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INTERNATIONAL FOREST FIRE NEWS

No. 33
July – December 2005

UNITED NATIONS

ECE/TIM/IFFN/2006/2

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New York, Geneva 2007

NOTE

ABSTRACT

This issue of IFFN contains national fire reports and dedicated fire research reports from countries on the Balkans and the Eastern Mediterranean region. Some of the reports were presented at the "Conference on Forest Fire Management and International Cooperation in Fire Emergencies in the Eastern Mediterranean, Balkans and adjoining Regions of the Near East and Central Asia". The conference was hosted by the Government of Turkey in Antalya, Turkey, 30 March - 3 April 2004,and held under the auspices of the Joint FAO/ECE/ILO Committee on Forest Technology, Management and Training. Following the conference an international technical and scientific consultation "Forest Fire Management in the Balkan Region" was held in Macedonia (4-5 April 2005),followed by the "Eastern European, Near East and Central Asian States Exercise on Wildland Fire Information and Resources Exchange 2005"(EASTEX FIRE 2005), a regional forest fire exercise hosted by Bulgaria,20-22 April 2005. The reports reveal the increasing interest of countries in the region to share fire management expertise and work together cooperatively in addressing fire emergencies.

KEY WORDS

Antalya, forest fire, wildfire, Eastern Europe, Balkans

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All IFFN contributions published between 1990 and this current issue are accessible through 77 country folders and other special files on the GFMC website.

Call for contributions

Readers of the International Forest Fire News are warmly invited to send written contributions to the editor at the above address. These may be in the form of concise reports on activities in wildland fire management, research, public relations campaigns, recent national legislation related to wildfire, reports from national organizations involved in fire management, publications or personal opinions (letters to the editor). Photographs (black and white) and graphs, figures and drawings (originals, not photocopies, also black and white) are also welcome.

Contributions are preferably received by e-mail.

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

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The International Boreal Forest Research Association
(IBFRA) Fire Working Group

The IGBP International Global Atmospheric
Chemistry Project (IGAC) Focus Impact of Biomass
Burning on the Atmosphere and Biosphere "Biomass
Burning Experiment" (BIBEX)

The International Union of Forestry Research
Organizations (IUFRO)
Forest Fire Research Group 8.05

CONTENTS

PREFACE ..... *vii*

EDITORIAL 1

BALKANS AND EASTERN MEDITERRANEAN SPECIAL

International Technical and Scientific Consultation "Forest Fire Management in the Balkan Region" (Ohrid, Macedonia, 4-5 April 2005): Technical Report of the Consultation 2

Eastern European, Near East and Central Asian States Exercise on Wildland Fire Information and Resources Exchange 2005 (EASTEX FIRE 2005): Report and Analysis by the Host Country Bulgaria 6

Cooperation in Wildland Fire Management: Italy – Kosovo: Project for the Establishment and Training of a Nucleus for Forest Fire Protection in Pec / Peja - Kosovo 10

Albania Country Report 2004 17

Croatia Country Report 2004 (Global Wildland Fire Assessment 2004) 26

Forest Fire Management in Cyprus 38

Fire situation in Hungary 44

Global Wildland Fire Assessment 2004: Country Report Turkey 51

Fire Management and Associated Public Policies in Turkey 62

Determination of the Basic Principles of a Fire Prevention Plan: The Case Study Manavgat, Turkey 70

Determination of Fire Danger Based on Weather Measurements Using GIS: A Case Study in Southern and Western Turkey 76

A Critical Approach to the Calculation Method of Economic Value of Forest Fire Damages in Turkish Forestry: A Case of Forest Enterprise From Mediterranean Region 82

The Impact of Forest Fire Damages on the Total Economic Value of Forest Resources in Turkey 88

The Vital Role of Geographic Information Systems to Fight Forest Fires 93

IN MEMORY

Frank Albini - 1936 – 2005 99

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

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The Secretariat takes this opportunity to thank the editor of the IFFN, Professor Johann Georg Goldammer of the Global Fire Monitoring Center (GFMC) and his team for preparing this issue of IFFN.

The Secretariat also wishes to express its appreciation to the national and international agencies who work together and are co-sponsoring the IFFN and GFMC: Deutsche Gesellschaft für Technische Zusammenarbeit, the International Boreal Forest Research Association Fire Working Group, the International Global Atmospheric Chemistry Project, the International Union of Forestry Research Organizations, the United Nations International Strategy for Disaster Reduction, the United Nations University, the U.S. Department of the Interior Bureau of Land Management, and the World Conservation Union.

