FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

UNITED NATIONS
ENVIRONMENT PROGRAMME

DETECTION AND CONTROL OF FOREST FIRES FOR THE PROTECTION OF THE HUMAN ENVIRONMENT

Proposals for a Global Programme

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Rome, 1975

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ABSTRACT

This report describes the adverse effects of forest fires on the human environment; identifies three areas of the world which are highly susceptible to fires (Mediterranean, Central American, and African Savanna regions); and recommends a long-term programme of work aimed at solving some of the most urgent problems. It discusses both the on-site and off-site damages caused by unwanted fires, and it emphasizes that, because of population pressures and other factors, the potential for fire-caused damages is greater than ever before.

The report proposes a global programme of integrated fire management and describes the specific jobs which need to be accomplished in each of the three regions as well as the implementation requirements for the first five years. The proposals cover field operations in fire prevention, detection, presuppression, and fuel management (including careful application of prescribed fire) and describe how optimum benefits can be obtained through an integrated fire management system. It also covers training, research and extension, and emphasizes the importance of interdisciplinary and multi-functional coordination in alleviating the impacts of forest fires on the human environment.

This report was prepared
as part of a cooperative project of the
United Nations Environment Programme

entitled

"Detection and control of forest fires
for the protection of the human environment"
(Project 0206-74-003)
with

The Food and Agriculture Organization of the United Nations
as cooperating agency

FAO acknowledges the valuable work

of the consultant
Carl C. Wilson

and the suggestions of the participants in the expert consultation
Rome, 1975

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1. INTRODUCTION

Fire is a natural part of the environment. Wisely used, or harnessed with discretion, it can be a valuable tool in land management. Uncontrolled, or incorrectly employed, it can have a devastating impact on all life, including man.

At the request of the United Nations Environment Programme (UNEP), this report has been prepared to outline a global programme in the rational use and the judicious control of wildland fire for the protection of man's environment. It was prepared by Carl C. Wilson, National Fire Specialist, Cooperative Fire Control, U.S. Forest Service, who served as consultant to FAO from 10 January to 9 May 1975. The expressed purpose of the consultancy was to prepare a long-term programme of work, including training requirements, aimed at:

(i) identifying areas where the forest ecosystems are more susceptible to fires;

(ii) elaborating a methodology for the assessment of the fire danger index, using meteorological observations in combination with the characteristics of the existing vegetation and the prevailing topographic conditions (use will be made of the report on forest fire weather forecasting to be prepared by the sub-project to be executed by WMO);[1/]

(iii) encouraging countries to develop and/or improve fire detection systems and to strengthen fire fighting organizations and techniques;

(iv) promoting regional cooperation on forest fire control by improving the exchange of information on techniques and equipment, by encouraging cooperative research work on fire behaviour and fire intensity according to fuel types and on other related problems, and by exploring the feasibility of mutual aid including the pooling of human resources and means;

(v) identifying basic ecological research requirements on the effects of forest fires on the ecosystem in collaboration with UNESCO (MAB projects No. 1 and No. 2).

The consultant visited the forest ecosystems most exposed to fire in 12 countries during two months of continuous travel - 20 January to 21 February in the Mediterranean region and 8 March to 11 April in the Central American and African savanna regions. He established contacts with forest fire control, forest management, range management and wildlife management organizations and had personal conferences with more than 120 key people.

In addition, an FAO/UNEP Expert Consultation on Detection and Control of Forest Fires for the Protection of the Human Environment was convened in Rome 28 April - 3 May 1975, to examine the long-term programme of work proposed by the consultant. The specific recommendations of the Consultation are given in Appendix 2 and are reflected throughout the contents of this report.

1/ At the time of writing, this report had not yet been completed.

Special experts who participated in the Consultation were:

A.G. McArthur (Australia)	L. Susmel (Italy)
A.M. Oseni (Nigeria)	L. Trabaud (France)
Ali Ozyizit (Turkey)	R. Velez Munoz (Spain)
B.R.K. Shuma (Kenya)	D.E. Williams (Canada)

Other individuals in attendance are given in Appendix 1.

2. GENERAL BACKGROUND

2.1 Extent of the Forest Fire Problem

Although fire has been a useful tool for man for millenia, in the 20th century forest fires cause grave economic losses and intolerable harm to the human environment. Unwanted fires not only destroy marketable products such as wood, cork, resinous materials, nuts, forage, game and fish, but also cause irreparable damage to other less tangible yet even more important aspects of the human environment by:

- decreasing recreational and esthetic values;
- their ecological impact on the vegetation, microclimate and soil microflora and microfauna;
- causing undesirable alterations in soil and water regimes;
- loss of human lives and homes;
- endangering unique flora and fauna in certain ecosystems;
- affecting social and economic consequences such as wood shortage and fire fighting costs.

These economic and social losses and adverse impacts on the human environment are particularly intolerable now when the world is in the midst of an "energy crisis", "double digit" inflation and in the "trough" of a recession. Paradoxically, as Susmel (1973) points out, both the number of fires and area burned seem to be increasing, especially in the Mediterranean region. In addition, destruction by fire in the pine forests of Central America and the African savannas is becoming much worse.

Some of the heaviest losses in forest fires occur in the highly flammable "fire types" of maquis, garrigue and matorral. Similarly, forests (especially pine), including plantations, suffer heavy losses each year (Wilson, 1971).

2.2 Development of FAO Programme in Forest Fire Control

The severity of the forest fire problem was recognised by FAO at an early stage after the Organization's creation. One of its first efforts in the field of forest fires was publication of the book The Elements of Forest Fire Control , issued in 1953.

Meanwhile, FAO has helped sponsor four Forest Fire Study Tours. The first was held in the United States of America in 1951; the second in 1964 in the U.S.A. and Canada; the third in Australia in 1970; the fourth in 1975 in the U.S.A. and Mexico.

In addition, within the limit of available resources, FAO has tried to incorporate fire control activities in field projects. A pilot fire control organization was developed in the Philippines to train a nucleus of forest fire personnel, to demonstrate detection and suppression techniques, and to accumulate basic fire data. The training aspect of this project was most practical as it was designed for forest guards and lookout observers.

In the framework of another FAO/UNDP project in Nicaragua, a forest fire control officer was appointed for 6½ years to develop a fire control programme; organize a protection service which will progressively cover all pine forests; and to formulate and conduct a training programme. Similar work is now being implemented or considered within the framework of several other field projects, such as those in Honduras, El Salvador and Thailand.

Concerning training, in addition to that done in the Philippines and Nicaragua, a course in Forest Fire Management was introduced into the curriculum of the forestry schools operated by FAO in Morocco and Honduras.

In addition, industrial forests have been considered by FAO as serious fire problems. The first effort was in an FAO/UNDP project in Zambia where one of the recommendations was to use prescribed burning to reduce fuel hazards in the plantations. A similar effort is being considered for Kenya.

Also, consultants were provided to Greece for three months in 1971 to advise that country on forest fire management and to Zambia for six months to develop a fire control and use organization for a wildlife and conservation project. More recently, FAO sponsored a comprehensive report on forest fire problems in the Mediterranean region, and the final draft is now ready for reproduction.

In 1975, there are nine field projects which have an input of 126 man/months of experts' service in forest fire management.

The primary aim of FAO, as it was more than two decades ago, is to serve as a catalyst in encouraging countries in critical forest fire areas to protect themselves from the adverse effects of unwanted fires and to enhance the use of fire as a tool in managing their limited natural resources.

2.3 UNEP Interest in Forest Fire Problems

Despite such efforts, the resources available to FAO were clearly insufficient in comparison to the overall magnitude of the forest fire problem on a global scale, and in 1972 the UN Conference on the Human Environment invited FAO to coordinate an international programme for research and exchange of information on forest fires (Recommendation 26 of the Conference). Paragraph (a) of the same recommendation specified that such a programme should include data collection and dissemination, identification of potentially susceptible areas and of means of suppression, and, interalia, establishment of a forecasting system in cooperation with the World Meteorological Organization (WMO).

Further to the above mentioned UN Conference, in February 1974 the UNEP Intergovernmental Meeting on monitoring met and laid down the objectives and principles for development of a Global Environmental Monitoring System (GEMS). The objectives of GEMS are:

(a) (i) increasing quantitative knowledge of natural and man-made changes in the environment and of the impact of these on man's health and well being;

(ii) increasing understanding of the environment and, in particular, of how dynamic balance is maintained in ecosystems as a basis for managing resources.

(b) Providing early warning of significant environmental changes (including natural disasters) in order that protective measures may be organized.

(c) Making it possible to check the effectiveness of established regulatory mechanisms and to plan optimal technological development.

The project "Detection and Control of Forest Fires for the Protection of the Human Environment" was conceived in keeping with Recommendation 26 of the UN Conference, and its objectives (see section 3.1) can clearly be identified with those set for GEMS.

The primary objective of UNEP in this project, as a coordinating body in the UN system, is to cooperate with FAO and other UN specialized agencies on the formulation of environmental programmes aimed at avoiding the negative ecological, sociocultural and economic consequences of the use and misuse of fire on the natural and man made ecosystems.

2.4 Basic Concepts of Integrated Fire Management

Despite the development of advanced techniques, particularly in fire detection and suppression, the incidence of unwanted forest fires has steadily increased, the area burned over has expanded, and the degradation of much of man's environment as a result of fire remains unchecked. A major problem which has greatly limited the success of most previous forest fire protection and control programmes has been a piecemeal approach to fire which typically concentrated heavily on only one activity, usually fire suppression. Paradoxically, a substantial part of today's fire problem has resulted from such efforts to control fire. In many areas, this has led to a dangerous build-up of flammable material which, when ignited, creates critical suppression problems and causes environmental destruction or severe degradation. In most areas, this is clearly a consequence of man's failure to recognize fire as a natural part of the environment - a part which should not be eliminated, but should be managed.

Fire management is not a simple task. It is a complex process requiring a balancing of the various components of an integrated fire management system. Such a system would have the following components:

(a) prevention of man-caused fires through education and environmental modification;

(b) quick detection of fires which may occur through a planned system of fixed observation points, roving ground patrols, and aerial patrols to supplement ground detection;

(c) fast initial attack with both ground forces and tactical air support based on accurate fire danger rating and fire weather forecasts (aerial support is most effective in early stages);

(d) strong follow-up action to assure first-night control;

(e) pre-planned and installed fuel modification systems along strategic ridges and routes of travel.

Each component in the integrated fire management system is significant to the success of the entire system. If any component is missing or inadequate, a destructive fire and major damages to the human environment will be inevitable.

Also inherent in the integrated fire management system is an interdisciplinary approach to solving problems and applying managerial techniques. Unwanted fires in the environment are not solely the concern of foresters. Range, wildlife and watershed managers are also directly concerned, as are ecologists and sociologists. It follows then that fire problems should be attacked through the pooled efforts of all concerned disciplines.

The success in establishing integrated fire management practices is most likely to be assured by making available a wide range of appropriate expertise on research/demonstration/training "pilot projects" to make the breakthroughs which are essential in proving the value of new approaches in fire management. This, in turn, will create confidence in widespread application of research and development results and new techniques and systems. For some countries, more practical research will be needed on the individual components of the fire management systems. However, in many cases existing knowledge is immediately available from Australia and progressive countries in Europe and North America for starting new fire suppression practices or using known fuel modification methods and systems. The first major step towards integrated fire management systems will be to make foresters, fire management and other specialists aware of the new techniques and approaches currently available from fire research and development. New techniques will be tested and introduced and less effective techniques will be withdrawn. Therefore, research and development of new techniques and methods of fire management is conceived to be a continuing process concurrent with extension and demonstration activities.

2.5 The Potential of Integrated Fire Management

It has been clearly demonstrated in several areas of the world that major improvements in all aspects of forest fire management can reduce the intolerable losses due to forest fires. For example, the Les Maures "pilot district" in the south of France in what is called the "Red Zone" is one of the spectacular success stories. In this area, existing fire research and development knowledge and practical experience from all over the world have been effectively integrated into a demonstration of the benefits which can be achieved from better prevention, detection, fire suppression, and fuel modification techniques.

Similarly, the strengthened fire programme in the pine savannas of eastern Nicaragua is proving that industrial forestry in the Pinus caribaea savanna is feasible, providing the seedlings, poles, and saplings can be protected from fires.

Finally, cost/benefit economic evaluations of improved fire management systems in North America have consistently proved that the social-economic benefits obtained more than offset the increased capital investments and annual operating costs.

3. GLOBAL PROGRAMME FOR THE DETECTION AND CONTROL OF FOREST FIRES FOR THE PROTECTION OF THE HUMAN ENVIRONMENT

It is proposed to establish and put into operation a Global Programme for the Detection and Control of Forest Fires for the Protection of the Human Environment which would employ the techniques of integrated fire management. The objectives of the Global Programme are outlined below.

3.1 Objectives of the Global Programme

The medium-term objective of the Global Programme is the development and application of safer and more effective forest fire management techniques and systems based

on ecological, social and economic considerations to avoid environmental pollution and/or degradation.

The immediate objectives of the Global Programme are:

(a) development or strengthening of national capabilities and organizations to handle integrated fire prevention, detection, control and fuel modification programmes for the forest ecosystems of major economic and ecological importance;

(b) promotion of research on fire prevention, fire behaviour, prescribed use of fire and related ecological problems;

(c) exploration of the feasibility of mutual aid and development of cooperative activities;

(d) exchange of information on techniques and equipment.

3.2 Structure of the Global Programme

3.2.1 Global Programme Coordinator

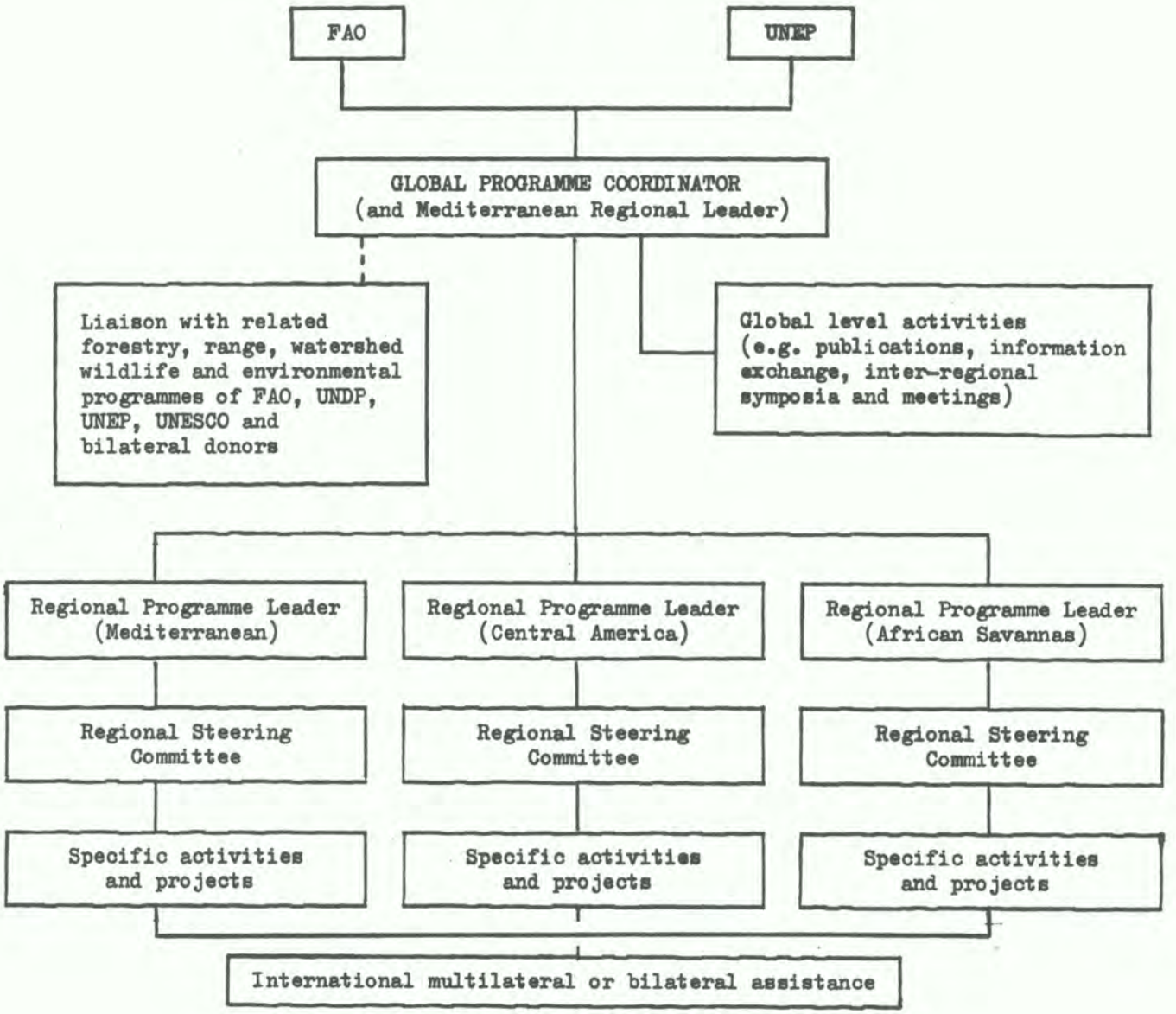
The Global Programme on the Detection and Control of Forest Fires for the Protection of the Human Environment will consist of certain activities of inter-regional or global importance and various regional programmes (initially three), each, in turn, composed of a number of national and intra-regional projects. The organizational structure of the programme is given on page 7. The overall activities of such a Global Programme need to be organized, directed and coordinated on a continuing basis. It is essential that one person, a Global Programme Coordinator, be responsible for this task.

