management this type of vegetation cover would reduce run-off, sedimentation and erosion.

As mentioned before a strict fire-exclusion policy would be highly unrealistic. As a consequence, integrated fire management should rather direct the fire instead of following fire occurrences caused by the unpredictability

of the weather and human behaviour.

Erosion and secondary pests are the main problem linked with the use of fire. The only two studies referring to this indicate that surface run-off and sediment transport is higher on prescribed burnt sites than on unburnt forest or grassland (Peñafiel, 1980; Costales, 1981). However, as vegetation develops the erosion rate will decrease. If the grassland or the herbaceous layer of pine stands are burnt at the beginning of the dry season the re-growth of vegetation is already developed at the beginning of the rainy season. If the burning is conducted at the end of the dry season the soil will be bare at the beginning of the rainy period and directly exposed to rainfall, causing detachment and dispersion of soil particles. However, field observations in both grasslands and pinelands have shown that the spatial distribution of individual plants leaves openings which remain bare, e.g. the bunch-type growing Themeda triandra. Unlike the fire followers Imperata cylindrica or Pteridum aquilinum which may form closed ground cover, many fire selected plants tend to this spatial dispersed growth behaviour.

The effect of prescribed fire on soil denudation can only be controlled on sites which develop an expressed (raw) humus layer. The moisture gradient inside a uniform (AoooL) or a stratified (AoooL, AooH, AoF) layer makes the partial burning of the upper layer possible. The energy released is sufficient to consume or kill the herbaceous vegetation or the understory plants; at the same time the wet layer of organic matter is maintained as protective cover of the mineral soil (Goldammer, 1983). The formation of this type of litter layer is only found in densely stocked plantations. When planning or using this burning technique on slopes, attention must be paid

to the drying process and fire behaviour which is extremely different from the ones on flat terrain.

Altogether the effects of prescribed fire on soil denudation of pine and grass lands are similar to a wild surface fire. However, since prescribed fire is to be planned in the early dry season the run-off and erosion will be less compared to the consequences of wildfires which mostly occur during the peak of the dry season.

Fire also contributes to the development of large populations of Ips calligraphus. FAO (1982) reports that practically all forest areas burnt in 1981 have been attacked by the bark beetle. The indirect effects of fire can affect the tree considerably. The removing of the organic layer and the exposure of the mineral soil cause the soil to break up, thereby reducing the water absorbing and retaining capacity. As a consequence mineral and water supplies are negatively influenced and the tree becomes susceptible to insect attacks.

The direct interactions between fire, insects and host tree are not known. It is assumed that increased attractivity of fire-damaged trees to bark beetle attacks can be determined by the degree of fire damage reducing the vigor of the tree; volatile compounds deriving from scorched and burned parts of the tree (needles, bole) may also attract the bark beetles (Goldammer, 1983). Some pilot experiments were set up during the mission as a first approach to a more extensive study of this kind.

However, in the Central Cordillera the populations of Ips calligraphus have decreased since 1982 and no larger outbreaks are reported. Therefore an evaluation of the recently prescribed burnt pine stands with regard to bark beetle attack do not show the real picture. However, the observations and the pilot experiments carried

out by the consultant showed, that some forest stands prescribed burnt in November 1984 had been heavily infested by mid of January 1985. Altogether due to lack of experience and sophisticated burning techniques it cannot be predicted at present if prescribed burning would contribute to an increased attractivity of Pinus kesiya to Ips calligraphus.

The burning of grasslands is also linked with the soil erosion and soil depletion problem. However, since uncontrolled fires are very regular fire management should concentrate on protection of sensitive sites like slopes and adjoining pine-grasslands. The use of prescribed fire should be concentrated on buffer zones surrounding the terrain to be protected. Early burning of strips by using desiccants is recommended to ensure the fire-retardant effect throughout the whole dry season.

To avoid an overall damage of inclined pine forests and grasslands caused by prescribed burning the first steps therefore have to be done carefully. The operations should be accompanied by documentation and be monitored after the burn. To gain more experience of the use of prescribed fire recommendations for documentation and burning techniques were given in the field (see para 2.10.3). The follow-up findings and results will be an essential basis for future fire management strategy (see para 2.10, 3.9 and 3.10).

### 2.4.3 Forest accessibility

The lack of forest roads, skid and foot trails is the most important impediment to a fast response by initial fire attack. The forest road network-density is very wide compared to european and north american standards. The average forest road length per ha commercial forest land in NRD-1-13 is 6,6 m/ha, but in most other forest districts it is presumably less than 2 m/ha.

The construction of new forest roads is linked with a lot of problems. Landslides and erosion caused by road construction in mountainous lands may even contribute more to the siltation of reservoirs and rivers than the forest fires. Another problem in the uncontrolled squatting following in the wake of any new road built into the forested land. Thus, man-caused forest fire hazard is expected to increase if squatting is not being controlled.

Road construction is essential for effective forest fire control. But to face the problem mentioned above it should be taken into consideration only in coordination with other planning bodies/agencies. However, the establishment of fuelbreaks which also improves the accessibility to forest land should be integrated in the development of the rural land.

### 2.4.4 Integration of local land-use practices

#### 2.4.4.1 Burning permits

The vast majority of wildfires is caused by the rural population. As a part of the fire prevention program the issuing of burning permits for kaingin making and range burning is a basic step to an improved fire management. The issue of a burning permit includes advising and help by the forest personnel thus increasing mutual confidence. Additionally the registration of rural fires facilitates the forest fire survey and is essential for the overall monitoring and coordinating function of the FCC. The system of permits should be carried out consequently and should not be a halfway measure.