Preface

In the last decade the Eastern Mediterranean Region, including the Balkan countries, the ECE member states of the Near East and Central Asia, and other neighbouring countries of Central Asia, e.g. Kazakhstan and Mongolia, have suffered major forest fires and other wildland fires. Around 2001 it was suggested to initiate a dialogue between the countries of the Western and the Eastern ECE region aimed at enhancing cooperation in fire management and fire science. In 2004 the FAO/UNECE Team of Specialists on Forest Fire and the Global Fire Monitoring Center (GFMC) organized the "Conference on Forest Fire Management and International Cooperation in Fire Emergencies in the Eastern Mediterranean, Balkans and adjoining Regions of the Near East and Central Asia". The conference was hosted by the Government of Turkey in Antalya, Turkey, 30 March - 3 April 2004, and held under the auspices of the Joint FAO/ECE/ILO Committee on Forest Technology, Management and Training. The objectives of the conference included the establishment of a permanent forum on cooperative fire management in the Eastern Mediterranean, Balkan and adjoining Regions of the Near East and Central Asia, and to initiate mechanisms for information and resources exchange in forest fire management within the region, including the establishment of partnerships for joint activities in fire research, training and policy development. The conference participants proposed governments and international organizations of the region to establish mechanisms for sharing resources in large fire emergencies in accordance with existing international procedures. The conference report, including the „Antalya Declaration", was already reported in detail in IFFN No. 31 (2004).

This issue of IFFN is providing country reports and reports on dedicated fire research of the Southeast Europe / Balkan region, particularly from the host country Turkey, which were presented at the conference. The follow-up activities of the conference and related to the Antalya Declaration in 2005 reveal the strong interest of the Balkan countries to intensify networking through the newly founded "Regional Southeast Europe Wildland Fire Network" operating under the UN international Strategy for Disaster Reduction (UNISDR).

I take this opportunity to thank the editor of IFFN and head of the Global Fire Monitoring Center (GFMC), Professor Johann G. Goldammer and his team, for their support in facilitating this important regional dialogue.

Marek Belka
Executive Secretary
UN Economic Commission for Europe

EDITORIAL – BALKANS AND EASTERN MEDITERRANEAN SPECIAL ISSUE

In April 2004 the Conference „Forest Fire Management and International Cooperation in Fire Emergencies in the Eastern Mediterranean, Balkans and adjoining Regions of the Near East and Central Asia" was held in Antalya, Turkey. In IFFN issue No. 32 we reported about the conference and the outcomes – the "Antalya Declaration". The conference was followed by a number of regional activities, which had been recommended at the conference.

This special issue is focussing on the Balkans and the Eastern Mediterranean region. A number of country reports, which had been prepared for the conference and the regional wildland fire assessment for the Balkans, provide insight in the specific wildland fire problems in the region. Several contributions delivered by scientists of Turkey, the host country of the Antalya conference, reveal the progress that has been made in fire management research, particularly in the use of GIS for fire management and in assessing the magnitude of economic assets affected by wildfires.

Most importantly are the follow-up activities in Southeast Europe. At the International Technical and Scientific Consultation "Forest Fire Management in the Balkan Region" (Ohrid, Macedonia, 4-5 April 2005) the former UNISDR Regional Balkan Wildland Fire Network decided to expand its scope of work and membership to the whole Southeast European region. Several weeks later the "Eastern European, Near East and Central Asian States Exercise on Wildland Fire Information and Resources Exchange 2005" (EASTEX FIRE 2005) was held in Haskovo Region, Bulgaria, 20-22 April 2005, in pursuance of the Antalya conference. The exercise brought together fire services from the host country Bulgaria and its neighbour countries Albania, Bosnia and Herzegovina, Greece, Macedonia, Romania, Serbia and Montenegro and Turkey.

The exercise revealed the importance of cooperation in fire management in a region, which had been weakened by conflicts and the process of political and economic transition. With the bilateral agreements in place and the experiences gained by active mutual assistance in suppressing wildfires close to or crossing national borders, the fire services and the forest services involved in the exercise showed remarkable professionalism and routine in exchanging personnel and equipment.