In addition to overall direction of the Global Programme, the Programme Coordinator will be responsible for formulation, management and coordination with on-going and future projects in integrated fire management supported by multilateral and bilateral agencies. He will be further in charge of the preparation of programme proposals and the solicitation of funds.

The Programme Coordinator will maintain close coordination with ongoing UNDP/FAO projects and programmes supported by bilateral agencies concerning integrated fire management. Other interested UN agencies will be consulted whenever deemed advisable. In particular, he will also be responsible for coordinating the activities of the Global Programme with Man and the Biosphere Programme No. 2, "Ecological effects of different land uses and management practices on temperate and Mediterranean forest landscapes".

During the initial stages, the Programme Coordinator will also be responsible for contacting the countries concerned in each region to solicit their cooperation and later to work with them in making detailed proposals based on the general design of the Global Programme. When appropriate, regional conferences should be used to discuss the interest of the countries and to define their requirements and possible participation in the programme. Once the regional programmes are well-structured, these activities can be turned over to the Regional Programme Leaders.

Organizational Structure
for Proposed FAO/UNEP Global Programme on
Detection and Control of Forest Fires for
the Protection of the Human Environment



Another key task of the Programme Coordinator will be to promote exchange of information and inter-regional collaboration by organizing inter-regional meetings and by serving as the focal point for the collection and dissemination of literature on a global level. He will also facilitate training in research and extension work for technical persons in the form of fellowships and study tours abroad, and inter-regional symposia, training courses and workshops.

Because of the current activities of FAO in fire-sponsored projects, its central location in the heart of the Mediterranean region, and administrative support available in the headquarters of the Organization, the Programme Coordinator should be stationed in FAO, Rome.

3.2.2 Regional Centres and Activities

At least three regional programmes, each composed of a number of national and intra-regional projects, will aim at the development and implementation of integrated fire management systems for the vegetative fuel types of primary regional importance. An experienced fire management specialist will be stationed at each regional headquarters to serve as Regional Programme Leader. In the initial years, the Global Coordinator would serve also in the capacity of Regional Leader for the Mediterranean Region (see section 4.1.2). Under the supervision of the Global Programme Coordinator, the Regional Leaders will be responsible for the overall direction and operation of the respective regional programmes. In particular, they will coordinate national, bilateral and multilateral activities within the region.

Each Regional Leader will also establish a Regional Steering Committee composed of not more than one representative from each country participating in the respective regional programme. Representatives to the Steering Committee should be of high technical competence in the field of fire management and should be in a position to influence implementation of national and regional projects within their respective countries. The Steering Committee should meet as needed, but not less than once a year, to give general guidance to the Regional Leader in implementing the regional programme and to ensure that the programme is developed in close collaboration with national authorities of the participating countries.

Regional Leaders will also work in close contact with forest, range, pasture and wildlife management specialists available in the region. They will also have special responsibility for identifying and developing cooperative regional programmes in research and training through personal contacts and by organizing intra-regional workshops for extension and research workers.

3.2.2.1 General regional plan of work In each region the first step will be to collect and evaluate existing statistics on forest fires (including all unwanted grass, brush and forest fires), current fire management methods such as prevention, detection, presuppression and suppression, and fuel modification practices that limit the numbers and sizes of destructive fires.

As soon as possible, this statistical information will be used to help devise a pilot control programme aimed at the development of a model fire management system. The pilot programme will need to be tested on a "pilot district" suitable for both experimentation and demonstration. The pilot district should be large enough to adequately represent a single or several forest ecosystems within the region. This and other areas will be used to test detection, prevention, suppression and fuel modification techniques against unwanted fires, to adapt the techniques to an integrated

fire management system which fits local conditions and to experiment with new techniques. Special studies will be made on subjects such as:

(a) fixed vs. aerial detection and/or ground patrols;

(b) the beneficial and adverse effects of prescribed fires in natural forests and conifer plantations, and savannas;

(c) the effects on the ecosystem of roadside treatments with retardant chemicals (DAP, MAP, etc.) and sterilants to prevent fires;

(d) the effects of herbicides and/or grazing by animals in maintaining "safe fuelbreaks" in maquis or matorral (brush);

(e) fire behaviour under various fuel and weather conditions;

(f) field trials of fire resistant plants;

(g) short- and long-term effects of unwanted fires on plant and animal communities.

Economically and ecologically sound fire management practices and systems must be developed in the context of a broad knowledge of the economics of the forest and range crops and ecological conditions of the region. Consequently, when gaps in knowledge are apparent, appropriate research will be encouraged and supported in collaborating scientific institutions, teaching and research facilities, and within national forestry organizations in the region. Research on the ecological impact of fire and fire management and research on fire management techniques will be emphasised.

Training activities will be organized primarily to familiarize applied research scientists, fire management specialists, and extension workers with the overall development and functioning of integrated fire management systems and to develop an ability to translate their experience and knowledge to forest workers and other practitioners. This will require in-field fire training courses, close participation with ongoing research on the projects, and associated seminars and symposia. A limited number of fellowships for experienced research scientists may be required and an annual exchange, on a "one-for-one" basis, of fire management specialists between interested countries is also considered beneficial. For some countries, funds will be needed for university level training in forest fire science, forest meteorology, fire ecology and principles of integrated fire management.

Two forms of meetings are envisaged: 1) Sessions for forest administrators of the countries concerned, aimed at familiarizing them with the concepts and practices of integrated forest fire management; and 2) workshops for research scientists, fire management specialists and extension workers from various countries who are collaborating in the programme.

3.2.2.2 Criteria for identifying priority regions The following criteria were used to identify priority regions where urgent implementation of integrated fire management techniques is required:

(a) existence of fire problems of vital national and regional importance to the economy and welfare of human populations;

(b) magnitude of forest product and other losses caused by unwanted forest fires;

(c) environmental problems caused by unwanted forest fires including threats to endangered plants and animals, degradation of sites, floods, accelerated erosion, desert encroachment, pollution of streams, lakes, seas and the atmosphere and damage to hydroelectric facilities;

(d) potential damages caused by some fire suppression practices, such as barren firebreaks, chemicals, etc.;

(e) potential damages caused by "pasture burning" and other forms of vegetation conversion;

(f) potential success of integrated fire management components and systems.

On the above basis, the Mediterranean, Central American and African savanna regions are identified as priority regions.

3.2.2.3 Criteria for selection of regional headquarters A regional headquarters will be established in each region. Subject to agreement of the governments concerned, choice of the locations for regional headquarters will be based on the following criteria:

(a) fire problems similar to those of other countries in the region;

(b) sufficient counterpart expertise in forestry and related disciplines such as range, wildlife and watershed management;

(c) adequate office and laboratory space, including training facilities;

(d) suitable research and demonstration areas where pilot areas of adequate size can be established;

(e) proximity to institutions and universities where information on forestry, plant sciences, range management or watershed management is available and liaison with research and teaching facilities is possible;

(f) adequate meteorological forecast centre which may be capable of providing fire weather forecasts.

4. SPECIFIC PROPOSALS FOR INTEGRATED FIRE MANAGEMENT IN THE THREE REGIONS

The following proposals for research and training programmes on integrated fire management in the Mediterranean, Central American and African Savanna Regions are considered to be most critical at the time of writing.

4.1 Mediterranean Region

4.1.1 Background and Justification

It is tragic, indeed, that the region of the world which gave birth to great religions, produced the civilizations of the Hittites, Persians, Egyptians, Greeks and the vast Roman Empire, should also bear the distinction of having the most serious forest fire problems in the world.

The fire problem is not new in the Mediterranean region. For centuries fire has been the most common, cheap, simple and rapid means of removing undesirable vegetation, such as trees and shrubs, for preparing the land for agriculture and animal husbandry. In Sardinia, for example, during domination by the Carthaginians, the plants and trees were burned to promote the more important agricultural uses, and capital punishment was decreed for those who dared replant shrubs or trees.

Conversely, the Romans who followed the Carthaginians protected the woodlands and set severe penalties for those who set fires. The Romans were right because the potential for the destruction of forests by fire is extremely high in the Mediterranean region, and the adverse effects of fires have left many deep, permanent scars on the landscape.

The delightful climate, with wet but short winters and long, dry summers, highly flammable fuels including woody shrubs (maquis, garrigue and matorral), the native pine forests and conifer plantations growing on rugged terrain, set the stage for disaster. Add the strong, desiccating winds from both the north and south and several hundred million residents and visitors, and an explosive combination exists. The spark which causes ignition and subsequent destruction is most often the result of negligence or, unfortunately, in too many cases is intentional.

Unwanted forest fires frequently cause irreparable and irreversible damage to the human environment in the Mediterranean region. In spite of recent advances in fire management technology, both the number of fires and area burned over are increasing sharply. For example, in 1971, Italy had a "bad year" with heavy losses - 81 000 ha. of forests, maquis and scrub vegetation were blackened - while in 1970 in Spain and the south of France alone, fires blackened an area of 160 000 ha., and 21 human lives were lost. The trend in the south of France since 1970 is toward an increase in numbers of fires, but there is a decrease in area burned. In Spain, the fire record seemed to be improving in 1971 and 1972 (as can be seen from Table 1). However, 1973 was a bad year, and 1974 was one of the worst years on record.

Table 1

Forest Fire Record for Spain - 1970-74

Year	No. of Fires	Total ha.
1970	3 203	87 324
1971	1 174	34 945
1972	2 148	57 283
1973	3 765	95 257
1974	3 800	140 000
5-year average	2 726	82 900

In 1974 there were about 40 percent more fires and 68 percent more area burned than the 5-year average.

Table 2

Causes of Forest Fires in Spain 1974

Cause	Percent
Lightning	3
Negligence	40
Railroads	1
Incendiary	20
Other Causes	3
Unknown	33
Total	100

It is reported in Italy that in 1974 more than 100 000 ha. of maquis and forests were burned over.

In general, most of the forest fires in this region are started by people, and about 70 percent are due to negligence and almost 15 percent to incendiarism. Most of the fires occur during the months of July to September, and more than one-third start along roads. In France (see Table 3) some 76% of fires are the result of unknown causes, but many of these can likely be attributed to man.

According to Tomaselli (1974), fire in the Mediterranean maquis is rarely the result of natural causes such as lightning. Fire is almost always the result of "negligence of passers-by who throw away cigarette-ends or who light fires for amusement as for cooking .....". Fire in the maquis is also frequently due to fires lit to burn brushwood in the countryside as along ditches. "In addition", Tomaselli (1974) says, "there are in certain regions of interest to tourists more and

Table 3

STATISTICS ON THE CAUSES OF VEGETATION FIRES IN FRANCE *

Cause	Percentage	
	Département of Hérault only, over 10 years (TRABAUD)	Entire French Mediterranean region, over 1 year (Stat. Offic., 1973
Origin unknown	76.3 %	69.5 %
Carelessness (mainly smokers)	8.0 %	5.8 %
Industrial origin	1.4 %	6.6 %
Domestic origin	1.0 %	0.4 %
Agricultural or forestry origin	9.0 %	9.2 %
Malicious origin	2.5 %	3.2 %
Lightning	1.0 %	2.7 %
Other	0.8 %	2.4 %

N.B. The official statistics are reliable since the introduction of "Project Prometheus"

* Verbal communication by L. TRABAUD

more fires deliberately started to destroy the vegetation. The aim of this is temporarily to lower the value of an area of land by depriving it of its main interest in order to be able to use it for buildings or facilities which would not otherwise be permitted."

The largest and most destructive fires occur under the influence of strong winds. In the Mediterranean region, these are usually the high velocity, desiccating föehn winds which blow from the north or northeast and in France are called "mistrals". In Spain and Italy, they are the "tramontanas". In Morocco, Algeria and Tunisia, the hot and desiccating winds, called "siroccos", blow from the desert (south) during September/October, and the relative air humidity often drops below 30 percent. In Israel, these winds are called "Sharav", a biblical term meaning "heat of the land". As a result, the maquis pine forests and dry herbaceous vegetation are extremely prone to fire during this period of critical fire weather.

It is under these adverse weather conditions, which rarely strike all the Mediterranean countries at one time, that there is a great need for cooperation and centralization. Under mutual aid arrangements any country would know what resources are available and could call on them when required. "A forest fire is an adversary which causes men to forget their differences and to unite in the face of a common enemy" (Anonymous, 1969).

The fire record has been bad, and it is getting worse. But what do "hectares blackened" mean in terms of adverse impacts on the human environment?

Velez (1974) uses four categories for evaluating effects on the human environment. They are:

1. Losses in products
2. Losses in services
3. Ecological impacts
4. Economic-social impacts

Losses in products

During 1974 Spain lost products worth 1 118 million pesetas ($22.3 million) and for 1974, 2 000 million pesetas ($40 million). Under "products" are included such marketable items as lumber, wood products, cork, forage, fish and game.

Losses in services

Losses in services include usable water and recreation values.

Ecological impacts

Ecological impacts are given as:

Damage to trees and shrubs;
Adverse effects on microclimate (higher temperatures, lower relative humidity and more wind);
Effects on the soil (losses of organic matter and nitrogen, erosion, floods, etc.);
Effects on the habitats of animal species;
Effects on animal migrations;
Effects on site productivity;
Effects on threatened and endangered flora and fauna.

Economic-social impacts

One of the social losses from fires is loss of human lives. For example, Velez (1974) reports that for Spain between 1961 and 1974, 32 lives were lost in Spain fighting forest fires, and one person was permanently disabled.