#### 2.4.4.2 Composting of debris/trash

Debris and trash burning also contributes to a high percentage of escaping fires. Instead of burning, much

of the organic matter could be composted and converted into organic fertilizer to be used for conserving and improving agricultural soil fertility. In addition foreign exchange for purchasing of imported costly anorganic fertilizer could be saved. The system of composting may even be more cost-effective and viable by growing mushroom on the same compost pile; appropriate technologies are available on the Philippines. A step into this direction is certainly not to realize in a short-term period and would require a concerted program of MNR and MAF.

2.4.4.3 Agroforestry

Hazard reduction in the pine-grassland can also be achieved by the integration of land-use practices into the forested land. Under the present law, those who entered the forest before the end of 1981 are given priority to participate in the government's Integrated Social Forestry Program. In the context of Forestry Occupancy Management the forest occupants are assisted in developing suitable land-use practices on occupied land. One component is agroforestry as a combination of production from trees and agricultural crops but also embracing animal husbandry.

As a part of agroforestry, the integration of livestock grazing in pine-grasslands as means of fuel/hazard reduction, should be taken into consideration. To achieve better control and to concentrate the grazing effects this agroforestry system should be implemented in fuelbreaks exclusively. As mentioned in para 2.4.2.2 the spacing of the trees should be extended to up to 10 x 10 m corresponding to 100 trees/ha as final stocking; in this final phase all trees should be pruned at least to a height of 6 m.

Two trials on this combination of land-use practices are being carried out in New Zealand and Chile (both on sheep grazing under Pinus radiata). Even not projected on a fire-related background promising results were obtained. In the Philippines local cattle could be chosen as animal husbandry as well as sheep and goats. Timber production would concentrate on high quality supply. A design of an experiment of this kind was given to the BFD. It is recommended carry out follow-up research in this aspect of combined land-use system.

2.4.5 Preattack planning

Preattack planning is a system of collecting, recording and evaluating information relevant to wildland fire management. Preattack planning should be carried out on the base of the forest districts. It contains the following informations related to the administrative units (forest districts, forest sectors) and ecological units (preattack blocks):

(i) Wildland informations

Topography, vegetation types, fuel load, water sources, meteorological particularities (e.g. local wind and fog patterns).

(ii) Technical informations

Localities of BFD/concession fire crews and barangay fire brigades, equipment (Communication, tool caches, fire trucks, water tenders, dozers, lookout towers), facilities for airborne control actions (helipads, heliponds, jump spots), control lines (fuelbreaks, firebreaks, greenbelts, and other barriers), access (roads, forest roads, skid and foot trails), safety islands, values-at-risk), smoke targets, travel time map.

(iii) Administrative informations

Area of jurisdiction (fire agency), direct protection area (fire crews, barangay brigades), communication, cooperators, detection system, ground attack plan, air attack plan, mobilization plan, logistics, mutual threat zones.

Most of this information may be figured on the district fire control map and more detailed on the preattack block maps. These maps should be based on a topograpnic map, showing the vegetation cover/fuel load type. Most of the other information like access, control lines, prescribed burned areas, water sources, helispots, jumpspots, heliponds, equipment locations and administrative boundaries are included by using symbols.

The preattack plan should be supplemented by oblique photos taken from an aircraft or neighbouring elevations. These photos show the main fire-problem sites of the preattack blocks and may be completed by hand-painted symbols/informations.

The preattack plan contains all information in wildland fire prevention and fire preparedness being essential for effective fire suppression. The FCC as coordinating agency is holding a copy of the preattack plans which are to be updated continuously by the forest districts.

## 2.5 FIRE DANGER RATING

Comprehensive and reliable fire danger ratings have to be derived from fire behaviour data of the relevant vegetation/fuel type. Decades of research were necessary before such ratings were developed in Australia and the U.S.A. Since the Benguet pine - grassland fuel types are similar to those in other regions, the suitability of developed and proven fire danger ratings could be tested. However, the complexity of a fire danger rating system must be rationalized against actual fire control requirements.

Following previous experiences (FAO, 1971b, 1980a, 1980b; ICONA, 1981), the "McArthur Forest Fire Danger Meter" and the "McArthur Grassland Fire Danger Meter" Australia) could probably be adapted to the prevailing conditions in the Philippines. This fire danger rating system integrates the four major meteorological factors affecting fire behaviour (temperature, relative humidity, wind speed, long and short term drought effects) to give a fire danger index by using a meter comprising a series of overlapping discs.

The potential use of this system should be object of a study carried out by FORI (see also para 2.2.3.1). BFD/FORI were provided with one meter; further information (detailed instructions and drought factor tables) were requested from C.S.I.R.O. and will be forwarded to BFD/FORI by the consultant.

## 2.6 DETECTION AND REPORTING OF FIRES

### 2.6.1 BFD detection system

The BFD fire detection system will be based on the operation of firetowers. As a part of the Fire Control Program eight lookout towers are established or planned within the Baguio City - Benguet - Mountain Province area. Since these towers are concentrated in the southern part exclusively, the middle and northern part of the most critical pine region is not covered by any detection system; this also refers to the surrounding provinces. Therefore high priority should be given to provide funds for construction, equipment, maintenance and manning of firetowers.

The towers should be located to ensure the maximum area seen from the least number of points and to obtain accurate cross bearings, intercepting at a reasonable angle. Reduction of visibility caused by fog/cloud patterns in the Central Cordillera should also be taken into account. The standard equipment of the lookout towers should consist of a fire finder (Osborne Fire Finder or improvised alidade), binocular (10 magnification), radio or telephone and anemometer. The cabin design should provide basic comfort to the operator. In addition, it may be necessary to install a number of emergency lookout points.