This cooperative work has been supported by government agencies and civil society of the region. Valuable assistance was given by the Federal German Foreign Office, which provided resources for the consolidation of the regional network. In accordance with the Ohrid Declaration the network was renamed "Regional South East Europe Wildland Fire Network". The new logo is symbolizing the expanded region.

UN - ISDR / GFMC Global Wildland Fire Network
Regional Southeast Europe Wildland Fire Network

Freiburg – Geneva, December 2005 Johann G. Goldammer

International Technical and Scientific Consultation
"Forest Fire Management in the Balkan Region"
Ohrid, Macedonia, 4-5 April 2005

Technical Report of the Consultation

The International Technical and Scientific Consultation "Forest Fire Management in the Balkan Region" was held in Ohrid, from the 4 to 5 April 2005, under the auspices of the Global Wildland Fire Network, United Nations International Strategy for Disaster Reduction (UN-ISDR). The realization of the consultation was supported by Global Fire Monitoring Center (GFMC), Freiburg, Germany, and financed by the German Foreign Office, Office for the Coordination of Humanitarian Assistance.

There were 18 participants from nine countries: Albania, Bulgaria, Croatia, Germany, Greece, Hungary, Republic of Macedonia, Serbia and Montenegro and Turkey.

Mr. Eng. Zoran Zlatevski, advisor of the Minister of Agriculture, Forestry and Water Supply, opened the meeting. A Letter of greetings from FAO was read by Mr. Bojan Rantasa, FAO Project Office, Macedonia. The Consultation had media coverage by a reporting unit of the Macedonian national television.

Opening of the International Technical and Scientific Consultation "Forest Fire Management in the Balkan Region"

The keynote speech and the eight national reports were presented on the first day of the Consultation. Prof. Johann G. Goldammer (GFMC) delivered the keynote presentation. The title of the presentation was: The Global Wildland Fire Network, United Nations International Strategy for Disaster Reduction (UN-ISDR): Challenges for the Regional Balkan Wildland Fire Network.

During the next sessions, National Wildland Fire Reports of the Balkan countries were presented (Albania, Bulgaria, Greece, Turkey, Hungary, Croatia, Macedonia, Bosnia and Herzegovina and Serbia and Montenegro). In these National Reports, the situation of forest fire management was presented, both the positive developments and the problems that countries encounter in forest fire protection.

The second day of the meeting continued with work in two working groups:

- Research and Development
- Transnational Cooperation in Fire Management

The main issue in there discussions was: Determination of the current problems and recommendations for future collaboration between countries in the Balkan Region. Chairmen of the first group were Prof. Dr. Ertugrul Bilgili and Prof. Dr. Johann Goldammer of the second group. After the completion of the working groups discussions and presentation of their conclusions, they brought the final conclusions from the meeting:

Conclusions

The participants of the consultation:

Recognizing the importance of forests as providers of environmental services and social, economic, and ecological benefits to humankind in Southeast Europe;

Expressing concern about the increasing frequency and destructive force of wildfires in Southeast Europe affecting human health and well-being, economic assets, property, biodiversity, water resources, soil, atmosphere and climate;

Noting that changing land use and rural exodus in some parts of the region is resulting in increased wildfire hazard and vulnerability of ecosystems; likewise urban encroachment in wildlands resulting in increased vulnerability of human populations to fire, notably at the rural-urban interface;

Noting an increase in vulnerability of humans and ecosystems to secondary disasters following fires, including floods, landslides and soil erosion;

Noting that the effects of climate variability and climate change caused by human activities are already producing periods of extreme drought resulting in an increase in the severity of fires in some ecosystems;

Concluding from the analyses and reports of the countries of the Balkan region presented at this consultation, it is evident that the majority of countries in the regions are ready to establish and strengthen a regional dialogue on cooperation and exchange of information, research and wildland fire management; bilateral and multilateral agreements should be considered;

Expressing the intention to overcome **current gaps and shortages** in:

- Consistent information and statistics about fires, their causes and their effects
- Applied research in social sciences and humanities, including finances for research
- Integration of social, economic, environmental considerations and institutions in developing tangible policies and practices related to wildland fire
- Integration of fire as a component of land, resource, and forest management
- Community-based approaches to fire management
- Training in the appropriate use of fire (for example, prescribed burning for fuel reduction and nature conservation)
- Training in the safe and efficient use of resources for fire suppression (for example, appropriate equipment for fire suppression, wildland fire safety)
- Compatible approaches, e.g., global implementation of the Incident Command System (ICS) and the International Wildland Fire Agreements Template