For the period of 1961 to 1973, the losses per year from forest fires in Spain varied from 754 million to 2 618 million pesetas ($15 million to $52.4 million) per year (Velez, 1974). It is evident that unwanted fires in the tree forests and matorral areas of Spain cause significant damages each year, and these impacts can be measured in monetary terms.

Some of the ecological impacts of forest fires are tangible, but they are more difficult to evaluate in terms of pesetas, francs or dollars. Studies of the dynamics of vegetation near Montpellier, France, show that after a wildfire, the pre-existing species which sprout from the stump or germinate readily from seeds, will tend to replace themselves on that site. Hence, highly flammable plants such as Rosmarinus officinalis, Brachypodium ramosum, Quercus coccifera and Cistus monspeliensis will quickly revegetate and assure the perpetuation of a hazardous fuel type.

In the matorral on the east coast of Spain near Gerona, a major fire in Los Angeles Canyon occurred in 1973 in a Quercus suber, Pinus pinea and Pinus halepensis forest. Now, the burned area is a highly flammable brushfield of Quercus coccifera, Rosmarinus officinalis, and similar species.

Further south in the Jeresca Fire area near Valencia, several fires have occurred since the last big burn of 1964. As a result, Cistus, Rosemarinus and Ulex are the only shrubs left. In some areas within the burn, there are no woody plants - only "erosion pavement" (bare ground and rocks) and a few useless herbaceous annuals.

Also, in the Valencia area, site and species deterioration occurs after fires in a conifer forest of Pinus pinaster (maritime pine) and Pinus halepensis (aleppo pine). Although Pinus halepensis trees are less resistant to wildfire than Pinus pinaster, the Pinus halepensis species will tend to dominate the site after repeated fires because fire causes greater germination of its seeds than those of the maritime pine.

Likewise, the Quercus ilex and Quercus suber stands of Tunisia are rapidly approaching the category of "rare" and/or "endangered species" in that country because of repeated fires and overgrazing.

One of the other serious consequences of forest fires is the accelerated surface and gully erosion which occurs when the vegetation burns. As a result, the downstream or off-site impacts can be equally, if not more, serious. For example, the unique fresh water Lake, Albufera, about one kilometer from the shore of the Mediterranean near Valencia, Spain, has been reduced in size from approximately 5 000 to 2 000 hectares during the past 100 years. This shrinkage is a direct result of the accelerated erosion, and much of it has been caused by forest fires upstream. According to local authorities, if this rate of loss continues, this unique and irreplaceable fishery and migratory bird santuary will disappear in less than 100 years.

Further south near Malaga, a reservoir with headwaters in the mountain of Sierra del Real, was built in 1970 to store irrigation water for local agriculture. Although the structure was designed to last several decades, erosion from a recently burned area upstream has reduced the storage capacity by 90 percent. If this rate of loss continues, the reservoir has a very limited life span.

An equally drastic water storage problem is occurring in Tunisia at the reservoir on the Oued Il Kebir River which was built in about 1935 to supply domestic water from the City of Tunis. Tunis has grown rapidly in four decades, but the reservoir has lost almost 80 percent of its storage capacity due to accelerated erosion.

These cases emphasize two key points. They are:

1) irreparable site degradation occurs as a result of repeated forest fires; and

2) off-site damage from fires can be even more destructive downstream and adversely degrade the human environment.

The major vegetation types of interest in the Mediterranean region are brush (maquis, garrigue, matorral), native pine forest and pine plantations. These are of special interest for three reasons. First, most of the fires occur in these vegetative types. Second, fires in these forest types can be the most destructive. Third, integrated fire management can be most effective in these types - particularly selective fuel modification.

The most flammable vegetative type is probably the brush (maquis, garrigue and matorral) because it is easier to ignite, and crown fires can occur under even moderate weather conditions.

In Spain, for the period 1970-74, 60 percent of the fires occurred in brush- or grass-covered areas.

Unfortunately, repeated intense fires in natural forests of pine tend to convert the type to brush. Paradoxically, most of the reforestation, using exotic and native pines, is done in burned areas which are very likely to burn again. The inevitability of fire occurrence is sometimes not considered in the design or management of the plantations.

While there are some major differences in forest fire occurrence and losses in the countries of the Mediterranean region, unwanted fires are recognized by authorities in each not only as a major constraint to production of forest products but also as a principal factor causing degradation of the human environment. Much progress has been made in integrated fire management in the Les Maures area, in the south of France - probably the most outstanding example in the world. Also, Spain has made rapid advances in fire suppression technology in the past few years. However, the drastic increase in both number of fires and burned area in 1973 and 1974 in that country (Velez, 1974), demonstrate that suppression capability needs to be supported by stronger prevention and fuel management programmes. Also, the 100 000 ha. burned area in Italy in 1974 proves the need for a well-coordinated and integrated fire management system. The fire record in Sardinia has improved with a reduction of the percent of tree forests burned in comparison to other vegetation (49% in 1950-54 to 20% in 1970-73). However, the shepherd-caused fires continue to plague the foresters of Sardinia and to do irreparable harm to the maquis.

4.1.2 Location of Mediterranean Regional Headquarters

As mentioned earlier (3.2.2) a Regional Programme Leader will be responsible for the implementation of a programme in each region except for the Mediterranean where the Global Programme Coordinator will assume that responsibility. Also, because of the present world-wide activities of FAO in fire-sponsored projects, its central location in the heart of the Mediterranean Region, and administrative support available in the headquarters of the Organization, the Coordinator should be stationed in Rome.

4.1.3 Proposals for the Mediterranean Regional Programme

Fire Prevention

(i) Problem: In each country, the number of man-caused forest fires has been increasing during the past few years - mostly due to negligence, but too many the result of incendiarism (wilful intent). Efforts to identify the incendiarists or to prosecute them have generally failed.

There is a need to conduct studies aimed at identifying problem user groups who intentionally start fires and to suggest fire prevention programmes aimed at reducing the number of such fires.

Recommendation: Propose several cooperative sociological and/or psychological studies be conducted - one each at University of Madrid (Spain), University of Padova (Italy), University of Montpellier (France) and the International Center of Mediterranean Agricultural Studies (CIHEAM).

(ii) Problem: Man-caused fires are rapidly increasing in Mediterranean region. At least one-third of these fires occur along roads, highways, or other routes of travel. Symbolic traffic safety signs have helped reduce traffic accidents in Europe. Hence, it is reasonable to assume that symbolic roadside signs to alert travellers to the hazard of forest fuels and danger of fire should help reduce the number of accidental fires.

Recommendation: Propose that a "Fire Prevention Sign Committee" be organized within the Mediterranean region to develop prototypes of several symbolic fire prevention signs.

(iii) Problem: There are many forest laws and regulations in each of the countries in the Mediterranean region. Tomaselli in his study on the degeneration of the Mediterranean maquis strongly emphasized the need for laws to protect what is frequently called "worthless brush". In reality, this valuable watershed cover should have the same legal status as "tree forests". Also, there needs to be clarification concerning the legality of burning "brushwood" in hazardous locations and during critical fire weather periods. Finally, it appears that incendiarism is not adequately covered by existing legislation.

Recommendation: Propose complete review and analysis of existing forestry and fire legislation in the Mediterranean region with special emphasis on the need for protecting the maquis, garrigue and matorral vegetative types, and to ascertain the need for laws to prevent the wilful and malicious setting of fires with the intent to destroy valuable forest and watershed cover.

(iv) Problem: There is increasing evidence that young children are accidentally (or intentionally) setting many forest fires. This may be either natural curiosity concerning fire; their reflection of the casual attitudes their parents have towards the brush cover (maquis, garrigue and matorral) in the Mediterranean region; or an overall disrespect for authority as reflected by increased vandalism.

Recommendation: Propose that special conservation/fire prevention education materials, including video tapes for TV, be developed for use beginning in kidergarten and continuing through all grades in schools. The primary objective would be to give these children an attitude of care and custodianship toward their precious but fragile environment - including the soil, plants, streams, wildlife and the atmosphere - using a fire prevention motivation.

Fire Detection

(i) Problem: In general, time from ignition to detection of forest fires during daylight hours is not excessive. Forestry agencies in the Mediterranean region usually have installed fixed observation points on high ground, use roving ground patrols, or supplementary aerial detection. Besides, most fires are discovered by other than the organized detection system.

However, there is an urgent need to detect the incendiary (intentional) fires which are ignited at night. It is important, too, that the perimeters of fires burning at night be mapped accurately.

Recommendation: The capability of flying helicopters at night has recently been developed in southern California in a task force effort involving county, state and federal agencies, as well as private industry. The Night Helicopter Operations project (with Night Vision Goggles and Forward Looking IR System) will be operational in May or June 1975. This technology is available for transfer to agencies in the Mediterranean region.

(ii) Problem: Under present circumstances, it is not physically nor economically feasible for forestry agencies to determine the extent of damages, site degradation, or off-site pollution of the human environment caused by large forest fires. Some "ground truth" sampling can be done, but the capability to assess damages over large areas is essential.

Recommendation: Propose that there be joint effort with Tropical Forest Monitoring Project to conduct feasibility studies of evaluating changes and severity of degradation caused by forest fires utilizing ERTS, Skylab, conventional aerial photography, and other remote sensing techniques and systems.

Fire Pre-suppression

(i) Problem: Fire Danger Ratings can be integral elements in a fire management system. The likelihood of fires starting (Ignition Index) and becoming large (Burning Index) are essential in planning for and executing prevention activities and in preparing to suppress any fires that may start. Yet, each of the countries visited by the consultant uses a different system to evaluate fire danger and, with the exception of southern France, little daily or seasonable use is made of fire danger rating. In some cases, ratings do not appear to reflect changes in the weather (daily or cummulatively). Also, the ratings are "Very High" or "Extreme" for much of the fire season.

Furthermore, without a uniform fire danger rating system, it is almost impossible to compare the fire danger ratings or seasonal severities with those of adjacent countries. So, this could prevent the pre-positioning of air tankers and/or an "elite corps of fire-fighters" in countries with current or anticipated Very High or Extreme Ratings, if there is no basis to compare fire conditions in one country with those of another.

Recommendation: Propose the installation in each participating country of a new Fire Danger Rating system (possibly a National FDR system from Australia, Canada or U.S.A.) for trial use in pilot districts. Evaluation should be conducted for at

least three years.

(ii) Problem: In the Mediterranean region the weather conditions which help cause destructive forest fires are droughts and strong, desiccating winds. However, except for Marignane in southern France, there are no central meteorological centres to provide early warnings of droughts and "red flag warnings" of strong winds.

Recommendation: Propose the establishment and operation of a Central Fire Weather Forecasting Centre with arrangements for appropriate communications facilities similar to the World Weather Watch. The purpose of this centre is to provide fire weather forecasts on a routine basis and special warnings of strong winds, droughts, and similar adverse fire weather to forestry and/or fire organizations in participating countries.

(iii) Problem: There are great variations in the probability of forest fire occurrence and spread in the regions during each month of the year. Yet, there is no effective method at present for evaluating on a world-wide basis the fire climates - in terms of monthly probability of fire ignition and intensity of fire spread. Such a system would be invaluable for allocation of firefighting forces and research funds, as well as evaluating potential for disastrous fires world-wide.

Recommendation: Propose that the manuscript "Fireclimates of the World" authored by Craig Chandler, Director, Fire and Atmospheric Sciences Research, U.S. Forest Service, be published and distributed.

Forest Fire Suppression

(i) Problem: Aircraft have been used in forest fire suppression for more than 50 years, but not until Operation Firestop in California were fixed-wing aircraft evaluated for cascading water and/or retardants on forest fires. In 1956, these"air tankers" or "borate bombers" as they were called, became important components of the firefighting team. Then, and even up to the present, surplus and obsolete military aircraft have been modified into air tankers.

In 1970-71, a new aircraft, called"Canadair (CL-215)",was designed for dropping 5 500 litres of water on fires. It has been found to be very useful in the Mediterranean region to pick up water from the ocean or a lake on take-off and to fly to the scene of the fire where the water is cascaded on "hot spots" along the perimeter.

There are twenty Canadairs available, ten in Madrid, seven in southern France and three in Corsica. These aircraft are on stand-by during the fire season, but use is intermittent in the immediate area. Pilots and crews would prefer steady use - to maintain skills, and they would prefer to attack fires when small (when they are most effective) than after the fires are conflagrations.

Recommendation: Propose that mutual aid agreements be developed, similar to those between Canada and U.S.A. and Mexico and U.S.A., to cover arrangements for dispatching a specified number of Canadairs to pre-determined air bases near potential or predicted "trouble spots" - before fires occur.

(ii) Problem: Many technological advances have been made in fighting forest fires during the past two decades - air tankers, helicopters, dragonwagons, to name a few. Yet, in spite of these advances, trained forces on the ground are urgently needed to build firelines, backfire, hot spot, mop up and assure positive control of each fire. Unfortunately, there are insufficient trained men available within each country in the Mediterranean region to handle fires which burn in hazardous fuels under critical weather conditions. As a result, lives are lost - six in Spain in 1974. Besides, untrained men are less efficient, cost more and are more likely to be injured.

Recommendation: Propose a "Forest Fire Management Working Group" be organized in the Mediterranean Region with appropriate representatives from respective countries. This group could then select a "Fire Training Committee" to assemble suitable materials to use in developing an "elite corps" of firefighters in each participating country - available for flying to potential trouble spots.

Fuel Management

(i) Problem: Some of the most flammable fuel types in the world are found in the Mediterranean region. Natural stands of conifers such as Pinus halepensis, Pinus pinaster and Pinus pinea are "fire climax types", i.e. created by fire. In addition, the maquis, garrigue, or matorral (brush) types are highly flammable, and when fires occur, they also tend to replace themselves. Further, the more flammable of these species, such as Rosmarinus and Cistus, begin to dominate the fire-scarred sites.

Hence, larger fires in these vegetative types are inevitable unless selective fuel modification is done in advance of fire occurrence.

Recommendation: Since the most dramatic demonstration of integrated fire (and fuel) management in the world is in the Les Maures "pilot district" of the south of France, the results of the work here should be summarized and published in several languages.

There will be costs of translation from French to Spanish, Italian and English, and need to publish at least 1 000 copies.

(ii) Problem: Many countries of the world (including the Mediterranean region) are developing man-made forests, mostly conifers, in large, continuous blocks. Ability to plant conifers exceeds the capacity to protect them from fire. For example, in the 1960's, Spain lost about 20 percent of the plantations to fire each year. Besides, in the Mediterranean region, conifers are being used to rehabilitate old burns - so losses from fire are inevitable - unless selective fuel modification is done in existing plantations and all new plantations are designed with fire safety in mind.

Recommendation: Propose the completion of a manuscript begun in 1967 by Carl Wilson and up-dated in 1971. Title is "Conifer Plantation Protection against Forest Fires" (Technical reviews are needed).

(iii) Problem: Today in Spain, Tunisia and Sardinia shepherds are causing forest fires, as they were 2 000 years ago, to obtain more forage in the fall for their flocks. Since these fires often occur under critical weather conditions, they do irreparable damage to maquis, conifer and oak forests. And foresters are further alienated.

Yet, there is evidence from research studies near Montpellier, France, that late fall burns under carefully prescribed conditions can encourage growth of a perennial grass and inhibit growth of the garrigue shrub Quercus coccifera.

Recommendation: Propose that cooperative studies similar to those by "the Centre d'études phytosociologiques et écologiques, Montpellier" be sponsored in an appropriate area, such as Sardinia.