In addition to current practice the fire report should include the wind direction and speed to be measured by the lookout man. Since the wind pattern within the Central Cordillera is not uniform and difficult to predict this actual wind report from the vicinity of the wildfire scene will be helpful to assess the development of the fire. Unfortunately some district forest offices like NRD-1-16 Urdaneta are not located in the fire hazard

zone belonging to the area of responsibility.

In this case the lookout tower has to read and transmit all meteorological parameters required for the determination of the planned fire danger rating system.

2.6.2 Use of aircraft

The integration of aerial fire detection and reporting would be ideal to complement the ground detection network, especially with regard to the topography, accessibility of remote forest land and ground based radio communication difficulties. To avoid high costs for chartering survey planes the cooperation of volunteer holders of a private pilot license should be seeked. To maintain the validity of a private pilot license a minimum of flying hours in command is required. If the BFD would provide the basic costs (AVGAS or costs for charter without pilot) it can be expected that many private pilots would participate in an airborne fire detection program. This kind of cooperation is highly approved of the Federal Republic of Germany and in other countries (e.g. Chile).

The fire spotter should be a local forest protection officer being familiar with the terrain of aerial survey and the radio procedures. Most cost effective are single engine land airplanes up to 2 000 kg max. gross weight. The use of aerial fire detection, however, should be restricted to extreme fire hazard periods. The additional cooperation of Philippine Airline pilots during regular domestic flights should be stimulated at the beginning of every fire season.

2.6.3 General public

It has been noticed that increased public awareness on wildfire prevention has led to active participation in reporting of wildland fires. The early reporting of fires

by local residents and travelers can be stimulated and facilitated by putting up billboards alongside roads and in communal centers. Besides a general slogan like "Prevent wildfires" and a forest fire symbol these boards should indicate the telephone numbers of the nearest barangay fire brigade, district forest office or the FCC (within a local telephone call area only).

## 2.7 EQUIPMENT, TOOLS AND MATERIAL

### 2.7.1 Handtools

Even if only few fire crews were inspected during the consultancy it seems that they are equipped with basic handtools (fire swatter, fire rake, fire shovel, Pulaski, McLeod tool, bolo, backpack pump). Most of the tools are manufactured locally. If the stock of tools has to be completed or renovated, attention should be paid to the quality. Fire tools, like most other tools, are manufactured in a great range of qualities. But unlike other tools, fire tools are used only in emergencies, and then under considerable stress. If they are not top quality tools the failure rate will be high, and this could result in the escape of a fire which should have been suppressed while still small. Quality is therefore critical, and should be considered more important than price. Specifications should accompany tool orders (FAO, 1980a).

The fire crews are generally not furnished with drip torches, a fundamental tool for both backfiring and prescribed burning. It is highly recommended that every fire crew will be equipped with one drip torch. If locally manufactured, special attention has to be given to safety features (flashback preventing device, oilproof gaskets and sealed outlets to prevent slopping of fuel, fuel flow regulator valve).

### 2.7.2 Personnel safety precautions

It has already been mentioned in para 2.3.2 that the firefighters are not equipped with fire protective clothing. As a high priority measure the BFD fire fighters should be furnished with protective pants and shirts. This clothing is made of fire retardant fiber (e.g. Nomex$^{R}$, Aramid$^{R}$),

light weight, and can be washed easily. Every fire fighter should therefore be supplied with one pair of green coloured pants and one yellow long-sleeved shirt, the team leader should wear a bright-red shirt to be visibly identified as fire boss. The light colour type shirts improve the perceptibility of men working at the fire.

Every fire fighter should be provided with a protective helmet with chin straps, heavy duty work gloves, eye protection (plastic goggles) and a flash light. Care should be taken that every man disposes of work boots. At least every fire crew should be provided with one first-aid kit.

2.7.3 Multiple-use vehicles

The general lack of vehicles for personnel and material transport is evident. In most forest districts besides NRD 1-13 there is a need of multiple-purpose vehicles to be used for fire control activities during the fire season. The most suitable type for both personnel and material transport is a 4-wheel drive pick-up with double cabin. Besides a truck tool box, a slip-on water tank for refilling backpack pumps should be provided.

The use of more specialized multi-purpose vehicles like the German UNIMOG type could be taken into consideration. This off-road vehicle is suitable for all kind of forest work like skidding and transportation in steep terrain. Different types of equipment may be connected to the system, e.g. pumps or shredding/mulching devices etc. A design of a multi-purpose vehicle for both fire prevention and fire fighting duties has been presented to the BFD. It consists of a UNIMOG, a slip-on 1 500 l water tank, pump and booster reel. Additional devices

can be connected: Mulching/shredding device (fuelbreak construction/maintenance), plow (firebreak construction/ maintenance), brush blade (fireline construction).

2.7.4 Communication

The efficiency of the Fire Management Organization will be highly dependent on the availability of communication installations. According to the basic data of the present organization, only 14 radios and 8 telephones are available in the Baguio - Benguet - Mt. Province region. This reflects not only the inadequate telephone network in rural areas, but also the lack of funds for procuring radio equipment. The improvement of communication systems should concentrate on radio facilities. At least all fire crews should be equipped with a mobile two-way radio to enable the communication with the relevant task force leader. The transmission problems caused by the topography of the mountainous terrain and the use of relay stations have to be solved by the advice of an electronic engineer and in cooperation with the Bureau of Telecommunications.