Recalling the recommendations of the International Wildland Fire Summit (Sydney, 2003), the UN-ISDR Wildland Fire Advisory Group / Global Wildland Fire Network (2004), and the FAO Ministerial Meeting on Forests (2005) with respect to the management of wildland fires and the strategy to strengthen international cooperation in wildland fire management;

Endorsing the efforts of the United Nations International Strategy for Disaster Reduction (UN-ISDR) and its Wildland Fire Advisory Group to assist and strengthen the efforts of United Nations bodies,

other international organizations, and non-governmental organizations, to reduce the negative impacts of wildland fires;

Supporting the objectives of the ISDR Global Wildland Fire Network (GWFN) and the Global Fire Monitoring Center (GFMC) to systematically increase the intra- and inter-regional cooperation in wildland fire management for the world;

Expressing gratitude to the Faculty of Forestry of Skopje, represented by Mr. Nikola Nikolov, for the preparation and organization of the consultation;

Recommend to governments, international organizations and non-government organizations the following action plan for cooperation on wildland fire research and management in Southeast Europe:

Research

- Secure financing of a regional wildland fire research programme
- Strengthening wildland fire research cooperation between neighbouring countries
- Develop standardization of terminology and procedures
- Develop standardized data collection i.a.w. the further development of global wildland fire data collection
- Encourage increased involvement of the science community in wildland fire-related research programmes (interdisciplinary research)
- Support the establishment of national or regional (international) wildland fire research centers
- Establish a regional wildland fire weather network
- Approach the EU Erasmus/Socrates programme for developing a dedicated programme for wildland fire exchange

Consolidation of the Regional Network

- Expand the current focus on the Balkan Region to a “Regional South East European Wildland Fire Network” and invite countries adjoining to the Balkan region to cooperate
- Establish a network of country Focal Points, preferably with one representative of a government agency and a representative of the academia
- Support the network co-coordinators that are representing the main stakeholders involved (Mr. Nikola Nikolov, Macedonia, Research; Mr. Vladimir Konstantinov, Bulgaria, Forest Service; Mr. Dulijano Grum, Croatia, Fire Service) (initially nominated for a 1-year period)
- Seek for widespread membership in the network
- Maintain a publicly accessible website of the network (communication language: English)
- Produce an initial publication of this regional consultation and the network foundation, to be published in UN-ECE/FAO International Forest Fire News, including a summary of previous activities in international cooperation in the SE European Region
- Conduct a first Regional Advanced Wildland Fire Management Training Course not later than 2006, based on experiences in other regions and the FAO courses in Bulgaria; seek support from the German Foreign Office
- Request a FAO Technical Development Project (TCP) on “Development of a Regional SE European Strategy for International Cooperation in Wildland Fire Management”, preferably to be conducted before 2007
- Improve access and reliability of regional and country / ecosystem specific early warning information, including automatic distribution
- Participate at the 4th International Wildland Fire Conference, Madrid, Spain (May 2007)
- Convene the next network meeting not later than 2006

During the meeting the participants exchanged experiences and agreed on cooperation in the future. This, along with other issues is one of the more important effects from the Consultation, proving that this type of gatherings and meetings are necessary and useful.

It may not be appropriate for the organizer to give any qualifications about the meeting, but it was the participants opinion (hopefully honest) that the meeting was well organized and that they are all leaving Macedonia richer by new knowledge and experience.

On the end, we are using this opportunity to thank the Global Fire Monitoring Center (GFMC), Freiburg-Germany, the German Foreign Office, for the support, and we are hoping that cooperation will carry on in future.

Participants from Albania, Bulgaria, Croatia, Greece, Hungary, Republic of Macedonia, Serbia and Montenegro and Turkey agreed to expand the current focus on the Balkan Region to a "Regional South East Europe Wildland Fire Network" and invited countries adjoining to the Balkan region to cooperate. The new logo is symbolizing the expanded region.