Concurrently, a watershed study also is needed in Sardinia to determine how much off-site damage is occurring from forest fires on steep slopes.

(iv) Problem: The most flammable (hazardous) plants in the maquis, garrigue and matorral is usually one or more of the following species: Cistus sp., Genista and Rosmarinus. Further, since they are pyrophytes, they tend to replace themselves in the plant community. It would be desirable, therefore, to replace these undesirable plants at selected locations with prostrate drought resistant plants of lower flammability.

Fortunately, after more than 40 years of research and field tests in the U.S.A. and several recent studies in the Mediterranean region, several candidate plants are available for mass planting or direct seeding after fires. These plants are: Salvia sonomensis, Atriplex muelleri, Galenia pubescens and Artemesia caucasia. Although small field tests are being conducted in several Mediterranean countries, the trials need to be expanded.

Recommendation: That extensive field trials be conducted with these plants in France, Spain, Morocco, Tunisia and Sardinia during 1975 - 1980, and that research be continued to identify other fire resistant plants and trees.

(v) Problem: Observations in the field and reports show that there is irreversible degradation of forest ecosystems from repeated unwanted fires. For example, the oak-pine forest may be replaced by pines; fire resistant pines, such as Pinus halepensis, will tend to replace other conifers; and the most flammable shrub species will replace themselves. So, fires "breed more fires". Finally, an "ecological desert" with "erosion pavement" may exist. In spite of the long-term degradation in the Mediterranean region, little specific information is available for use by foresters and other land use planners.

Recommendation: Propose that studies be conducted in representative vegetative types in the Mediterranean region to evaluate the extent and severity of site deterioration or degradation as a result of unwanted forest fires.

(vi) Problem: Observations and subjective evaluations in the Mediterranean region indicate that site degradation from unwanted forest fires causes soil erosion and floods (off-site) which have serious, if not irreversible, effects on cities, streams, lakes, man-made reservoirs and the Mediterranean Sea. Objective measurements of these adverse impacts on the human environment are not available, but they are urgently needed in helping justify stronger programmes of integrated fire management.

Recommendation: Propose cooperative studies be conducted in representative countries to determine rates and order of magnitude of these adverse off-site effects of unwanted forest fires on the human environment.

Education and Training

(i) Problem: In each of the countries visited, there is much knowledge in fire management which is of interest to other countries. Foresters and fire people say that their respective countries have few opportunities to learn how their neighbours are solving similar fire problems. Some of the countries visited have simple solutions to the difficult problems of nearby countries. Yet, there is no medium, at present, for the exchange of ideas on mutual problems.

Recommendation: International Symposium and/or study tour on forest fire management should be organized periodically to allow exchange of ideas and experience.

(ii) Problem: There are several outstanding forest fire specialists in the Mediterranean countries who could provide assistance to research and State and Private Forestry units in Australia, Canada and U.S.A. - and simultaneously broaden their experience. Similarly, there are competent scientists and fire specialists in North America and Australia who could be of great help in the Mediterranean region.

Recommendation: Suggest setting up a formal exchange programme of scientists or other forest fire specialists among interested countries - with a one-year limit on a man-for-man (or woman-for-woman) basis. Home country continues to pay salary (5-year evaluation period).

(iii) Problem: Foresters and fire specialists complain that they not only do not know what is going on in "FIRE" in Australia and North America, but also in the next-door Mediterranean countries with similar forest fire problems. Most express a need for a newsletter, like the Fire Management Notes from U.S.A., but somewhat less formal.

Recommendation: Propose informal "Fire Management Newsletter" be developed and issued.

(iv) Problem: Since the "pilot district Les Maures" is the best example of "Integrated Fire Management" in the world, more people should have the opportunity to learn from it.

Recommendation: Encourage France to establish the Les Maures "pilot district" as a special training area which would be available for study by trainees from many countries. Sponsor training for selected trainees.

4.1.4 Summary of Proposed Projects and Requirements for Implementation

The following table summarizes the specific projects and activities requiring immediate attention in the Mediterranean region, gives estimates of the number of man-months required for their implementation, and suggests the earliest possible times when action could be initiated. Further information on the global requirements is given in section 5.

SUMMARY OF PROPOSED PROJECTS AND REQUIREMENTS FOR IMPLEMENTATION
FOR THE
MEDITERRANEAN REGION

Description of Projects	Estimated man months	Recommended starting date	Remarks
PREVENTION			
1. Conduct cooperative sociological or psychological studies	18	year 1	At least three studies need to be conducted by university faculty member and graduate student in advanced countries with most critical incendiary fire problems.
2. Organize a "Fire Prevention Sign Committee" to develop prototypes of symbolic fire prevention signs for roadsides	1	year 1	Committee in this region could use as guides the symbolic signs developed by North American Forestry Commission Fire Management Working Group.
3. Review and analyze existing forestry and fire laws with special emphasis on need to protect maquis and reduce incendiary fires	3	year 1	Should be joint study involving law school faculty and forestry fire agencies
Develop conservation education material for children in all elementary school grades emphasizing fire prevention	6	year 1	Need cooperative study involving Education Dept. of a university and forest fire agencies - with assistance of audio-visual staffs and elementary school teachers (Coordinate with similar proposed projects for Central America and Africa).
DETECTION			
1. Transfer Night Helicopter Operations technology from USA to Mediterranean Region.	0	year 0	Can be activated by formal request to Chief, U.S. Forest Service. No direct costs except travel.
2. Conduct feasibility studies of aerial photography or other remote sensing methods.	6	year 1	Joint effort of existing Tropical Forest Remote Monitoring Project and Forest Fire Management to evaluate technique for measuring rates and magnitude of vegetation degradation.

Description of Projects	Estimated man months	Recommended starting date	Remarks
PRESUPPRESSION			
1. Install new FDR system in pilot districts of Region and evaluate.	6 (assumes no contribution by WMO)	year 2	Based on WMO Consultant's report, one FDR system would be installed in pilot districts of interested countries. Should be evaluated at least 3 years.
2. Establish and operate Central Fire Weather forecasting Centre similar to World Weather Watch.	1 (assumes 3 man/mths contribution by WMO)	year 2	Based on WMO Consultants report, either World Weather Watch needs to include fire weather forecasting or a new centre needs to be located in interested and advanced country.
3. Publish Chandler's "Fireclimates of the World"	1	year 1	Manuscript will likely be published in English in USA. Travel to Rome and return and translation into French and Spanish will be needed. (Is applicable to all 3 regions).
4. Develop mutual aid agreements to cover dispatching of Canadairs to pre-determined air bases near predicted trouble spots.	1	year 1	Convene technical workshop on "International Mutual Aid with Aircraft on Forest Fires".
5. Set up a Fire Mgt. Working Group to develop fire training materials.	0 (can be done with present staff)	year 0	Representatives from respective countries will constitute the Forest Fire Management Working Group which will select a Training Committee to assemble suitable materials for training.
FUEL MANAGEMENT			
1. Publish the results of the "Les Maures" pilot district.	1	year 1	Encourage France to publish in French. Then, manuscript will need translation into English and Spanish.
2. Publish manuscript, "Conifer Plantation Protection against Forest Fires" and distribute.	2	year 1	Manuscript needs to be revised, updated, and have technical reviews. Then, final draft will be ready for printing in English. Needs translation into French and Spanish. (Is applicable to all 3 regions).
3. Conduct cooperative prescribed burning studies similar to those in France in other countries	24	year 0	Requires the scientific skills of plant ecologists and/or fire management specialists to plan studies and execute prescribed burns.

Description of Projects	Estimated man months	Recommended starting date	Remarks
FUEL MANAGEMENT 4. Make extensive field trials of four lower flammability shrubs & continue research to identify other plants of this kind.	36	year 0	The field tests require botanists, plant physiologists, ecologists, or pasture specialists. These studies should be conducted for not less than 5 successive years.
5. Make studies in repsentative vegetation types in this region to determine extent and severity of site deterioration because of unwanted fires.	60	year 1	These studies require at least 5 scientist man-years to plan, conduct and report. Ecologists or watershed management specialists would be most desirable.
6. Conduct cooperative studies in representative countries to determine rates and order of magnitude of off-site effects of forest fires on the Human Environment.	36	year 1	These studies require at least 3 scientist man-years to plan, conduct, and report. Watershed specialists or hydrologists would be needed.
EDUCATION & TRAINING Organize periodical symposium and/or study tour to allow exchange ideas and experience			
2. Develop an informal "Fire Management Newsletter" and issue within Mediterranean Region.	1	year 1	Programme Coordinator (Rome) to work with interested countries in Mediterranean Region in developing "newsletter".
3. Encourage France to set up Les Maures "district" as training facility for all countries.	0	year 1	Programme Coordinator to work with France in encouraging development of this pilot district at Les Maures as "International Fire Management Training Facility".
4. Set up a formal exchange program among fire-specialists in interested countries - with a one-year limit on a one-to-one basis.	1	year 1	Programme Coordinator to notify interested countries in Mediterranean Region and in North America. (Salaries paid, but travel costs needed).
Total man/months	204		

4.2 Central American Region

4.2.1 Background and Justification

Until about 150 years ago, Central America, the land bridge between two continents, was just one country with what is now Guatemala City serving as the capital. Today it consists of a number of small countries. Like miniature continents, each country, except El Salvador and Belize, has two coastlines - the Pacific Ocean and Caribbean Sea. Contrary to Europe and North America, the dry months and forest fire season occur between December and June.

Natural disasters, including forest fires, all too frequently leave behind death and destruction in this region. For example, in Nicaragua on 22 December 1972 one of the most damaging earthquakes of modern times killed an estimated 25 000 residents and visitors in the heart of its capital, Managua, and levelled most of the structures. More recently, in 1974 Hurricane "Fifi" struck the San Pedro Sula area of Honduras and wiped out several villages, and the floods and debris caused multimillion dollar damages to agricultural crops and massive erosion from fire-denuded mountain watersheds.

Less spectacular but more damaging pasture and escaped plantation fires for centuries have been destroying forests, deteriorating the soils, sedimentating streams and reservoirs, and causing flood damage to communities. Population pressures are forcing the pastures and small plantations to creep further up the steep slopes, and this presents an even greater threat to the residual forests and watersheds.

Budowski (1966) and others mention that in Central America almost all fires are intentionally set by man. This is confirmed by foresters and fire specialists contacted by the consultant in Guatemala, Honduras, Nicaragua, and Costa Rica. However, with the exception of Balize which began keeping records in the 1940's, Nicaragua in 1968 and Honduras in 1972, there are few statistics available to confirm this statement. Moreover, with the possible exception of Balize (Wolffsohn, 1967), there are generally no data available for the Central American countries for fires in the matorral or tropical rain forests. As a result, the problems of the region are vastly greater than the records show.

Most of the pastoral or agricultural burning - and forest fires - coincide with the drier season of the year - usually during the first few months of the calendar year. Batchelder (1967) suggests that this burning takes place at the end of the dry season, although this consultant saw numerous fires in Guatemala, Honduras, Nicaragua and Costa Rica during mid March. For example, on the short flight between the Pacific Ocean and Guatemala City, at least ten fires were seen burning in forests or rangelands. Besides, there were many other recently charred areas.

Pasture and plantation fires - as well as occasional "grudge fires" continue to occur in Honduras. The consultant visited the scene of a 60-hectare fire which occurred on 22 February 1975 a few miles northwest of Tegucigalpa. The fire was apparently started because the landowner would not sell fuel wood. The area also had been burned several years ago, and the fire spread rapidly upslope, but slowed as it entered the more favourable microclimate of second-growth Pinus oocarpa forest along the ridge.

In Nicaragua one of the most urgent problems concerns the many thousands of hectares of steep,highly erodible watersheds which are burned annually for the renewal of pastures and clearing of land for agriculture. Even from an aircraft at 10 000 feet above the earth, it is possible to observe these fires and the watershed damages they inflict.

Costa Rica has critical forest fire problems. The consultant, accompanied by the

local FAO Project Manager, on 21 March 1975, saw more than 100 fires while driving along the Pan American Highway (Costa Rica No.2). In addition to the re-burning of pastures, new pastures are being created, seemingly haphazardly, by clear-cutting and burning the tropical forests. Also, due to sharp increases in the retail price of sugar, more forest areas are being converted to sugar plantations on steep hillsides.

Child-caused fires are a serious problem in many parts of the world, and Costa Rica is no exception. The consultant saw two fires recently started along the Pan American Highway by children 6 to 8 years' old. It was apparent they were emulating their parents.

Foresters say there is a wide variation in forest fire laws in Central America. In Guatemala, it is reported that "anyone can start a fire any place at any time". Costa Rica has a law which prohibits open burning during the fire season without a permit. However, except for a few of the most conscientious managers of sugar cane plantations, this law is largely ignored. In the other countries, laws either do not exist, or they are not enforced.

There are a few reliable estimates available on the adverse effects of unwanted fires on the human environment in Central America. According to Fiester (1975) and Ferraté (1973), forest fires and over-grazing are causing serious damage to watersheds and jeopardizing hydroelectric power systems in Guatemala. Ferraté said that three major projects have lost almost 40 percent of their generating power due to erosion from deteriorating watersheds. In the vicinity of Santa Cruz del Quiche, the loss of soil in surface erosion has been estimated at 34 metric tons per hectare per year (Ferraté and Flannery, 1973).

Accelerated erosion is causing serious off-site damages in Costa Rica, too. Some of the "clear-cut and burn" areas are extremely steep- nearly the angle of repose for the respective soils (70 to 75 percent). The consequence of this new clearing is mass erosion (slips) in pastures, corn and sugar cane fields. Soil is moving into small canyons and also into the Pan American Highway.

Another adverse effect of unwanted fires is the large amount of smoke and ashes contributed to the atmosphere. March and April are particularly bad months for fire-caused air pollution in Central America. In Honduras, for example, smoke from pasture and plantation burning combines with low-level clouds, and a heavy haze forms. This makes fire detection from some look-out towers almost impossible.

Also, the consultant was informed that because of the "agricultural burning", commercial aircraft arriving at Guatemala City International Airport must frequently use "instruments" to land during March-April. Private aircraft are grounded.

In Costa Rica the smoke-filled valleys made viewing the scenery along the Pan American Highway difficult, and the eye irritation was almost as bad as southern California smog.

Plantation and forest fires in this region are contributing to the world's energy crisis. Although there is a shortage of fossil fuels in Central America, little effort is being made to utilize the cellulosic fuels after clear-cutting. Yet, the largest single use of wood in the world is still the oldest one - fuel. Moreover, a recent study in Oregon, showed that wood fuel costs, in dollars per million BTU's used for steam generation, were about 25 percent as much as natural gas or fuel oil (Corder, 1973).

In addition to degrading the human environment, destructive fires are continuing to destroy the pine forests of Central America as they have for centuries. Cooke (1909) said that 400 years ago, prior to the arrival of Spaniards in Central America, there must have been many more pine forests than he could find when he made his investigations in 1908. As proof, he said he found "numerous pitchy roots far away from any living pine forest".

According to Hancock (1975), until protection was started in Honduras about 60 percent of the pine forest area was burnt annually causing the death or retarding the growth of regeneration and damaging the older trees. Also, the bark beetle epidemic in 1963-64 caused many trees to die and, as snags, they represent a special kind of aerial fire hazard.

In addition, the pine savannas in Honduras and Nicaragua have been heavily damaged by fire. When wildfire enters the Pinus caribaea forest, all the seedlings are killed and most of the small poles. Larger trees up to 12 inches in diameter may also be damaged or killed. As the stand is opened to additional sunlight, more grass becomes established. With repeated fires, the forest becomes more and more open, and regeneration of the pines disappears. Grasses dominate the site, and fires become more intense. Meantime, according to Budowski (1966), a hard pan is formed. Not only do the pines disappear, but most of the grasses are unpalatable for livestock.