2.7.5 Other equipment

For the collection of data of both prescribed fires and wildfires the protection officers should be equipped with basic meteorological instruments (see also para 2.2.3.4). A fire-weather instrument kit would be most suitable for field-work conditions.

A catalogue containing description and prices of most equipment afore-mentioned has been handed over to the BFD. In addition, the BFD was supplied with photos showing designs of equipment, the fire operation center, fuel break constructions and the prescribed burning techniques.

## 2.8 FIRE CONTROL

### 2.8.1 Fire fighting techniques

As it is practised presently, the main fire fighting techniques will remain based on the use of handtools. The fire control training therefore must concentrate on the use of these handtools in fire suppression and fire line construction, e.g. progressive line construction (bump-up and one-lick method).

Attention should be paid to backfire techniques which can be improved by the ability of fast fire line construction and the use of drip torches. The procurement of portable water pumps and hoses should be taken into consideration only in the vicinity of the rivers and the water reservoirs. The use of fire retardants, wetting agents, fire fighting foam or explosives cannot be recommended in the present stage of development and in the near future.

### 2.8.2 Use of aircraft

Regardless of the financial aspect, the potential use of both fixed-wing aircrafts and helicopters has been discussed with the BFD. There are some main restrictions for the use of fixed-wing aircrafts for airborne fire fighting. The steep and dissected terrain of the mountainous pine region causes unpredictable wind patterns like eddies or thermal turbulences which do not permit safe operations in flight altitudes suitable for water dropping. In addition, in high elevations the formation of clouds often limits the visibility required for conduction of visual flight approaches.

However, the undulating and flat terrain at lower elevations permits the use of fixed-wing airplanes.

The most cost-effective fixed-wing fire fighting

system can be obtained by the use of multiple-purpose airplanes which can be converted to waterbombers during the peak fire season. Two principal alternatives are available and could be taken into consideration:

(i) Agricultural aircraft

The tank and gating system of some small aircrafts used for agricultural spraying operations may be converted for fire-fighting purposes. One example is the Polish "PZL DROMADER" STOL aircraft (4 200 kg max. gross weight) with a tank capacity of 1 500 l.

(ii) Fire fighting kit for transport planes

A simple technical concept has been developed by the German Messerschmitt-Boelkow-Blohm Aircraft Industries. The fire-fighting kit operates on the gravity principle. The kit comprises a cylindrical tank terminating in a discharge tube assembly and operates independently from the aircraft, so that structural or system alterations of the aircraft are not required. The tank has a capacity of 12 000 l and is designed for use in the TRANSALL C-160 and the HERCULES C-130 H. The cooperation with the Philippine Airforce (PAF) which is operating the C-130 would be a cost-effective option in providing airborne fire-fighting capability compared to the procurement of a conventional fire-fighting aircraft.

With regard to the present economical situation of the country, the consideration of using helicopters seems to be the most realistic approach to airborne fire control.

In the past years the BFD has been supported occasionally by the deployment of one PAF helicopter stationed at Baguio during the fire season. Besides first-attack crew transportation, the continuous cooperation with PAF would enable BFD to use helibuckets either by hovering over rivers/reservoirs/ponds or by water pumps. Most types of helibuckets are equipped with openings which permit the adjustment of water load to the maximum computed gross weight of the helicopter. Examples are the CHADWICK C 140 (content 420, 340, 265 or 190 l), SMOKEY III (900, 600 or 400 l) and SMOKEY I (5 000, 4 000, 3 000 or 2 000 l).

Technical information on airborne fire-fighting equipment (fire-fighting kit, helibuckets) has been handed over to the BFD.

## 2.9 POST-FIRE ACTIVITIES: REPORTING, EVALUATION AND ECONOMICS

Within Region I, a standardized form is being used for fire reporting. It requires all basic specifications on location, time, size and cause of the fire as well as a brief description of suppression activities. The damage record contains information on the type of area burned (pine forest, grassland) and the number of trees burned (trees, saplings and seedlings).

These forest fire statistics should be extended so they can be compared to other countries. Attempts to standardize forest fire statistics have been made by the ECE/FAO Joint Working Party on Forest Economics and Statistics. According to this, definitions are given to specify vegetation cover and ownership of the land affected by fire (high forest, coniferous, forest, non-coniferous forest, coppice and coppice with standards, other wooded land, other land, publicly owned, privately owned land). These ECE/FAO forest fire statistics which include the inquiry instructions and definitions (ECE/FAO, 1984) have been handed over to the BFD.

The evaluation of losses should be more detailed. As already mentioned in para 2.1.2, the present statistics do not show the real picture of the value of losses caused by the forest fires. Depending on fire intensity, stand age and stand composition, some forest fires cause little damage or may even have beneficial effects. On the other hand, the fires may cause non-tangible damage to the environment (soil, erosion, landslides, decrease of productivity or protective capacity, etc.).

To obtain a more realistic relationship between the expenditures (on fire prevention and control) and the value of losses (tangible and non-tangible), methodologies of assessing/estimating the losses should be developed. Appropriate methods of evaluating these losses were demonstrated and handed over to the BFD.

## 2.10 FIRE RESEARCH AND DEVELOPMENT

More attention should be paid to basic research related to both wildfires and prescribed fires. Unfortunately the research projects previously proposed by FORI have been rejected twice. These proposals should be realized as soon as possible. According to the foregoing conclusions of this report, future fire management decisions refering to prescribed burning should be based on these findings. Priority has to be given to the following fields in research and development:

### 2.10.1 Impact of prescribed fires on run-off and erosion

Prescribed burning operations of the BFD should be accompanied by soil erosion/run-off studies. The quantity of soil erosion in both pinelands and grasslands should be measured in different treatments and be compared with wildfire-affected stands as well as with unburned sites. Special attention should be paid to the interception of rainfall by the remnant vegetation, the general development of the plant cover, the timing and the intervals of burning operations. As it has been proposed by Peñafiel (1980), this kind of observation should be carried out in long-term investigations.