UN - ISDR / GFMC Global Wildland Fire Network
Regional Southeast Europe Wildland Fire Network

Meeting Report / IFFN Contribution by

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Eastern European, Near East and Central Asian States Exercise on Wildland Fire Information and Resources Exchange 2005 (EASTEX FIRE 2005)

Report and Analysis by the Host Country Bulgaria

The international "Eastern European, Near East and Central Asian States Exercise on Wildland Fire Information and Resources Exchange 2005" (EASTEX FIRE 2005) was held at the field exercise area "Koren", Haskovo Region, Bulgaria, 20-22 April 2005, with the participation of forces and equipment of fire services from the Republic of Bulgaria and neighbouring Balkan countries (Albania, Bosnia and Herzegovina, Greece, Macedonia, Romania, Serbia and Montenegro and Turkey).

This exercise was held in pursuance of the written statement approved by the "Conference on Forest Fire Management and International Cooperation in Fire Emergencies in the Eastern Mediterranean, Balkans and adjoining Regions of the Near East and Central Asia" which was held in Antalya, Turkey, 30 March - 3 April 2004.

This event was organized in accordance with the "Working plan 2005 of the Standing Committee for management of forces and equipment of Ministry of the Interior during crisis situations", as well as the "Annual working plan 2005 of the Standing Committee on population protection in case of disasters, emergencies and crashes at the Council of Ministers" of Bulgaria.

The exercise was a practical drill with imitation of real situation. Participants in this event were the institutions responsible for the prevention and extinguishing of forest fires in the Republic of Bulgaria and fire crews from the Balkan countries.

Objectives of this exercise were as follows:

1. Improvement of the interaction between competent bodies from Balkan countries during forest fires management.
2. Carrying out of united management of forces and equipment in the conditions of forest fires and working off the procedures on interaction and co-ordination between institutions responsible for crisis management in the Republic of Bulgaria and the leaders of international crews.
3. Provision of logistics for the needs of participants in similar operations.

This exercise was held in two main stages:

- First stage – organization actions and staff drill.
- Second stage – practical actions of specialized crews within the zone of the wildfire crisis.

Following activities were included in the first stage of this exercise:

- Receiving of a call with a report on the outbreak of the fire. Undertaking of due measures by the competent institutions from the Republic of Bulgaria. Concentration of forces and equipment at the fire location.
- Provision of permanent information exchange concerning fire development between the head of firefighting operations and representatives of executive and local authorities. Alerting, information and taking immediate measures for the deployment of forces and equipment in the zone of crisis situation.
- Introduction of action plans for crisis situations intended for institutions responsible for extinguishing of forest fires, which might develop into emergency situations.
- Provision of information to neighbour countries about the crisis situation and implementation of procedures for request of assistance. Creation of organization for reception and escorting of foreign crews.

Opening by the Bulgarian hosts

UNISDR representatives and Greece

Delegation from Bosnia and Herzegovina

Delegation from Macedonia

Delegation from Romania

Delegations from Serbia and Montenegro, Greece

Delegation from Turkey

Wrapping up of the field exercise

Some impressions from EASTEX FIRE 2005 – Hosts and Participating Delegations

The exercise site “Koren”, Haskovo Region

…. fire trucks

… impulse guns

… rescue of injured firefighters

… reinforcements

… arresting the arsonist

… post-exercise celebrations

… all crews for group photograph

Some impressions from EASTEX FIRE 2005 – Hosts and Participating Delegations

Following practical actions of participants were included in the second stage:

- Survey and observation of the fire region; management of forces and equipment; emergency rescue and fire fighting operations; closing off the disaster area; provision of escorting and movement of crews taking part in the operation; creation of additional organization of moving within crisis zone; medical and psychological assistance for the sufferers and personnel, taking part in firefighting and their transportation to the hospitals; specifying the places of natural and man-made barriers suitable for fire spread stopping; determination the needs of equipment for making of cuttings.
- Creation of organization for reception of foreign fire crews from neighbour countries at border control checkpoints and their escorting to the place of crisis situation. Provision of communication with the forces, dispatch to render assistance for fire elimination. All participating crews were instructed about labour safety measures during extinguishing of a forest fire.

In the course of exercise different tactical actions intended for extinguishing of forest fires were worked off depending on the equipment of participants. Representatives of the countries having predominant deciduous vegetation like the Republic of Macedonia, Bosnia and Herzegovina used backpack fire extinguishers and impulse fire extinguishing systems for fighting forest fires of low intensities. Representatives of fire service of Romania used equipment for water supply from the natural and man-made water sources. Crews from the Republic of Bulgaria, Republic of Greece and Republic of Turkey, where coniferous vegetation is predominant, used fire vehicles with high cross-country capability and larger quantities of fire extinguishing media, owing to the lack of enough water sources at the territories of their countries. Heavy engineering equipment was used for cutting firebreaks with the purpose of limiting the fire spread.