One of the principal reasons the countries in Central America are suffering from the adverse effects of forest fires is that, with the exception of COHDEFOR in Honduras and INFONAC in the Nicaragua pine savannas, the fire suppression organizations are almost non-existent, poorly equipped or inadequately trained.

Yet, on the positive side, Central America is also rich in forest resources - if wisely used (FAO, 1974). Forests cover 15 490 000 hectares in Central America - more than one-third of the land area. The first requirement is to organize to control fires and to develop intensive management plans including reforestation.

There are sound economic reasons for preventing fires and developing viable forest industries in Central America. For example, in 1972, Guatemala imported $16.4 million worth of pulp, paper and cartons, yet only exported $6.8 million worth - a deficit of $9.6 million per year - much of which could come from the altiplano forests if properly managed and protected.

A development plan has been prepared for the altiplano (elevations of 800 to 4 000 metres) where there are 1 000 000 hectares of pine forest; another 1 000 000 hectares have the potential for development. There are ten species of pine with an estimated average of 50 years - most of which is owned by municipalities.

A "pilot district" called "Totonicapan" is being established in the altiplano. This will provide opportunity to develop a strong pulp, paper and fibre industry. Besides, the local residents will have a "stake" in the products and can become involved in a long-range forest management programme, fire prevention, education, fire danger rating and fuel management activities.

Another "pilot district" of 3 200 hectares is being established in the Jutiapa area of Honduras (Hancock, 1975). There are four small communities (Jutiapa, Mendes, La Jagua and Talgua) and some scattered houses that influence the ability of COHDEFOR, the fire organization, to protect the district from fire. Most of the residents create plantations and also graze cattle within the area. Burning to obtain fresh pasture for cattle and escaped fires from plantations are the major causes of forest fires now, but the following special actions are being taken to reduce fire occurrence and damages:

a) Employ as many people from the area as possible.

b) Set aside areas for cattle grazing to be burnt under guidance.

c) Issue permits for burning plantations and prosecute violators.

d) Use schools to encourage young children in the district to become conservation-minded.

e) Hold extension workshops for the adults and have "open house days" to demonstrate conservation work.

f) Post fire prevention signs.

g) Maintain "vigilantes' patrols".

h) Demonstrate that local people can share benefits from conservation such as resin tapping, which is now in operation.

The Jutiapa Pilot District has high potential for demonstrating integrated fire management in the Honduras Pinus oocarpa and Pinus pseudostrobus pine forests. In concept, it is similar to the Les Maures "pilot district" in the Côte d'Azur area of France. However, these plans must first be fully implemented before the benefits can be realized.

In Nicaragua major efforts have been concentrated in protecting the forests of Pinus caribaea in the vast savannas northwest of Puerto Cabezas. The objective there was to develop a long-range plan for managing the pines in that proposed industrial forest - in principle, to protect from fire the pine reproduction in the savannas so that it can grow to merchantable size.

Total area of the project is 1 503 405 hectares of which 510 000 hectares is Pinus caribaea reproduction. The northern section, 335 000 hectares, has been given special attention by Proyecto Forestal (INFONAC). Of the total area, 27 000 ha is covered by broadleaf trees or marshes. Terrain is generally level to undulating and is less than 100 metres above sea level.

During the 4-year period (1968 to 1972) covered by the report (Hancock 1972), there were a total of 3 346 forest fires. This number has been reduced considerably during the past few years by an effective socio-economic fire prevention campaign. One phase of the special effort has been to develop cooperative working arrangements with the local Mosquitia (Moskito) Indians. This has been a two-pronged approach involving Indians in the Waspan and Ulwas Villages. The first part is the "food-for-work programme" in which the Indians can work part of each day on forestry projects such as, fire training, bridge-building or tree-thinning. Then, they are paid in flour or oats.

The second approach is to help the Indians obtain title to the land which their villages occupy so they can become custodians of their own forests. This special effort seems to be successful because a few years ago there was an average of almost 40 fires a day in the project area during the fire season. Now, there are only 12 to 15 per year.

However, in 1973 a fire started southeast of the project headquarters, Slilma Sia, under critical weather conditions - 18 knot south wind, temperatures greater than 99° F and relative humidity 30 to 40 percent. After 12 days the fire had blackened 30 000 hectares (almost 10% of the project area) and, for a time, had threatened to destroy the headquarters' facilities. This fire demonstrates one special protection need:

- **Implementation of a large-scale fuel modification system** - including thinning and pruning of pines at key locations and prescribed burning on a selective basis.

Holdridge (1975) who has worked in Central America for many years, believes foresters should be using more prescribed burning in pine forests to reduce the fuel hazard (and potential for large fires) and to encourage pine reproduction.

Budowski (1966) also comments that he is much concerned that so little work has been done on the use of controlled fires (prescribed fires) although he said a 1946 report from British Honduras had recommended use of this technique of fuel hazard reduction.

Fortunately, several prescribed burning experiments are underway. For example, in Honduras, the 3 200-hectare Jutiapa Pilot District will be used for experiments in prescribed burning, aimed at hazard reduction. Reproduction of Pinus oocarpa and Pinus pseudostrobus according to Hancock (1975) and others, must be at least 7 years old to withstand the effects of prescribed burning. Then, plans call for light prescribed burns every 3 to 5 years to create a strategic mosaic of vegetation. Tentatively, through use of prescribed fires, a fuelbreak system along ridges will be coordinated with existing rocky expanses, stream courses and the broadleaf forest - so as to divide the area into 16 blocks of about 200 hectares each. Also being considered, is the establishment of fire resistant broadleaf species along creek sides to improve the effectiveness of these zones as vegetative barriers.

Further, in eastern Nicaragua there are indications in Pinus caribaea forests that prescribed burning can be an effective hazard reduction tool if carefully utilized. Reproduction up to 6 to 8 years of age is very susceptible to fire, but this species seems fire resistant after 20 years. So, prescribed burning guidelines need to be developed, and this will require studies over several years. Already, prescribed burning is being used in INFONAC District I to reduce the fuel hazard on the most vulnerable north perimeter of the unit.

Despite the progress being made to develop "pilot districts" in several Central American countries, there are still numerous investigations which must be conducted in order to fill in the gaps in fire management knowledge. Some examples of needed studies are:

- Fire spread and other fire behaviour studies in representative fuel types.

- Analysis of fire management statistics.

- Evaluating sample fire danger rating systems.

- Evaluating fire resistant trees, shrubs, and grasses for dividing fire management units into national blocks or mosaics.

4.2.2 Location of Regional Programme

Pasture burning, plantation development (milpah) and forest fires as described in 4.2.1 are critical and urgent problems requiring solution in each of the four countries visited by the consultant in Central America. Hence, there is strong justification for the development of a well-coordinated regional programme.

A good case can be made, too, for locating the Regional Leader at Guatemala City. However, both the Regional Representative for UNDP and FAO Country Representative for Central America suggested otherwise. Instead, the Headquarters of the Central American Regional Programme for Integrated Fire Management ought to be located where there is a viable national programme and good prospects for research investigations to be conducted by qualified university faculty and students.

The Regional Programme for Central America should be centred at Tegucigalpa, Honduras, where there is a competent forestry and fire management staff (COHDEFOR), strong fire management leadership by FAO and the School of Forest Sciences at Siguatepeque. The Jutiapa "pilot district" in integrated fire management can be used as a demonstration and training area. Moreover, it is significant that the major weather forecasting facility for Central America is situated at the International Airport Toncontin on the edge of Tegucigalpa. This unit could serve as a coordination centre for forecasting droughts or "red flag warnings" of critical fire weather for the forests and range lands of Central America. Finally, Tegucigalpa, Honduras, is easily reached by commercial airline from other countries in Central America, and it has excellent hotel and conference facilities for symposia and workshops.

4.2.3 Regional Programme - Central America

Fire Prevention

(i) Problem: For economic, social, or psychological reasons, adults start most of the destructive pasture, plantation, or forest fires in Central America. Since children usually adopt the same attitudes as their parents, the next generation will probably follow the age-old custom of pasture-burning, plantation burning and general lack of care with fire unless they are taught basic conservation principles in the earliest grades of elementary school.

Recommendation: Propose that an educational project be started with the specific objective of developing suitable teaching materials in water, soil and forest conservation for use by all grades in elementary school beginning with kindergarten. The materials should be oriented toward developing an attitude of custodianship concerning the environment - including water, soil, forests and the atmosphere. Principal objective is to develop a land ethic in children. In the long run, this project could have a most profound and far-reaching influence in protecting the human environment from forest fires. Also, this would provide an excellent opportunity to reactivate the FAO "School Forests" project initiated at the Fourth World Forestry Congress, Dehra Dun, India, 1954.

(ii) Problem: In Central America, there are apparently few forestry or fire laws which prohibit people from igniting fires in grass, brush, or forest vegetation during critical fire weather. Moreover, the existing laws are either inadequate, or there are too few forest officers available to enforce them - or both.

Recommendation: An in-depth study is needed of the existing forest and present fire laws in each country of the Central American region. In addition, proposals are needed for revising existing laws or for enacting new forestry and fire legislation.

(iii) Problem: Destructive roadside fires seem to be increasing in Central America especially along the route of the Pan American Highway. There needs to be some meaningful way to inform travellers who smoke or use camp fires that much of the vegetation through which they drive is highly flammable.

Recommendation: Traffic safety signs using symbols apparently have been found effective in reducing the incidence of automobile accidents in Europe. Hence, a similar approach might be equally useful in forest fire prevention. The North American Forestry Commission's Fire Management Working Group has developed a series of signs for Canada, Mexico and U.S.A. which might be usable.

Detection

(i) Problem: There are no current data or recorded statistics available in Guatemala, Honduras, Nicaragua, or Costa Rica on the number or size of pasture, plantation, matorral or forest fires which occur and cause damage each year. Nor is it physically or economically feasible to determine accurately the extent of damages, site degradation, or off-site pollution of the human environment caused by unwanted fires. Limited "ground truth sampling" can be done on a very selective basis. However, the ability to assess damages currently over very large areas is essential for integrated fire management and sound land use planning programmes in each country in Central America.

Recommendation: Tropical Africa has been selected by the Tropical Forest Cover Monitoring Project as the best choice to begin monitoring studies. However, the consultant recommends that several preliminary studies be conducted by the above project in Central America as soon as possible because of the urgent need for information on the rates of depletion and degradation of grass and woody vegetation types. In some cases the rates of deterioration and impacts on the human environment may be greater here than in the tropical forests of Africa.

Presuppression

(i) Problem: In spite of the many technological advances made in forest fire suppression during the past few decades, ground forces, including men, still play a major role in building firelines and assuring control. Well-trained men are not only more effective but also have fewer accidents. Therefore, the best available materials should be developed for training prospective fire-fighters.

Recommendation: Propose that the best of the currently available Spanish language fire training manuals and visual aids be assembled and published for use in all the Central American countries. Samples are:

1. "Manual de Prevención y Control de Incendios Forestales" by M.J.D. Hancook, El Salvador, December 1973.
2. "Manual de Prevención y Lucha contra los Incendios Forestales" by ICONA, Madrid, Spain, 1972.
3. "Manual de Prevención y Combate de Incendios Forestales" by Carlos F. Solórzano M., Ministry of Agriculture, Caracas, Venezuela. Third Edition, 1967.
4. "Manual de Control de Fuegos en el Noreste de Nicaragua" por A. Wolffsohn (Documento de Trabajo).

(ii) Problem: The most damaging forest fires in Central America occur following long droughts and/or during periods of critical fire weather. Yet, there have been very few studies or documentation by meteorologists or climatologists of the duration or frequency of these adverse conditions which lead to destructive forest fires. Also, there is no forecasting centre in Central America which can provide current information to each of the countries concerning the onset, duration or decay of strong winds or other weather conditions favourable to fire ignition and spread.

Recommendation: Propose establishing a Fire Weather Forecasting and Research Centre at the international airport in (Toncontin) Tegucigalpa, Honduras. This facility now serves as the principal aviation forecasting headquarters for Central America. With a new charter and some additional staff assistance, it probably could conduct both research and development studies as well as meet the forecasting requirements. Weatherfax and other teletype facilities are now installed. In addition, if Tegucigalpa is to serve as headquarters for the Regional Leader for Central America, this unit could also assist in implementing and operating a standard fire danger rating system in "pilot districts" in respective countries.

Fuel Management

(i) Problem: Poor quality pasture management is one of the most serious fire problems in Central America. Most of the examples of pasture or range management available to cattle and sheep owners are on steep slopes with volunteer annual or poor quality perennial grasses.

Recommendation: Propose establishing a "pilot district" of pasture management in each country in Central America utilizing the most modern techniques.

(ii) Problem: Observations by the consultant and reports show that there is irreversible degradation of forest ecosystems in Central America from repeated forest fires. Persistent, destructive pasture and escaped plantation fires have for centuries been destroying forests and causing accelerated soil erosion. Population pressure is forcing the pastures and plantations to creep further up the steep slopes, and to pose an even greater threat to the residual forests. Despite long-term degradation of this region, little quantitative information is available for use by foresters and other land use planners.

Recommendation: Propose that cooperative studies be conducted in representative vegetative types in the Central American region to evaluate the extent and severity of site deterioration as a result of unwanted fires.

(iii) Problem: Observations and subjective evaluations in the Central American region indicate that site deterioration from unwanted forest fires causes soil erosion and floods which have serious, if not irreversible, effects on streams, lakes, man-made reservoirs, and hydroelectric facilities. Objective measurements of these adverse impacts on the human environment are not available, but they are needed to help justify strong programmes of integrated fire management.

Recommendation: Propose that cooperative studies be conducted in representative countries to determine rates and order of magnitude of these adverse off-site effects from forest fires.

Training and Education

(i) Problem: There are competent fire-oriented foresters in the Central American countries. However, the skills of individuals in integrated fire management, including prescribed burning and other aspects of fuel management, could be expanded and enhanced by training assignments to North America. Also, their special backgrounds of experience in several fuel types in Central America could be mutually beneficial to the countries to which assigned.

Recommendation: Propose that a project involving the exchange of key fire-oriented personnel in Central America be developed in cooperation with the Fire Management Working Group of the North American Forestry Commission. The exchanges would be planned on a one-for-one basis for one year. The sending country would continue to pay its employee's salary, but costs of travel and other associated expenses would need to be covered. Key people in all countries visited were enthusiastic because the "exchange" means fresh ideas are brought to the country. Similarly, the employee returns with renewed interest in his own job.

(ii) Problem: Each of the countries in Central America has special forest fire problems for which it has no solutions. Neighbouring countries frequently have solutions or insights to some fire problems which could be of value to their neighbours. For example, the results from developing the integrated fire management "pilot district" in the Jutiapa area of Honduras could be of value to Nicaragua which is setting up the Totonipacan "pilot district". Similarly, the benefits of the fire prevention efforts with the Mosquitia Indians of Nicaragua could be extremely useful to Honduras when that country sets up a "pilot district" in the Pinus caribaea forests of eastern Honduras. It is important that this information be exchanged on a timely basis.

Recommendation: Propose that a Central American symposium on "Integrated Fire Management" be held as soon as possible at Tegucigalpa, Honduras and that all countries in Central America be invited to participate.

The Symposium could not only serve as a medium for summarizing state-of-the-art in fire management in Central America, but also provide a means for setting up a Fire Management Working Group.