### 2.10.2 Interactions between fire, insects and host tree

The need to investigate the influence of both wildfires and prescribed fires on the predisposition of *Pinus kesiya* to infestation by *Ips calligraphus* has been stressed in the previous chapters. Follow-up research should concentrate on three main questions concerning the potential fire-insect-pine interactions:

(i) Direct influence of the fire on the vigour of the tree

In all probability, the direct damage caused by fire may be determined by the degree of

needle scorch or consumption. Reduced vigour of the tree and thereby the increased susceptibility to bark beetle attacks are reflected by the change of xylem water potential (water stress) and oleoresin exudation pressure. Both parameters may be measured in field experiments (Goldammer, 1983). FORI should be equipped with the appropriate instruments (Scholander pressure bomb, pressure gauges of Bourbon type) which are also suitable for other experimental approaches in tree physiology.

(ii) Indirect effects of fires on the vigour of the tree

As it has been assumed by FAO (1982), the indirect effects of fire may also affect the tree considerably by influencing the water absorbing and retaining capacity of the soil. Studies of this kind should be carried out parallel to the above-mentioned experiments.

(iii) Attraction of bark beetles by volatile compounds

The trigger mechanisms influencing the aggregation behaviour of bark beetles to fire-damaged trees are not known. It is assumed that volatile compounds deriving from scorched/burned parts of the tree may be similar to the insect pheromones (Goldammer, 1983). In the last phase of the consultancy a pilot experiment was set up to prove this hypothesis. It has to be seen as the beginning of a series of trials to be conducted by the consultant. A continuation of follow-up research could be ensured by the cooperation with Freiburg University, Institute of Forest Zoology, West Germany.

2.10.3 Fuel reduction by prescribed burning

Detailed basic data on the behaviour of prescribed fire and its influence on the fuel complex should be obtained. The following parameters have to be measured/ described before, during and after the prescribed fire:

(i) Fuel complex: Stand density, crown cover, stand height, crown length, draped fuels, understory, herbaceous layer, pine litter, activity fuels, fuel moisture.

(ii) Topography: Aspect, slope, soil type.

(iii) Environmental parameters: Wind (speed, direction), temperature, relative humidity.

(iv) Fire behaviour: Rate of spread (forward, perimeter), flame height and flame length.

(v) Fuel consumed by fire, scorch height (bole, crown).

All prescribed burning plans have to be written according to the general objectives of the treatment. The planning should follow the recommendations given by Martin and Dell (1978); this guide has been handed over to BFD library (Baguio).

## 2.11 FOREST POLICY

The Revised Forestry Code of the Philippines, the Presidential Decree No. 705 (1975) as amended by PD 1559 (1978), forms the framework of forest policy in the Philippines. The basic forest protection policy, as embodied in PD 705, is:

> "The protection, development and rehabilitation of forest lands shall be emphasized so as to ensure their continuity in productive condition".

As can be seen in the foregoing chapters, the fire protection aspect of this framework may be filled by a broad variety of provisions in fire management. Law enforcement is essential, but cannot be effective without the cooperation of the public and the active support of all government employees. Besides the information and education of the general public, this can be achieved by two basic measures of forest policy:

(i) Increasing the responsibility of the rural population

The sense of responsibility for forest fire protection can be increased by sharing the legal occupancy or yields of the forests with the rural population. A leasehold system for the small forest farmer would be very appropriate to stimulate the interest in fire prevention.

The example of the Sagada forests (Forest District NRD-1-9 Bontoc, Mt. Province), which are well maintained by small forest farmers, should be considered as a model of this kind of active participation in social forestry. Agroforestry systems as mentioned in para 2.4.4.3 should also be taken into account.

(ii) Increasing the active support of government employees

In the same connection, priority should be given not only to the provision of regular employment, but also to the elimination of delays in the payment of wages which may result in the deliberate starting of forest fires (see FAO, 1983a).

Attention should also be focussed on adequate salaries of forest guards as means of strengthening the loyal performance of their duty.

# 3. RECOMMENDATIONS

The decreasing forest resources of the Philippines and the increasing demands on the remaining forests require absolute protection of the forests against destructive wildfires. If neglected, all efforts at a sustained multifunctional forestry may easily be jeopardized. Therefore priority should be given to strengthen and support the fire management organization, to develop skill and to provide adequate funds for equipment, personnel and research.

The recommendations given in the following are condensing the most urgent needs of measures to be taken in the near future.[1/]

## 3.1 FIRE MANAGEMENT POLICY

(1) Change the designation of the organization and activities according to the modified fire management policy from "fire control" to "fire management" where applicable (2.2.1). The consequent integration of prescribed burning and man-caused fires into fire management strategies has to be introduced and extended carefully (2.1.4, 2.4.2, 2.4.4, 3.9.2).

(2) Prepare a comprehensive statement of fire management policy and incorporate this policy into implementing regulations and guidelines.

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1/ Some of the general recommendations given in the MUFM Terminal Report (FAO, 1983a) apply also to fire management which is considered to be an integrated part of MUFM.

3.2 FIRE MANAGEMENT ORGANIZATION

(1) Strengthen and support the fire management organization within the BFD (2.2, 2.11).

(2) Improve the efficiency of the fire management organization, by establishing a Fire Control Center and provide adequate funds and trained fire management personnel (2.2.3, 2.3.2).