Following results were achieved during the exercise:

- There was good organization for efficient co-ordination and interaction between institutions in the Republic of Bulgaria responsible for the forest fires elimination and leaders of foreign crews during the operations for limitation and elimination of the forest fire.
- United centralized management of all operations and efficient communication between all participants in the exercise EASTEX FIRE 2005 were realized.
- This exercise contributed to the strengthening of cross-border co-operation with respect to management of forces and equipment of Balkan countries during elimination of forest fires developed into crisis situations.
- EASTEX FIRE 2005 was a further step towards the establishment of the Regional Southeast Europe Wildland Fire Network under the Global Wildland Fire Network of the United Nations International Strategy for Disaster reduction (UNISDR) and its cooperative activities between the Balkan countries. It is closely related to the initiative of Global Fire Monitoring Center (GFMC) within the framework of European Union program INTERREG III B, priority zone 4 “Environment Protection, Resources Management and Risk Prevention”. The Central Adriatic Danube Southeast Region (CADSES) is referred.
- This exercise contributed to the strengthening of international co-operation with respect to forest fire management and mitigation of their consequences; the improvement of co-operation between competent institutions at the Balkans responsible for extinguishing of forest fires; the consolidation of capacity for fire management.

EASTEX FIRE 2005 demonstrated the capacity of Balkan countries to cope with forest fires, spreading on large areas and having undesirable environment impact.

Exercise Report / IFFN Contribution by

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Cooperation in Wildland Fire Management: Italy – Kosovo

Project for the Establishment and Training of a Nucleus for Forest Fire Protection in Pec / Peja - Kosovo

1. Goals, expected results and activities of the project

The general goals of the initiative were

- Improving cohesion in civil society in order to facilitate the standardisation of social life in the province;
- Improving the relation between people and the institutions by involving a methodological approach that would enhance the potentials of the community;
- Contributing to the defence of the forest heritage in Western Kosovo, that, despite the current problems, which cannot be quickly solved, is facing the serious threats of forest fires.

The specific goals of the initiative included:

- Turning a big nucleus of former combatants into civil officials of the civil defence body, while contributing to the respect of peace agreements and the calm of political atmosphere across the province.
- Training and equipment of former UCK members who, after the end of the conflict, envisaged the disarmament and demobilization. This was considered fundamental for fostering civil activities while facilitating the reintegration and rehabilitation.

The expected results included:

- On-site training of a nucleus of 250 former combatants in the operative forest firefighting techniques;
- Training of ten former combatants at a School of the *Corpo Forestale dello Stato* (CFS - the Italian State Forestry Corps) as forest fire fighting team leaders;
- Delivery of fire suppression equipment to the newly formed teams;
- Creation of a network of fire fighting teams to be distributed over the territory; and
- Creation of public awareness on the importance of forest defence.

The activities envisaged for the implementation of this initiative were:

- **A practical training course** (5 days) to be held in Kosovo for the training of a number of elements of the Kosovo Protection Corps (KPC) (Trupat and Mbrojtjes se Kosoves – TMK), up to a maximum of 250 units. The course would mainly be focused on fire fighting techniques with hand tools. The so formed units would form the operative “workforce” to be used in forest fire suppression.
- **First theoretical-practical training course**: 10 days of study for a limited number of people (some five or ten people, turned into 21 as explained afterwards) with the status of Incident Command Leader. This course would have been held in Italy, at the facilities of the CFS, with the detailed development of issues and topics related to forest fires putting off.
- **Complete supply of individual equipment** corresponding to the equipment provided to the Italian firefighters for all people attending the basic course (in Kosovo), material including a leather belt (as those already used by the CFS) with bill hook and case, flask and torch for orientation at night, moreover, individual equipment of protection helmet, working gloves and handkerchief to be used as protection against smoke;
- **Complete supply of team equipment**: fire swatters, rakes, shovels, pickaxes, chain saws, water sprayer, and first-aid boxes.

The intervention strategy of the initiative was mainly based on the training of former combatants currently in the civil defence corps, with no specific technical training.