4.2.4 Summary of Proposed Projects and Requirements for Implementation

As was done for the Mediterranean region in section 4.1.4, the following table summarizes specific projects and activities requiring immediate attention in the Central American region, gives estimates of the number of man-months required for their implementation, and suggests the earliest possible times when action could be initiated. Further explanation on implementation requirements is given in section 5.

SUMMARY OF PROPOSED PROJECTS AND REQUIREMENTS FOR IMPLEMENTATION FOR THE CENTRAL AMERICAN REGION

Description of Projects	Estimated man-months	Recommended starting dates	Remarks
FIRE PREVENTION			
1. Make trial use of symbolic signs developed by Fire Management Working Group, North American Forestry Commission.	0 (Can be done with present staff)	year 0	Suggest contact by proposed Programme Coordinator with Chairman of Fire Management Working Group, North American Forestry Commission. Next, a representative country in Central America could conduct field trials.
2. Conduct in-depth study of present forestry and fire laws and recommend new legislation.	3	year 1	Should be a joint effort involving forest fire agencies and law school faculty.
3. Develop education/ conservation fire prevention materials for early grades in elementary schools.	6	year 1	Should be cooperative, interdisciplinary study with Education Department of a university, forest fire agencies, audio-visual aid staffs, and elementary school teachers.
DETECTION			
1. Conduct preliminary studies with Tropical Forest Monitoring Project to determine rates of degradation of burned areas.	3	year 2	Joint preliminary study with Tropical Forest Monitoring Project and Forest Fire Management using approach developed by McArthur (Australia).
PRESUPPRESSION			
1. Assemble best available fire training materials in Spanish for use in Central America.	3	year 1	Initial drafts are being prepared in Honduras, but assistance in assembling for publication is needed from proposed Programme Coordinator.
2. Set up a Fire Weather Centre at Tegucigalpa, Honduras Airport, now serving as forecast centre for aviation for Central America.	0 (Can be done with present staff)	year 1	With the guidance of WMO consultant's report and FAO (Honduras), fire weather forecasts could be started at an early date.

Description of Projects	Estimated man-months	Recommended starting dates	Remarks
PRESUPPRESSION (cont'd)			
3. Install new FDR system in pilot districts of region — evaluate 3 years.	3	year 1	With the guidance of WMO consultant's report, a new FDR system could be installed in Jutiapa pilot district in 1976. Fire Danger Rating consultant needed.
FUEL MANAGEMENT			
1. Conduct prescribed burning studies in pine forests and Pinus caribaea savannas in several countries.	36	year 2	Requires assistance from consultants from Australia or North America as well as cooperative studies by forestry school faculty and students. (Minimum of 3 years.)
2. Establish pilot district of pasture management in each country of this region using the most modern techniques of "safe prescribed burning, type conversion and best grasses".	48	year 1	Will need supervision by range or pasture management consultants and participation by agronomists from local universities or forestry schools.
3. Make studies in representative, vegetative types in this region to determine extent and severity of site degradation caused by fires.	60	year 2	These studies require a minimum of five scientist man-years to plan, conduct and report. Specialists in ecology or watershed management will be needed.
4. Conduct cooperative studies in several interested countries to determine rates and magnitude of off-site effects of fires on the human environment.	60	year 2	Studies will require at least five scientist man-years to plan, conduct and report. Watershed or hydrology specialists would be needed as consultants.
EDUCATION AND TRAINING			
1. Hold a Symposium on "Integrated Fire Management" at Tegucigalpa, Honduras as soon as possible.	1	year 1	The proposed Regional Programme Leader should select a "programme committee" so that participation in Symposium can be scheduled.

Description of Projects	Estimated man-months	Recommended starting dates	Remarks
EDUCATION AND TRAINING (cont'd)			
2. Exchange fire-oriented personnel through North American Forestry Commission on a one-for-one basis for maximum of one year.	1	year 2	Proposed Regional Leader should notify interested countries through Global Programme Coordinator.
3. Develop "Fire Management Newsletter" and issue within Central American Region.	1	year 1	Proposed Regional Leader should work with interested countries in Central American Region in developing the informal newsletter.

Total man-months - 226

4.3 African Savanna Region

4.3.1 Background and Justification

Fire problems in Africa are commensurately large.

Evidence indicates that man in Africa began to make and to use fire after the Early Stone Age. Since then, use and misuse have been extensive.

Batchelder (1967) presents a unique set of maps showing the incidence of man-set fires and its relationship to climatic dry seasons and major vegetation. This is possible, he says, because man-set fires follow definite patterns adjusted to dry seasons, agricultural calendars and religious beliefs. His maps portray the spatial and temporal patterns of fire for the major tropical land areas - including the following five savannas of interest in fire management:

(a) forest-savanna mosaic;

(b) moist, sub-humid wooded savanna;

(c) dry, sub-humid wooded savanna;

(d) savanna grassland;

(e) semi-arid shrub and grass.

Curry-Lindahl (1972) estimates that savannas cover about 40 percent of Africa, in both the sub-tropical and tropical regions, and they vary greatly from region to region. "Africa's savannas, steppes, arid plains and sub-deserts stretch in an arc across the continent. Beginning in East Africa between the latitudes of 20° and 10° North, they fill practically the whole of Africa south of 10° South, with the exception of the Cape region. Some of the plains have become, or are becoming, deserts; others are still fertile grass or tree savannas which in places turn into open forests " (Curry-Lindahl, 1972).

There are two principal fire causes in the African savannas. The first is "pasture burning" and the second is "shifting cultivation". Yet, there are few records available to document the magnitude of the problem in any of the savanna countries. In Cameroon there is much concern regarding the "pasture burners" and "shifting cultivation" fires which burn into the several national parks in that country. In addition, bare firebreaks as wide as 10 metres are being built around eucalypt and pine plantations because of the threat of escaped fires started by pasture people.

The incompleteness of fire statistics is reflected in the following fire statistics for Kenya for the 1969-73 five-year period, which show only those fires which

occurred within the gazetted reserves. This is so because the Forest Department does not have responsibility for protecting areas outside the reserves. Hence, most of the savannas in this country are without organized protection from fire.

Forest Fire Record - Kenya*

1959 - 1973

Year	Area Burned in Ha
1969	416
1970	2 900
1971	16 872
1972	570
1973	2 495

Likewise, in the Sudan only 15 forest fires were shown in the 1969 - 1970 annual report for the Forests Department. The Forest Reserves cover only 0.5 percent of the 640 million acres in Sudan, but the savannas constitute about 60 percent of that country. Unfortunately, fire losses are extremely heavy in the savannas. For example, a Range Department report (Sudan Government, 1974) said that in 1968 "seasonal fire removed annually 80 million tons (air dry matter) from the dry savanna range resources". If two tons per acre is assumed for the annual grass forage, then 40 million acres were blackened; yet, no fire statistics, except the above report, were available to document this.

In the savanna areas of Nigeria, where the relative humidity is low, with a long pronounced dry season, from November to April, annual fires are noticeably severe. The "Harmattan", a north-easterly dry wind which blows during the dry season, increases the fire hazard.

Traditional farming methods, which involve clearing of the bush by burning for a new farm, regular burning of the grass by cattle herdsmen and setting of ring fires by hunters to catch rodents and other small mammals, are among the major causes of fire, and contribute to the burning of up to 75 percent of the savanna areas in Nigeria each year.

Batchelder (1967) confirms that those countries which maintain fire statistics usually record fires which occur in (gazetted) Forest Reserves, tree plantations and national park and wildlife areas. Further, he reports that uncontrolled set fires in savannas and forest-savanna environments are the largest single group of causes of fire in tropical forests and grasslands. He includes fires set by aborigines, peasants and ranchers which then get accidentally out of control. He says, too, that pyromania and incendiarism are causes which should be given more attention.

*gazetted reserves

The statistics on number of fires, specific causes, and area involved, may be non-existent, uncertain and/or unreliable. However, there is no question that unwanted fires cause extensive damage to the human environment in the African savanna region. Raeder-Roitzsch (1974) in his special report on the Sahelian region, emphasizes that commercial tree species are the sole inland source for the supply of domestic and semi-industrial energy. Further, he points out that, with the tremendous population growth and rising wood consumption, there is danger that by the year 2000, 50 percent of the natural woodlands would have disappeared. (The consultant was also repeatedly warned of this possibility during the visits to North Africa and Central America.) "Besides", as Raeder-Roitzsch (1974) says, and many others confirm, "the uncontested degradation of the Sahel is only partly due to climatic accidents (droughts). Its main cause is uncontrolled pressure of man on the land and severe over-use of the precious and precarious resources.

There is much concern in Central Africa regarding the threat to forest plantations. For example, the forest plantations in savanna and forest areas of Nigeria are very susceptible to forest fires. (About 1 000 ha of plantations are destroyed annually.) In this country, plantations cover approximately 90 000 ha, and in the Third National Development Plan (1975 - 1980) extensive additional areas of trees will be planted to feed five proposed large pulp mills, three of which will have paper mills. Hence, the values at risk are extremely high, and the need for fire prevention is urgent.

In the Sudan pasture burning and shifting agricultural operations are accelerating desert encroachment. Deterioration of Acacia senegal (gum arabic) and its replacement by Laptodenis pyrotechnica (a highly flammable pyrophyte), as a result of fire, was observed by the consultant near El Obeid.

In addition, unless positive actions are taken soon to prevent fires, desert encroachment will:

(a) Endanger the following unique wild animals:

(i) Dama gazelle (Gazella dama)

(ii) Scimitar oryx (Oryx dammatah)

(iii) Addax (Addax nasomaculatus);

(b) Endanger the following valuable plants:

(i) Juniperus procera

(ii) Podocarpus milidiana.

Moreover, destruction by fire of forests and other vegetation in Kenya is having profound effects on other aspects of the human environment. Since all rivers in Kenya have their origin in the gazetted reserves or National Parks, each fire which destroys vegetation affects stream flow and water quality. Streamside clearing and burning have caused much erosion, and this mis-treatment has had a major impact at the mouth of the Tana River at Malindi. Eroded material and ashes from fires are degrading the beaches and impairing their value for tourism.

Some of the most serious destruction from fire in Kenya is occurring in the marginal land areas in the north-east near the Ethiopia border. There, the rainfall is much less than 30 inches per year, and the nomads are causing heavy damage by pasture burning. Also, African ebony may become a rare species here if wildfires and overcutting continue.

Despite the enormous fire-related damages in the African savanna region, forestry agencies are still ill-equipped to prevent, detect, or suppress unwanted fires. For example in one country visited, there are a few manually operated rega fire pumps and a few motorized pumps scattered within the forest stations. The major fire-fighting force consists of forest workers using tree branches to beat out fires. Moreover, the detection system is hopelessly inadequate, and there is no standard or uniform system of rating daily or seasonal forest fire danger. Nor is there a central fire weather forecasting service. When fires occur in the forest reserves, each is handled on an individual, non-coordinated basis with no centralized direction or control.

Unfortunately, this statement is more or less applicable to other countries in Central Africa. However, there is decidedly strong interest in each of the three countries visited in making major improvements in fire management systems. In particular, the foresters and fire specialists are eager to use prescribed burning to reduce fuel hazards. In Cameroon, guides for prescribed burning are needed for protecting the national parks as well as eucalypt and pine plantations. Also, in the Sudan there is a desire to conduct prescribed burning studies to reduce fuel hazard and improve forage and wildlife habitat.

"Early burning" for hazard reduction purposes is under study in both Kenya and Nigeria. Oseni (1975) in a report titled, "Detection and control of forest fires in Nigeria", describes their work with "early burning" as follows:

> "The virtue of early burning lies in the fact that the herb layer is not uniformly dry at the time of burning, and although some of the grass may burn more or less fiercely, other places are still too moist for the fire to catch. This is particularly so under and around trees and clumps of trees. In these unburnt patches seedlings of both fire-tolerant and fire tender trees can grow and when the early burn comes around the following year there is a good prospect of a slightly larger patch being too moist to burn. The pattern of early burnt savanna is therefore a patchwork of gradually expanding unburnt foci. It is therefore evident that early burning, carried out according to the aim stated above, will eventually enable forest vegetation to be re-established in the derived savanna. It is however recognised that the process could be very much slower than under complete protection. As for late burning, the treatment was found devastating."

However, "to burn or not to burn" the savannas is still controversial in Africa. Heady (1960) in his classic text on range management, said "There is little doubt that fire in East-African semi-arid vegetation has occurred continuously in recent geologic time". "Few types of vegetation", he continues, "have been completely without fire". He devotes ten pages of his text to the pros and cons of "controlled" or prescribed burning.

Similarly, Bentley (1963) indicates that fire can be an effective tool in converting brush to grass - inexpensively. However, he warns that ineffective burning can be costly in terms of forage lost with very little reduction of the brush cover.

T.W. Box (1969), one of the top range management specialists in the United States, summarized it by saying, "Burning is praised and condemned in Kenya", and then suggests, as do many others, that research studies are needed on both prescribed burning in the savannas as well as evaluation of the effects of wildfires. Thus, prescribed burning studies are one of the high priority research needs in this region.

Further, there is keen interest among foresters in the countries visited by the consultant concerning the development of integrated fire management "pilot districts"

similar to Jutiapa in Honduras and Les Maures in France.

Cameroon has proposed a project in the Sahelian region in the northern part of that country. Kenya suggests the Machakos District, a hilly area southeast of Nairobi and convenient for tours from that city. In addition, the Sudan Government submitted in May 1974 a Desert Encroachment Control Project proposal to the United Nations. It was prepared jointly by the Ministry of Agriculture, Food and Natural Resources and the Agricultural Research Council, National Council for Research. This proposal includes a request for a 5-year project (1975 - 1980) aimed at reducing if not halting desert encroachment, and protecting and reclaiming as much useful land as possible to provide for future needs on the local, regional and international levels. The strength of the proposal, in the opinion of the consultant, is the strong thrust toward the "concept of integrated multiple land use". Furthermore, the results of pilot projects here can easily be extended to the other African countries. Also, the proposal recognizes the significant impact that "seasonal fires" and other destructive fires have had in helping trigger the desertisation.

Finally, the proposal suggests the following fire research studies which are considered desirable:

1. Evaluate vegetational changes in response to different intensities of burning.

2. Test the response of various vegetation communities to fire and determine the effect of fire on desert encroachment.

3. Test feasibility of creating firebreaks (or fuelbreaks) with chemicals, machines, and fire resistant plants.

Development of the proposed "pilot districts" in the African savannas not only provides an opportunity to integrate and demonstrate existing knowledge in fire, forestry, range wildlife and watershed management, but also to identify research needs for the future.

4.3.2 Location of Regional Programme - African Savannas

There could be a strong case made for having several African fire programmes. However, the most urgent problems, at present, are in the "tension zones" of the Savanna Grassland, Semi-Arid Shrub and Grass and Dry Sub-humid Wooded Savanna because of the triggering effect of fires in speeding desertisation. For this reason, one programme is proposed, which will be headquartered in Nairobi, Kenya. Nairobi is suggested not only because there is a viable national forestry programme, but also because air transportation is convenient. Moreover, there are critical fire problems in Kenya in the three savanna types referred to above. In addition, educational research and training facilities are readily available in Nairobi. Also, the Sudan, with equally, if not more critical fire-caused desertisation problems, is within 2½ hours by jet.