(3) Seek continuous cooperation with PAF to ensure the seasonal use of helicopter for fire crew transport and airborne fire fighting (2.8.2).

3.3 EQUIPMENT

(1) Pursue the principle of appropriate technology and provide all fire crews with personnel safety equipment (fire protective clothing etc.) and handtools (2.7.1, 2.7.2).

(2) Procure sufficient multi-purpose vehicles for personnel and material transport (2.7.3).

(3) Improve the communication system by procuring mobile two-way radios for fire crews (2.7.4).

(4) Procure or manufacture a water container (helibucket) for airborne fire fighting with PAF helicopter (2.8.2).

3.4 PUBLIC INFORMATION

(1) Provide BFD task force on Forestry Information and Education with updated campaign material applying to local circumstances present in the country (movie, slides, permanent exhibition material, brochures etc.; projector, tape recorder) (2.3.1).

(2) Increase the number of billboards alongside roads (2.3.1, 2.6.3).

(3) Create a nation-wide uniform fire prevention symbol (2.3.1, Appendix 2).

3.5 TRAINING

(1) Distribute the "Fire Fighters Handbook" to every fire crew and prepare a more comprehensive textbook for the use of fire crew team leaders etc. (2.3.2).

(2) Ensure the appropriate training of fire management officers by organizing periodic workshops and seminars (2.3.2).

(3) Select a young forest officer to be trained in forest fire management preferably in the U.S.A. (future Chief Fire Management Officer of the FCC). Ensure that he will stay on nis duty for a sufficient period to justify the costs (2.3.2, 3.10; see also FAO 1983b, para 36).

3.6 HAZARD REDUCTION, PREATTACK PLANNING, FIRE DETECTION AND REPORTING

(1) Intensify fire hazard reduction by timber stand improvement (2.4.2.1) and establishment of fuel breaks (2.4.2.2).

(2) Give high priority to gain skill in the proper use of prescribed fire to avoid damage to the site and the remaining stand (2.4.2.3, 3.9.2).

(3) Integrate local land-use practices into fire management strategies (burning permits, debris composting, agroforestry, leasehold systems) (2.4.4, 2.11).

(4) Introduce preattack planning as a comprehensive system of wildland-fire related information (2.4.1, 2.4.5).

(5) Improve the BFD fire detection and reporting system (2.6, 2.7.4).

3.7 FIRE CONTROL

(1) Pursue the principle of appropriate technology and concentrate on the hand-tool based techniques (2.8.1).

(2) Seek continuous cooperation with PAF to enable the use of helibuckets for airborne fire control (2.8.2, 3.2.3, 3.3.4).

3.8 EVALUATION

(1) Adapt fire statistics to international standards (2.9).

(2) Obtain a realistic picture of fire economics by developing methodologies of assessing/estimating the value of losses (2.9).

3.9 RESEARCH

(1) Give absolute priority to provision of funds for fire research which had been neglected during the past (2.10).

(2) Concentrate on basic studies on fire behaviour and effects of prescribed fire on erosion, vegetation and secondary pests before extending prescribed burning operations in the practice (2.10.1, 2.10.2, 2.10.3). Carry out research in use of animal husbandry for fuelbreak maintenance (2.4.2.2, 2.4.4.3) and in development/ adaptation of a fire danger rating system (2.5).

(3) Cooperate with international research and development organizations, e.g. IUFRO Subject Group S.1.09 "Forest Fire Research" and ECE/FAO

Project Group on "Forest Fire Prevention and Control". Provide funds or seek foreign aid to enable officers of FORI and BFD to participate in relevant seminars and meetings.[1/]

(4) Provide FORI and BFD with periodicals and a basic stock of literature refering to fire management (2.2.3.4 (ix) ).[2/]

3.10 FOLLOW-UP ACTIVITIES

The MUFM Report of the Joint Government/UNDP/FAO Evaluation Mission recommended that a fire management specialist should be recruited for a minimum of 18 months (FAO, 1983b: para 36,53). Since the fire management research and development problems in the Philippines are very comprehensive, this recommendation points out a realistic need: Unlike in other countries, where the development of fire management has been based on decades of experience in fire control, the present situation in the Philippines requires a fast response to this menace to the forest resources.

Therefore it is recommended repeatedly to extend the assistance by providing follow-up mission to amend this first three-months consultancy. These consultancies should be distributed successively over the following years and accompany the development of fire management organization and research rather than recruiting a fire

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1/ The consultant who is vice-chairman of the IUFRO Subject Group and member of the ECE/FAO Team of Specialists on Forest Fire Prevention and Control respectively will set up this communication.

2/ The consultant will try to arrange the cost-free subscription of the "Forest Fire News" and the "Fire Management Notes".

specialist for a continuous period of one year or more. Together with additional consultancies, foreign aid should be sought for procuring the most urgently needed equipment (see FAO, 1983b, para 36). This assistance should include one fellowship dealing with fire management to be undertaken at a relevant university (2.3.2, 3.5.3, see also FAO, 1983b: para 36).

It is highly recommended to formulate an appropriate request for assistance under the FAO Technical Cooperation Programme (TCP).

## 3.11 FINAL STATEMENT

As it has been expressed by the MUFM Evaluation Mission (FAO, 1983b), it is strongly recommended that the Government of the Philippines attach the highest priority and importance to the protection of forests and forest lands from fire and human elements causing degradation of vegetative and soil resources. The Government should commit itself to a firm and sincere policy in this regard, which considers the crucial impact on protection of socio-economic factors. This policy should be effected through appropriate legislation and institutional strengthening.