A practical training in the base course for the operators of the fire line and a theoretic-practical one for a limited number of people was envisaged. The last one was addressed to all those who, after a selection, would have sent to Italy at the CFS Schools to become “Forest Firefighting Team Leaders”.

The whole staff involved in the training process was envisaged to be supplied with elementary equipment ordinarily provided to Forest Firefighting Teams in Italy.

2. Partners and beneficiaries

The project was carried out together with the Defence General Staff - III Division, Military Policy and Planning - Military Centre for Civil Defence and Operative Command of Inter service Summit. It was a training-didactic activity of high level were co-operation between the Defence General Staff and the State Forestry Corps was first evident.

Direct beneficiaries of the initiative were the members of the KPC / TMK. The training was originally addressed just to the III RTG of the TMK in Pec.

The KPC was established on 21st September 2000 with Regulation 1999/8 of UNMIK on the basis of Resolution 1244 of UN Security Council. On 21 September 1999 the KPC was officially presented with a ceremony. The KPC should be made of 3000 men in permanent service and 2000 reservists to be chosen on the basis of professional and functional profiles. The tasks of this civil defence Corps are:

1. First aid in case of natural or environmental disasters, including forest fires of particular dimensions and accidents in industrial buildings
2. Search and rescue services
3. Humanitarian assistance in particularly isolated areas
4. Assistance / participation in land mine clearing / drainage activities
5. Rehabilitation / reconstruction of infrastructures and communities
6. Other tasks requested by KFOR.

It was envisaged that the people of Western Kosovo indirectly would be a beneficiary of the programme. It would benefit from the reinforcement of the civil defence service and the forest fire fighting services, including the post-fire environmental rehabilitation. The transformation of the UCK into a civil defence corps would lead to a gradual decrease of the tensions across the province.

3. Project implementation and completion of the activities

First mission (February 2004)

In the time after the planning and the implementation of the project, the General Inspectorate of the State Forestry Corps felt the need to launch a mission of actualisation and logistic preparation in Kosovo in view of the implementation of training activities in the year 2004. That mission was carried out from 3 to 10 February 2004 by two SFC officials.

The officials proved that the significance and overall objectives of the project were valid and did not need to be altered and its political importance was considerably increased compared to the time of its planning, because of all political changes in the area and the situation the TMK was facing. During the meetings with the representatives of the TMK on the overall operative agreements related to the project, they showed a deep interest and satisfaction for the initiative.

New structure of the project

During the debates it was also stated the need for adjusting the project to the changed organization system of KFOR and the new TMK situation. Therefore, the project was substantially changed as compared to its initial planning.

Indeed, in 2002, it was envisaged just for the benefit of the members of the 3rd Zone of the TMK corresponding to Pec/Peja, area of direct competence of Western Multinational Brigade, under Italian command. However, in 2003 another change occurred in the internal organization of KFOR, with a new territorial division of Kosovo in the following multinational brigades: the Multinational Southwest Brigade (headquarters in Prizren, under German-Italian command), the Multinational Eastern Brigade

(headquarters in Gnjilane, under USA command,) the Multinational Northern Brigade (headquarters in Mitroviça, under French command), and the Multinational Centre Brigade (headquarters in Pristina, under Scandinavian command).

Subsequently the enlargement of participation in capacity building in firefighting was in line with

- request of Vice Commander of KFOR;
- request of the representatives of TMK, later formalised by an official note;
- full consensus of the commander of the Multinational Southwest Brigade and the request by TMK;
- the priorities set by the Italian Government to assist in stabilisation of the region.

Those attending the courses came not only from the 3rd Zone of the TMK, as originally envisaged, but also from all six zones of the TMK and the Central Fast Intervention Group (that is from the whole Kosovo). Afterwards it was decided to increase the number of attendants from 10 to 21 for the high level course which was to be held in Italy at the CFS School for getting the qualification of “Forest Firefighting Team Leaders”, in order to guarantee a higher training to at least three elements for each TMK zone.

During the mission, the Officials of the SFC set all the practical aspects of the project implementation in Kosovo. An operative agreement was made with the Commander of Villaggio Italia, in order to use the logistic base of the Italian Army which offered adequate structures for the small contingent of the CFS dispatched to training 250 TMK members in forest fire fighting.