4.3.3 Regional Programme - African Savannas

Fire Prevention

(i) Problem: In general, present forest and fire laws in Africa do not clearly define the responsibility for fire prevention (and suppression) in the savannas unless they are included within the boundaries of forest reserves or national parks. As a consequence, many fires are ignited accidentally or intentionally within these

important ecosystems - reported 80 million tons of forage destroyed each year in the Sudan (Sudan Government, 1974). Similarly, there appears to be no existing legislation which might curb the widespread destruction caused by pasture burners whose fires escape.

Recommendation: Propose a complete review and analysis of existing forestry and fire legislation in the African savanna region with special emphasis on the need for protecting the forests and the highly fragile and valuable savannas and to ascertain the need for new laws to prevent accidental and/or wilful setting of fires.

(ii) Problem: Since children tend to reflect the attitudes of their parents toward fire prevention and conservation, the next generation of adults who live in the villages in the savannas of Africa will probably continue to start seasonal fires to "improve pastures" or will permit plantation fires to escape.

Recommendation: Propose that conservation/fire prevention education materials be developed for use in all grades of elementary schools beginning with the earliest (kindergarten) located in villages or towns within or adjacent to the savannas.

The major objective would be to give youngsters a positive attitude of care and custodianship toward their precious but fragile environment - including the soil, plants, animals, streams and the atmosphere.

(iii) Problem: Because of population increase in each country and the desertisation influence in the savannas because of fire and other misuse, there will probably be a strong tendency on the part of local villagers and nomads to ignite more pasture and "shifting agriculture" fires than ever before. This will likely be done in the desperate hope that more forage will be produced for starving livestock.

Recommendation: Propose that "pilot districts" be established as soon as possible, where appropriate, in the savannas of each country. The purpose would be to demonstrate that integrated land use, including cultivation, livestock grazing, gum Arabic production, etc. are compatible. Besides, this provides an opportunity for the local people to share in decision-making and to have a "stake" in the outcome.

Detection

(i) Problem: Desertisation, the process of desert encroachment in the semi-deserts and savanna grasslands of Central Africa, needs to be monitored on a recurrent basis. Yet, because of the vast expanses involved, it is physically and economically impossible to perform this task on the ground.

Recommendation: Propose that a study be made in coordination with the Tropical Forest Cover Monitoring project to evaluate the feasibility of utilizing satellite, aerial photography and other remote sensing techniques to monitor the impact of fire degradation, including desert encroachment, on the African savanna ecosystems. Initial studies should be made in a pilot district in the North Kordofan Province of Sudan if feasible.

Fire Suppression

(i) Problem: Fire danger ratings are key elements in any integrated fire management system. The possibility of fires starting (Ignition Index) and becoming large (Burning Index) are essential in fire prevention and in preparing to suppress any fires that may start. Yet, none of the countries visited in this region had even the simplest elements of a FDR system. As a result, fire management activities are necessarily poorly planned and executed.

Recommendation: Propose the installation of a basic structure of a fire danger rating system for use in the proposed "pilot districts" in each country. Evaluation should be conducted for not less than three years.

(ii) Problem: In Africa, fires may occur in the savannas, according to Batchelder, almost anytime of the year, but they are more likely during the "dry season", which in many areas extends from October to May. However, fire occurrence and severity are both dependent on droughts, strong winds, etc. In Kenya, for example, the present drought began in 1971. The most severe condition influencing fire spread is a hot, dry wind, which blows from the northeast. In the Sudan, it is called the "Haboob", and in Nigeria it is named the "Harmattan". Yet, there is no central fire weather forecasting unit in any of the countries to forecast the critical weather condition.

Recommendation: Propose the establishment and operation of a Central Fire Weather Forecasting Centre at the regional programme headquarters and suitable arrangements to be made to communicate forecasts within that country and to participating countries. This centre could also conduct studies directed toward improving forecasts of such critical fire conditions as the dry Haboob winds in the Sudan.

Fuel Management

(i) Problem: Many countries in the savanna region are developing man-made forests, often conifers, in large, even-aged, continuous blocks without provision for selective fuel modification to prevent loss of the stand in a crown fire. Some information and guidelines are available on the fire safety design of conifer plantations and fuel management after establishment, but these guides have not been widely disseminated.

Recommendation: Propose the completion of a manuscript begun in 1967 by Carl Wilson and updated in 1971. It needs revision and technical reviews.

(ii) Problem: There is much information available on integrated fire management with special emphasis on fuel modification, but rarely is this knowledge assembled and applied as it has been at Les Maures in France or is planned in the Jutiapa District in Honduras. Yet, this is the most effective way to demonstrate the value of such an approach to local people, such as pasture burners, other villagers, or the legislators who approve budgets.

Recommendation: Propose that each participating country establish at least one pilot district for integrated fire management. This should include at least a basic prevention, detection and suppression system, but special emphasis should be given to fuel management which aims at a pleasing and productive mosaic of vegetation types or patterns. When appropriate, special studies of prescribed burning will be conducted.

(ii) Problem: Many of the plants in the African savannas are highly flammable - particularly where the perennials have been replaced by annual grasses or by pyrophytes such as Laptadenia pyrotechnica. Besides, these plants will continue to replace themselves in the plant community after each fire. If possible, it would be advantageous to replace these undesirable plants at selected locations with perennial grasses or prostrate shrubs of lower flammability.

There are now available after more than 40 years of research and field tests in the U.S.A. and several studies in the Mediterranean region, several candidate plants which can be used for mass planting or direct seeding after fires. These are: Salvia sonomensis (creeping sage), Atriplex muelleri (prostrate saltbush), Galemia pubescens and Artemisia caucasia (Caucasian sagebrush). Small-scale field tests are being conducted in several countries in the Mediterranean region, but the trials need

to be expanded. Also, there are several perennial grasses available for experiments.

Recommendation: Propose that field trials be conducted with these prostrate shrubs and native perennial grasses in the pilot districts.

(iii) Problem: Observations in the field and reports show that there is irreversible degradation of ecosystems in African savannas from repeated "pasture burnings" and other unwanted fires. Damages from fire are becoming more serious each year. Site degradation occurs; islands of natural forests are shrinking; gum Arabic gardens are producing less gum; and rare plants and animals are endangered. Yet, very little quantitative information is available for use by foresters and other land-use planners.

Recommendation: Propose cooperative studies be conducted in representative countries in Africa to determine quantitatively the rates and magnitude of site deterioration as a result of unwanted forest fires.

(iv) Problem: Subjective evaluations in African savannas indicate that site degradation from pasture fires and escaped plantation fires accelerate soil erosion, cause floods, and fill streams and lakes with debris. Objective determinations of these adverse impacts on the human environment are not available, but they are critically needed to help justify adequate programmes in integrated fire management.

Recommendation: Propose cooperative studies be conducted in representative countries to evaluate the rates and magnitude of these adverse off-site effects of forest fires on the human environment.

Education and Training

(i) Problem: In each of the countries visited by the consultant in Africa there was lively interest in fire management activities and a desire to meet and discuss mutual problems with their neighbouring countries. Some of the countries have made substantial progress in solving some difficult fire problems and would like to share this knowledge with their neighbours. Yet, there is no present medium for the exchange of ideas on integrated fire management. An international symposium for interested African savanna countries could help establish the foundation for a viable regional programme.

Recommendation: Suggest that an "African Savanna Fire Management Symposium" be organized as soon as possible and a Fire Management Working Group in Central Africa be constituted.

(ii) Problem: There are several enthusiastic foresters in African countries who could provide solid assistance to research and State and Private Forestry Units in Australia, Canada, Europe and U.S.A. - and broaden their own experience and knowledge in fire management. Likewise, there are competent scientists and fire specialists in Australia, Europe and U.S.A. who could be of definite value in helping develop pilot districts in integrated fire management in the African savannas.

Recommendation: Suggest setting up a formal exchange programme of scientists and other fire management specialists among interested countries - with a one-year limit on a man-for-man (or woman-for-woman) basis, home country to continue to pay salary (5-year evaluation period).

(iii) Problem: Training in integrated fire management is not developed to an adequate level in any forestry schools or other educational facilities in the savanna region. In many cases, such as at the Forestry School in Khartoum, the institutional framework exists, but strengthening of the curriculum is required. In other areas, a suitable institutional framework is lacking.

Recommendation: Provide advisory assistance to existing forestry schools in the savanna for the purpose of developing integrated fire management courses in professional and subprofessional curricula.

4.3.4 Summary of Proposed Projects and Requirements for Implementation

A summary of the individual projects and activities needing urgent attention in the African savanna region, estimates of the man-months required for their implementation, and recommendations on when action should be initiated, are given in the following table. See section 5 for further discussion of implementation requirements.

SUMMARY OF PROPOSED PROJECTS AND REQUIREMENTS FOR IMPLEMENTATION IN THE AFRICAN SAVANNA REGION

Description of Project	Estimated Man Months	Recommended Starting Dates	Remarks
PREVENTION 1. Review and analyse existing forestry & fire laws & ascertain need for new legislation.	3	Year 2	Should be a joint study involving both law school and forestry faculty from an African university.
2. Develop conservation education materials for children in elementary schools in savannas.	6	Year 1	Suggest a cooperative inter-disciplinary study with Education Department of a university, forest fire agencies, audio-visual aid staffs, and elementary school teachers.
3. Develop pilot districts in problem areas of savanna to prevent fires and demonstrate good range management.	1	Year 1	Should be a joint effort involving range management, wildlife management, and forest management specialists aimed at integrated land use planning.
DETECTION 1. Conduct study in collaboration with Tropical Forest Cover Monitoring project to evaluate feasibility of using remote sensing to evaluate rate of desertization.	3	Year 0	First priority should be given to this joint study with Tropical Forest Cover Monitoring project because of a sense of urgency in monitoring desertisation in savannas.
PRESUPPRESSION 1. Install basic fire danger rating system in "pilot districts" of each country and make 3-year evaluation.	6	Year 1	Based on WMO Consultant's report, one FDR system would be installed in "pilot districts" of interested countries and evaluated for at least three years.
2. Establish and operate Fire Weather Forecasting Centre in Nairobi, Kenya.	0 (can be done with proposed specialist)	Year 1	With guidance from WMO Consultant's report and FAO specialist, fire weather forecast centre could be established in 1976.
FUEL MANAGEMENT 1. Make field trials of the four lower flammability shrubs (from USA and Med. Region) and conduct similar trials with perennial grasses.	36	Year 2	Nursery studies and field tests require botanists, plant physiologists, or pasture specialists. These studies need to be conducted for at least five successive years.
2. Establish at least one "pilot district" in each country to demonstrate prevention, detection, suppression and particularly fuel management methods.	60	Year 2	Will need technical supervision and coordination by range or pasture management consultants as well as foresters and agronomists from local schools.
3. Conduct studies in representative vegetative types in the savannas to determine the extent and severity of site degradation caused by fires.	60	Year 2	These on-the-ground studies will require a minimum of five scientist man-years to plan, conduct, and report. Specialists in ecology or watershed management are needed.

4. Conduct cooperative interdisciplinary studies in several interested countries to determine rates and amount of off-site effects of fires on the human environment.	48	Year 2	Studies will require at least four scientist man-years to plan, conduct, and report. Watershed or hydrology specialists will be needed.
EDUCATION & TRAINING 1. Tentatively schedule an "Integrated Fire Management Symposium" for African countries.	2	Year 1	The Fire Management Specialist planned for Kenya could select a "programme committee".
2. Develop a formal exchange programme of scientists and fire management specialists among interested countries on a one-for-one basis not to exceed one year.	1	Year 2	Interested countries could be notified by proposed Global Programme Coordinator and level of interest ascertained.
3. Develop a "Fire Management Newsletter" and issue within African Savannas Region.	1	Year 1	Fire Management Specialist planned for Kenya could begin to develop informal "news notes" for Kenya and then broaden to cover savanna countries.
4. Assist in developing "Integrated Fire Management" courses in forestry schools in Savanna Region.	12	Year 2	Consultant should determine what fire-related courses are being taught now and identify fire management curricula needs. Natural Resources Institute in Sudan should have high initial priority.
TOTAL MAN-MONTHS	239		

5. SUMMARY OF REQUIREMENTS FOR IMPLEMENTATION OF THE GLOBAL PROGRAMME

Sections 4.1.4, 4.2.4 and 4.3.4 give estimates of manpower requirements needed to implement the projects recommended for each regional programme. Proposed starting years are also indicated, with "year 0" corresponding to the immediate present (i.e. 1975). Because of the urgency of the fire problems in all three regions, all projects should be initiated within two years of start-up of the Global Programme (i.e. "year 2"). Although initial funding is sought for only a period of five years, it is stressed that some projects proposed will require at least ten years to ensure development of successful integrated fire management programmes in the three regions. In particular, sufficient time is needed to strengthen extension and training services and for making the foresters and fire management specialists familiar and confident with the new techniques and systems of fire management.

It should be noted that the man-months requirements specified are in addition to the Global Coordinator and the Regional Leaders. A summary of these additional needs is shown below:

- Mediterranean region:	204
- Central American region:	226
- African savanna region:	239
	669 man-months

Further expenditures still to be determined, and depending, in part, on the outcome of proposed regional studies, are outlined below:

- Travel within regions for each Regional Leader
- Inter-regional travel for the Global Coordinator
- Research contracts to universities and research institutions
- Funds for symposia and workshops
- Fellowships and study tours
- Equipment and supplies
- Miscellaneous

Appendix 1

LIST OF PARTICIPANTS

IN

FAO/UNEP EXPERT CONSULTATION ON

DETECTION AND CONTROL OF FOREST FIRES FOR THE

PROTECTION OF THE HUMAN ENVIRONMENT

(Rome, Italy, 28 April - 2 May 1975)

Name	Title and Organization	Address
- Participants		
McArthur, A.G.	Director, Forest Research Institute, Forestry and Timber Bureau	Canberra, Australia
Oseni, A.M.	Director, Federal Department of Forestry	Ibadan, Nigeria
Ozyigit, Ali	Directorate General of Forests	Ankara, Turkey
Shuma, B.R.H.	Deputy Conservator of Forestry, Forests Department	Nairobi, Kenya
Susmel, L.	Director, Institute of Ecology and Silviculture, Padova University	Padova, Italy
Trabaud, L.	Centre d'Etudes Phytosociologiques et Ecologiques, C.N.R.S.	Montpellier, France
Velέz, R.	Forest Fire Protection Section, ICONA	Madrid, Spain
Williams, D.E.	Director, Forest Fire Research Institute, Canadian Forestry Service	Ottawa, Canada
Wilson, C.C. (Consultant)	Assistant Director, Cooperative Fire Control, Forest Service, U.S.D.A.	Washington, D.C. U.S.A.
- FAO Secretariat		
Polycarpou, A.	(Chairman), Chief, FORW	Rome, Italy
Fugalli, O.	(Vice-Chairman), Chief, FORM	Rome, Italy

Name	Title and Organization	Address
- FAO Secretariat (cont'd)		
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Appendix 2

RECOMMENDATIONS OF THE FAO/UNEP EXPERT CONSULTATION ON DETECTION AND CONTROL OF FOREST FIRES FOR THE PROTECTION OF THE HUMAN ENVIRONMENT

FAO, Rome, 28 April - 2 May 1975

In reviewing the draft report of the consultant, the Expert Consultation noted with grave concern the extent of degradation of the human environment brought about by unwanted wildland fires. It agreed that the areas of most critical concern are the Mediterranean, Central American and African savanna regions and endorsed a Global Programme for action which would concentrate initially on these regions and would apply techniques of integrated fire management.