# Appendix 1

## TABLES AND FIGURES

| Month | Rainfall (mm) | No. of Rainy Days |
|---|---|---|
| January | 12.7 | 4 |
| February | 9.0 | 3 |
| March | 34.3 | 6 |
| April | 97.5 | 11 |
| May | 312.6 | 21 |
| June | 477.2 | 24 |
| July | 740.7 | 27 |
| August | 855.2 | 28 |
| September | 602.4 | 25 |
| October | 344.8 | 19 |
| November | 142.7 | 11 |
| December | 25.9 | 6 |

Tab. 1: Mean monthly precipitation, Baguio City, 1950-1977
Source: PAGASA Baguio City

| Slope, percent | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 |
|---|---|---|---|---|---|---|---|---|
| Slope, degrees | 0 | 6 | 11 | 17 | 22 | 27 | 31 | 35 |
| Spread factor | 1.00 | 1.25 | 1.67 | 2.30 | 3.24 | 4.65 | 6.78 | 10.0 |

Tab. 2: Effect of slope on spread factor: Source: Wolffsohn, 1980

| Year | No. of fires | Total area burned (ha) | Forested | Non-forested |
|---|---|---|---|---|
| 1977 | 163 | 8 300 | ns | ns |
| 1978 | 340 | 7 539 | ns | ns |
| 1979 | 306 | 3 336 | ns | ns |
| 1980 | 165 | 4 353 | 1 383 | 1 380 |
| 1981 | 425 | 9 484 | ns | ns |
| 1982 | 218 | 4 235 | 2 376 | 1 858 |
| 1983 | 309 | 13 259 | 12 350 | 909 |
| 1984 | 62 | 1 382 | 677 | 706 |

Tab. 3: Number of fires and area burnt within Region I, 1977-1984 (ns=not specified). Source: Fire statistics, Forest Protection & Law Enforcement Section, BFD, R-1, Dagupan City

| Causes | Number of Fires Started 1981 | 1982 | 1983 | Percent of Total Causes 1981-1983 |
|---|---|---|---|---|
| Cigarettes | 31 | 33 | 20 | 12.2 |
| Incendiary | 45 | 30 | 27 | 14.8 |
| Torches | 25 | 16 | 4 | 6.2 |
| Outdoor cooking | 7 | 3 | 9 | 2.8 |
| Range/Pasture preparation | 54 | 34 | 30 | 17.1 |
| Escaped kaingin fire | 22 | 8 | 13 | 6.2 |
| Fertilizer preparation | 10 | 5 | 6 | 3.0 |
| Hunting | 14 | 14 | 7 | 5.1 |
| Children, playing | 14 | 11 | 13 | 5.5 |
| Trash burning | 5 | 2 | 4 | 1.6 |
| Unknown | 86 | 29 | 61 | 25.5 |
| Total | 313 | 183 | 194 | 100.0 |

Tab. 4: Causes of forest fires, Baguio-Benguet-Mt. Province, 1981-1983. Source: Baguio-Benguet-Mt. Province Fire Contol Council

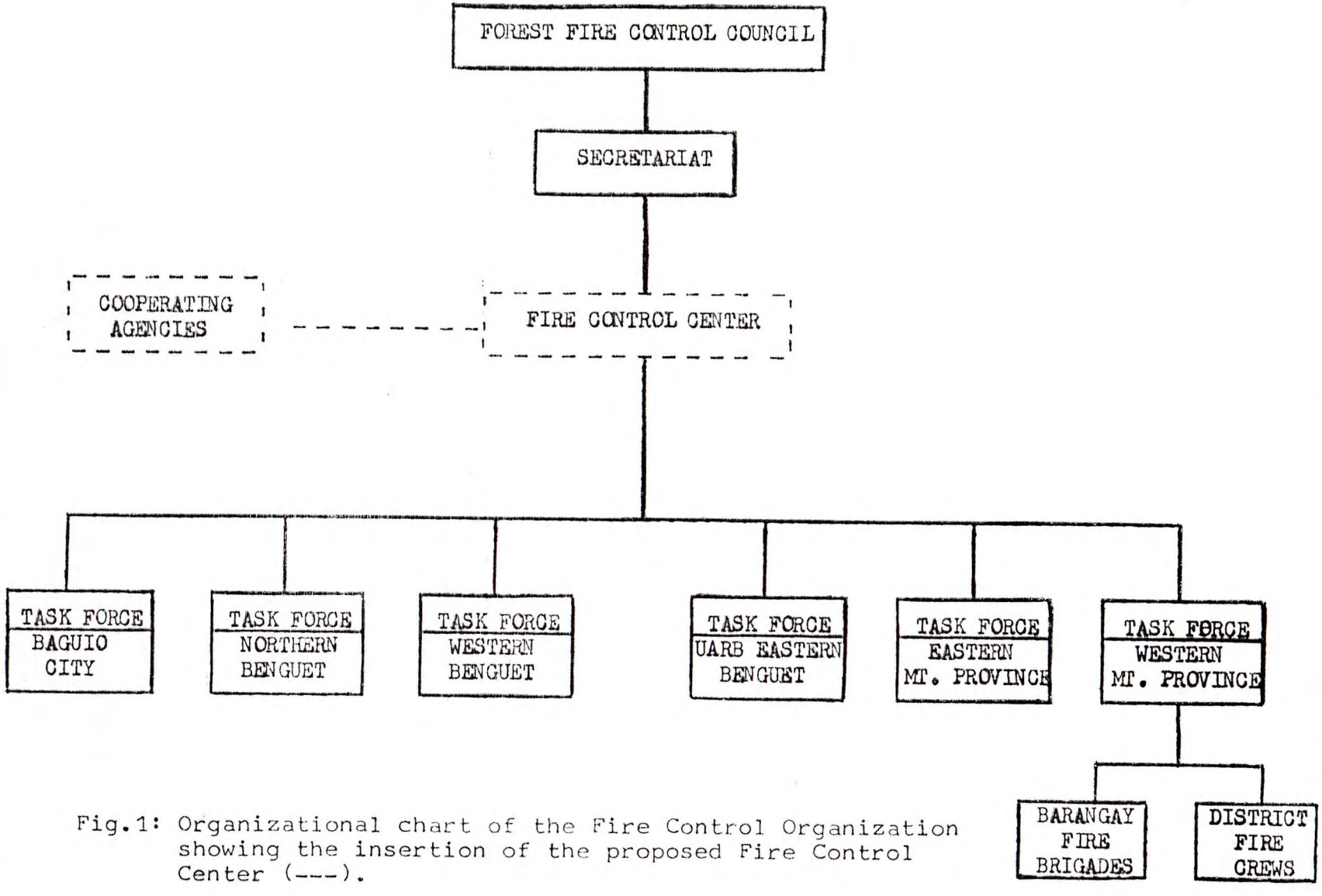


Fig.1: Organizational chart of the Fire Control Organization showing the insertion of the proposed Fire Control Center (---).

## Appendix 2

PROPOSED FIRE PREVENTION SYMBOL (see para 2.3.1)

## Appendix 3

LIST OF MATERIAL HANDED OVER TO BFD/FORI

1. BFD NRD-1-13 (Baguio)

   1.1 Guide on prescribed burning
   Martin, R.E. and J.D. Dell 1978: Planning for prescribed burning in the Inland Northwest. USDA For. Serv. Gen. Tech. Rep. PNW-76, 67 p.

   1.2 Guide on fire behaviour
   USDA FOREST SERVICE 1972: Intermediate fire behaviour. USDA For. Serv. TT-80-(5100), 59 p.

2. BFD Central Office (Manila)

   2.1 Technical information on airborne fire fighting equipment.

   2.2 Technical information on other equipment, including an equipment catalogue (Forestry Suppliers, Inc., No. 34, 1984-85).

   2.3 Fire management textbooks for forest technicians and fire suppression crew team leaders (exemplary):

   Goldammer, J.G. 1982: Incendios florestais. Prevenciao, controle e uso do fogo. Destaque especial para es reflorestamentos de Pinus spp., Colegio Florestal Irati, 93 p.

   ICONA 1981: Technicas para defensa contra incendios forestaless. ICONA Monografia 24. Madrid, 200 p.

   2.4 Evaluation

   ECE/FAO 1984: Forest fire statistics (2nd edition). Timber Bulletin for Europe, Vol. 36, Supp. 7. Geneva, 32 p.

   2.5 Fire danger rating

   Forest fire danger meter (MK. 5, 1973), designed by A.G. McArthur, Forest Research Institute, Forestry & Timber Bureau Canberra, Australia.

2.6 Bibliographical list of textbooks on fire ecology and fire management.

2.7 Set of photos showing design of FCC, equipment, fuelbreaks and prescribed burning operations.

2.8 Proposed fire prevention symbol

2.9 Follow-up

Guidelines, FAO Technical Cooperation Programme (TCP)

3. FORI (Baguio)

3.1 Literature on fire ecology

Goldammer, J.G. 1983: Sicherung des sudbrasilianischer Kiefernanbaues durch kontrolliertes Brennen. Hochschul Verlag Freiburg, Forstwiss. Bd. 4, 183 p.

Goldammer, J.G. (ed.) 1983: DFG-Symposion" "Feueroekologie". Freiburger Waldschutz Abh. 4, Forstzool. Inst. Univ. Freiburg, 301 p.

3.2 Bibliografic list of textbooks on fire ecology and fire management.

## Appendix 4

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FAO 1971a — Demonstration and training in forest, forest range and watershed management, The Philippines. Fire control, based on the work of E. C. Kimball. Rome. 62 p. FO:SF/PHI 16, Technical Report 10.

FAO 1971b — Forest industries feasibility study, Zambia. Fire protection of industrial plantations, based on the work of N.P. Cheney. Rome. 70 p. FO: SF/ZAM 5, Technical Report 4.

FAO 1980a — Maputo firewood plantation, Mezambique. Protecting the Maputo eucalyptus plantations from fire, based on the work of C.B. Lyon. Rome (draft). FO: GCP/MOZ/007/SWE, Technical Report.

FAO 1980b — Forest fire management planning, Kenya. Fire danger rating for forest areas, based on the work of G.B. Peet. Rome. 93 p. FO: DP/KEN/74/024, Technical Report 1.

FAO 1982 — Multiple-use forest management, The Philippines. Possibilities for the control of Ips calligraphus (Germar) in the Philippines, based on the work of P. Grijpma. Rome. FO: DP/PHI/77/001, Project Working Paper No. 7, Vol. 1 and II.

FAO 1983a — Multiple-use forest management, The Philippines. Project Findings and recommendations. Rome. pp p. FO: DP/PHI/77/011, Terminal Report.

FAO 1983b — Multiple-use forest management, The Philippines. Report of the Joint Government/UNDP/FAO Evaluation Mission. Manila. 14 p. FO: DP/PHI/77/011.

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Wolffsohn, A. 1980 — Fire control in tropical pine forests. Commonwealth Forestry Inst. Occ. Pap. 17, Oxford University. 96 p.