Fire and weather statistics

The Consultation outlined the vital role of fire and weather statistics for determining the pattern of fire causes, identifying critical areas and periods, and predicting the occurrence of fires, yet it regretted that most countries, particularly in Africa and Central America, keep very few statistics. It strongly recommended that all fires in grass, brush or forest areas, be recorded and that fire statistics be centralized to the maximum extent possible.

Research on fire's impact on man's environment

The Consultation recognized the need for fire research in each of the three regions. In particular, it stressed the need for more information on the ecological impact of fire on the human environment through its effects on atmosphere, soil, water, plant communities and fauna, including both on-and off-site effects. It indicated the need for a series of studies which would include a wide range of fire intensities and sites. Nevertheless, the Consultation cautioned that such studies would be costly and time consuming. It further cautioned that they should be interdisciplinary in approach and that they concentrate on applied research which could easily be made operational.

Prescribed burning

The Consultation recognized that fire is a natural component in the major Mediterranean, Central American and African savanna ecosystems. Fire should not, and probably cannot, be eliminated from them. In fact, it should be used as a tool to prevent the disappearance or deterioration of the existing vegetation. The Consultation recommended that guidelines for the correct and timely application of prescribed burning be drawn up for the Central American and African Savanna regions following on some applied studies in the various regions combined with existing knowledge. Because of the special nature of the vegetation and people's attitude with regard to fire in the Mediterranean region, the Consultation noted that intensified research would be needed before guidelines for the use of prescribed burning could be formulated and advocated for this region.

Social aspects of fire use

The Consultation recognized that fire was widely used in an uncontrolled fashion by local people in all the regions as a means of vegetation conversion especially for grazing. Without the cooperation of the local people the implementation of the Global Programme is doomed to failure. The Consultation therefore recommended the implementation of the Global Programme with the wide involvement of local populations. It also suggested that a further utilization of manpower in both detection and suppression as well as educational programmes and demonstration areas would be possible means of attaining this. Year-round employment opportunities should be aimed at.

Legal aspects

The Consultation noted the lack of control by fire prevention and control organizations over land outside reserves, particularly in Africa. It strongly stressed the need for a thorough review of forest fire laws in each of the regions and a sharper definition of responsibilities in fire matters between government agencies.

Fire weather forecast and fire danger rating systems

Despite the fact that fire weather forecast and fire danger rating systems are not difficult to formulate and implement, the Consultation noted with some concern that such systems exist in only a few countries. Although responsibility for advising on both of these systems is that of the WMO consultant, the Consultation stressed the need to implement such systems in each of the three regions. It suggested that whereas one universal fire weather forecast system could be feasible, one fire danger rating system for each region would be required. The need for simplicity in formulating and using the systems was underscored.

Silvicultural techniques in fire management

The Consultation noted that in organizing fire prevention, the role of silviculture has too often been overlooked (other than prescribed burning). It stressed the need to build fuel management components into afforestation schemes at an early stage, and pointed out that there was still scope for such practices as firebreak construction and maintenance, pruning, thinning and grazing in plantation fire prevention. It recommended that an up-to-date set of guidelines for fuel management for new and existing forest plantations be published and widely circulated.

Extension, education and social relations

The Consultation noted the high proportion of fires which are man-caused and recommended that programmes involving education of school children from the early grades to around 16 years, and the education of the general public to the causes and effects of wildfire could be implemented in each region. It noted the important role to be played by the communication media and extension officers in education. For school children, it suggested studying the possibility of reactivating the FAO school forest concept. It also suggested that standard (visual) signs as designed by the North American Forestry Commission may be applicable in other regions. It further recommended the establishment of an exchange programme involving fire scientists to stimulate the exchange of information and ideas, and suggested that training centres for teaching fire control and effects are greatly needed. The need to improve the exchange and dissemination of information, particularly printed matter, was emphasized.

Fire detection and control equipment

The Consultation took note of technological advancements made in the field of fire detection, fire mapping, fire suppression and vegetation monitoring and recommended that an indepth assessment of the various types of equipment available be made for each region, keeping in mind the cost of purchasing and maintaining the equipment, its effectiveness under local conditions, and its adaptability to the local level of technology and trained manpower. Nevertheless, it was pointed out that such standard techniques as ground patrol, firetowers and reporting by the general public should still play major roles in detecting fires in all regions. The advantage of these techniques in developing areas was particularly noted.

The feasibility of obtaining fire reports from all aircraft passing over countries concerned was also discussed. Although the Consultation recognized that it may be difficult to obtain useful reports in some areas, it noted this detection method has worked well in some countries and recommended that it be further studied in each region.

The Consultation further noted that the interchange of detection and control aircraft over large distances has resulted in a more efficient use of equipment in some regions, particularly North America. Although it recognized that legal and logistical problems would be encountered, it urged that further study of this possibility is warranted and suggested that a special meeting on this topic be convened for the Mediterranean region.

Fire management organizations

The Consultation stressed the need for effective, well-managed fire organizations in order to implement the techniques of integrated fire management. It recommended that an aim of the Global Programme be to strengthen or promote the formation of such organizations within countries.

Coordination

The Consultation fully recognized the need to coordinate the plan of work of the Global Programme with the activities of other multilateral and bilateral organizations. It therefore, warmly welcomed the interest expressed by Unesco to support some aspects of the Programme, particularly those related to ecological research and education.

Appendix 3

AN EXAMPLE OF A DEVELOPING INTEGRATED FIRE MANAGEMENT PROGRAMME (Pilot District) 1/

M.J.D. Hancock, Tegucigalpa, Honduras
24 February 1975

1. HONDURAS

1.1 Objectives

The area of the Demonstration District represents a typical forest with possibly above average normal hazards to protect. The object is to carry out successful protection of the area and the immediate surroundings by employing different methods that could be utilized in the Protection Programme for the entire country. In this way the feasibility of each method is tested; experience is gained; and costs obtained. Total costs for protection will not be representative as the area is relatively small and protection much too intensive than that which could be employed on a larger scale. The experience gained from the Demonstration District will be of most use in formulating protection plans up to a national level as well as indicating the direct benefits to be derived from protection followed by the appropriate forest management.

1.2 The Past and Present Situation

1.2.1 The Forest

The forest which requires most attention for protection consists of Pinus oocarpa and represents approximately 75 percent of the area of the Demonstration District or approximately 2 400 ha. Of almost equal concern is the forest of Pinus pseudostrobus, this species being slightly less susceptible to insect attack, and because it is found at higher elevations, to fire damage. However, it only represents 11 percent of the District Area or approximately 360 ha. The strips of broadleaf forest amounting to 4 percent of the area are considered as fire resistant and should be utilized as such by the protection plan. The remaining 10 percent of the area have other uses and they are scattered throughout the area and often represent the fire hazard and/or fire risk.

1/ Extracted from FAO-COHDEFOR Document, Distrito Forestal Demostrativo de Jutiapa—D.F.D (Plan de Ordenación, Capítulos Protección Forestal y Caminos)

The damage to the pine forest by fire and insect attack has been severe. Until protection was started, probably about 60 percent of the area burned each year causing the death or retarding the growth of the regeneration and increasing the scar damages on the older trees. The country-wide bark beetle epidemic of 1963-1964 left its mark in the area, and there are many standing dead trees which represent an additional fire hazard.

There is evidence that in some years fire has passed through the broadleaf forest areas, but this is considered unlikely to occur again if protection of the area is maintained and large fires are not allowed to develop within or near the area.

1.2.2 The Ground Vegetation

The accumulative rate of burn of the ground fuel varies according to slope but averages about 1.5 ha per hour.

1.2.3 The Climate

Over a five-year recording period, the following data have been collected which are of importance to the protection of the area. Annual rainfall averages 1 210 mm; d day temperatures average from 24° C to 30° C; and relative humidity mid-day averages 62 percent. There is a well defined dry season which, of course, coincides with the fire season and can be considered to be from January to May inclusive. February, March and April are the most critical months, especially the latter when the local inhabitants burn their plantations, with the following climatic conditions relative to fire danger:

- Average rainfall per month - 14.8 mm
- Average mid-day temperature per month - 27° C
- Absolute maximum temperature per month - 33° C
- Average relative humidity mid-day per month - 61 percent.

The average cloud (stratus) level in the morning during this period is around 1 500 metres, and the fire observation posts are often clouded over during the early hours of the day. But, positioning them lower would impede their general visibility too much. The smoke build-up from forest and agricultural burns surrounding the area, combined with the climatic conditions, form a haze which can make the sighting of fires difficult within most of the district. The difference in elevation from 700 to 1 700 metres in the area give quite varied climatic conditions. Those quoted above are recorded from the lower elevation. The conditions higher up are slightly more unfavourable for fires, but as most fires start at the lower elevations by the time they reach the higher elevations, if uncontrolled, they have created their own climate (weather) which propagates the fire rapidly.

The meteorogical station has been improved upon and accurate readings should now be made of the following:

At 07:00, 12:00 and 16:00 hrs
- Relative Humidity
- Rainfall
- Velocity and Direction of Wind
- Temperature

At 07:00 hrs the maximum and minimum temperatures are recorded for the previous 24 hours. This information, combined with fire behaviour data should be sufficient to formulate a fire danger rating system.

1.2.4 Infrastructure

A reasonably good access road serves the District from the Campamento - Salama Road, this same road limits the whole southern border of the District being approximately 10 km from this road a few old logging trails offer some very limited vehicle access into the forest area. A camp exists almost at mid-point along the southern limit. This was constructed for a previous project and has the basic requirements for the Demonstration District. Two fire observation posts exist, again from a previous project, and these are adequately located both at approximately 1 200 metres. They require proper access (see chapter on roads) and certain modifications (see diagram of proposed layout).

An airstrip exists near the camp adequate for small, twin-engined airplanes.

1.3 Protection Activities

1.3.1 Prevention

Social Aspects - there are four small communities (Jutiapa, Mendes, La Jagua, Talgua) and some scattered houses that influence the protection of the District. Their total population of active men amounts to approximately _____ . Most of these make plantations within the forest areas and also graze cattle, there being approximately _____ head of cattle within the neighbourhood.

The frequency of fires is high in the area and the main causes are as follows:

- Burning for fresh pasture for cattle
- Burning getting away from plantations
- Burning for tick control
- Carelessness and ignorance
- Burning to encourage deer to come to fresh pasture for hunting.

It is suggested that the best ways to tackle the problems of prevention are as follows:

a) Employ as many people as possible in the work of the District from the communities mentioned.

b) Set aside specific areas for cattle grazing which should be burnt under the direction of District personnel with possibly the introduction of improved pasture and cattle dips under a self-help scheme.

c) Insist on permits for burning plantations which lay out the conditions required to carry out a burn. Inspection of the plantation before a specific date is allowed on which to burn.

d) Utilise the schools that exist in the four communities to encourage the young to become forestry conscious and hold meetings with "propaganda materials", e.g. films, drawings, etc. for the adults.

e) Have open days at the camp organized so that the local population can see the work of the District.

f) Put up rotulas (signs) along roads and frequented trails warning with pictures against carelessness with fire.

g) Maintain vigilantes patrolling the forest area in the dry season.

It is most important to try and get the people interested in the forest and to appreciate the benefits that they might receive, such as employment, turpentining and other forest products. Application of the law should be used only as a last resort and as a just example.

1.3.2 Roads

The necessity for access by roads in the District is obvious for successful protection as well as their importance as firebreaks. Roads are dealt with in some detail under the chapter referring to this.

1.3.3 Controlled Burning

It is considered that prescribed burning for hazard reduction may be one of the most effective forms of wildfire prevention throughout the whole country—after an initial period of successful protection. The Demonstration District is and should continue to be a trial area to find out the truth of this supposition.

It is considered that after approximately 7 years, natural regeneration will have reached sufficient size to withstand the effects of a control burn. To be effective in hazard reduction, burns should be prescribed in 3 - 5 year cycles until the forest canopy becomes sufficiently dense to control the ground vegetation. Conforming to the management plan for the burnt areas should form a mosaic pattern throughout the forest to be most effective in fire prevention.

It is estimated that such a crew can burn an average of 50 ha per day including mop-up operations. Preparation of firelines would be carried out previous to burning, and it represents another day's work for a 10-man crew.

(More on costs of burning, etc.)

1.3.2 Presuppression

Firebreaks - It is proposed to finish the construction and continue maintenance on the firebreaks planned and partially completed in the District. These follow the limits of the District where it is necessary, not where there is broadleaf forest or brush nor in very rocky exposures. The firebreaks divide the area from West to East and the quebrados (gullies) run from North to South dividing the total area into 16 blocks of 200 ha each. This division of the area would not be practical on a larger scale but in this Pilot District will serve as a demonstration as to the usefulness of such firebreaks (fuelbreaks) under different conditions indicating to what extent they would be practical on a large scale protection organization. The firebreaks wherever possible will be constructed as follows:

(Is essentially fuelbreak construction in timber.)

A problem exists as to what to do with the trees that are cut in the thinning. In some cases they can be extracted and utilized, but in most cases this is impractical. The majority can be cut into logs and rolled by hand out of the firebreak (fuelbreak) where they can be left to rot. Those that are impossible to move should be burnt during

maintenance operations along with the trash (slash) remaining from the crowns. The trees should be cut low during felling to avoid leaving high stumps.

There are approximately 18 km of firebreak (fuelbreak) of this type to be constructed and maintained. (Covers costs of doing work.)

The larger quebrados (gullies) which, as earlier mentioned, further divide the area, usually have a reasonably clean water course and a belt of broadleaf forest on either side which, after clearing the dead wood and intercrossing crowns, act as efficient firebreaks (fuelbreaks) especially as they are naturally located in gullies. Many of these quebrados have water all through the dry season, and it is anticipated to use portable pumps with long lengths of hose in fire suppression should the need arise. It is recommended to locate and improve natural pools and construct small foot paths to them. It might be worthwhile in the future to regenerate fire resistant broadleaf species along creeksides to further improve their effectiveness as barriers.

Mapping - A map showing the facilities available for fire protection has been prepared on the topographic map of scale 1: 10 000. This should be improved upon and kept up to date with the following information:

a) Location of the fire observation posts with their appropriate quadrants

b) Location of roads and footpaths

c) Location of ————————

etc. etc.

Organization of Personnel - During the main fire season, 1 February until approximately 15 May, it is proposed to split the working force, probably 15 workers into three groups. (Discusses how assignment will be made.)

Fire Detection - The two fire observation casetas (towers or cabins) should be manned during the fire season —— —— ——

(Describes how lookouts will be occupied 7 days per week.)

Communication - Each of the two fire observation casetas, the fire control office and the fire control vehicles should be equipped with radios tuned to the same frequency.

(Describes how radio communications system will operate.)

Transportation - Transportation for fire control will be limited to one pick-up with trailer, if required, and a "Trail Breaker" motorcycle.

(More details on transportation.)

Equipment Distribution - Equipment, except wheeled units, is stored in the main bodega and when outside should be assigned to a responsible person.

(Maintenance and No. of tools of each kind etc.)

1.3.3 Suppression

Fires reached while they are still small, not in too steep terrain and in normal ground vegetation conditions can be controlled by direct attack. This is mainly done by _____ .

For larger, more intense fires, indirect attack should be employed especially on the head of the fire.

(Describes backburning and mop-up.)

1.4 Investigations (Practical Research Studies)

(i) Meteorological Data
(ii) Behaviour of small fires
(iii) Evaluation of type and amount of light fuel
(iv) Analysis of Fire Data
(v) Fire Danger Rating System
(vi) Controlled Burning
(vii) Backburning Guide
(viii) Fire resistant species trials
(ix) Fire Ecology
(x) Cost of protection operations.

Appendix 4

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