The availability of the structure of Italian base were extremely helpful not only for the mere implementation of the project activities, but also in terms of efficiency of the action for reaching the goals of the project. The availability of the structures of Villaggio Italia was the result of the initiative launched by the Defence Ministry involving the General Staff, the Inter-Agency Operative Command, and the Civil Military Cooperation (CIMIC).

Also the Multinational Southwest Brigade Command provided its full availability to grant the implementation of the course and took charge of many burdens and costs for overcoming the problems of increasing costs as a consequence of the project enlargement.

Second mission and second non-burdensome changes

From 11 to 14 May 2004 a second mission of CSF was sent to Kosovo, to gauge the political situation after the violent interethnic clashes of March 2004 and to further elaborate project.

Provision of equipment

The equipment for the KPC staff envisaged by the project were bought in Italy and moved to Kosovo in the first week of June 2004 through military flights made available for free by the General Staff of the Army.

As agreed with the military authorities the theoretic base course for 250 people was implemented between 18 June and 6 July 2004 in the Italian military base “Villaggio Italia” in Belo Polje (Pec/Peja).

The subjects addressed by the course included the theoretical basis of fire behaviour, the fire impacts and problems associated with forest fires, and practical instructions of the use of hand tools and portable devices (chain saws and water sprayers) for forest fire suppression.

The program of the activities carried out (theoretic in the classrooms and practical in the areas of the rifle range linked to the Italian Military Base) is reported in the weekly timetable available in Italian, Kosovan-Albanian and for the first week only also in Serbian, since this minority was present in the first contingent of attendants. All attendants were provided with the document drafted for the course and translated into Kosovan-Albanian and into Serbian too.

The level of preparation and learning of the attendants of the course was tested through a final evaluation, made up of ten questions with multiple answer for the drafting of a list according to merit. All attendants were given an attendance certificate.

Considering the importance of the initiative, some representatives of the United Nations Mission in Kosovo (UNMIK) the UN leaders in Kosovo were invited as observers and actually followed the whole course.

From the presence register kept by the Secretariat of the Course results that the attendants of both modules were up to 246 Kosovars out of 250 envisaged. There was also a small number of representatives from the Serbian minority. A translation into Serbian of the didactic documents was provided.

At the end of both modules of the course the TMK/KPC was provided with the following equipment:

- 250 plastic protection helmets
- 250 tissues against smoke
- 250 pairs of leather gloves
- 250 fiber belts
- 250 plastic flasks with cover
- 250 torches for orientation at night with double battery charger (with direct power pack and power cable for cars)
- 250 bill hooks with cover
- 70 fire swatters (metal)
- 70 fire swatters (rubber)
- 35 fire shovels
- 35 pickaxes
- 70 fire rakes
- 7 chain saws
- 7 mist blowers
- 7 first aid kits

With the delivery of the materials the complete training and equipment of the TMK / KPC was successfully implemented, and the staff is therefore able to autonomously intervene in case of forest fires.

Figure 1. Unloading of hand tools on the Italian military base “Villaggio Italia”

Course for Forest Firefighting Team Leaders

The second part of the project envisaged the launch in Italy of the "Qualification Course for Forest Firefighting Team Leaders". The course was held from 16 to 26 November 2004 in Cittaducale (Rieti), at the SFC School.

21 members of the TMK/KPC (Trupat e Mbrojtjes se Kosoves/Kosovo Protection Corp) attended the course and they were carefully selected among the attendants of the base Course held in Kosovo.
The above-mentioned Course sets the conclusion for the "Project for the establishment and training of fight against forest fires nucleus in Kosovo".

Figures 2 and 3. Classroom training on the Italian military base "Villaggio Italia"

Didactic activities

The subjects of the course (after a general introduction on the dynamic of forest fires and the use of manual tools and portable devices for their putting off) focused on the main theoretic-practical notions of the Forest Firefighting Team Leaders.

The role and the tasks of the last were analysed, beyond the ways of actively fighting against flames and the case studies, the backfire technique, cartography and topography elements, first aid elements.

Activities were also carried out on the ground, with the monitoring and study of two different areas (one in the province of Terni and the other one in the province of Viterbo) crossed by fires and where all the tasks of the Forest Firefighting Team Leaders were introduced.

The level of preparation and learning of participants of the Course was tested through a final evaluation test. The activities of the Course were concluded with a Ceremony held on 25th November in the "Salone Giovanni Gualberto" of the Direction of the SFC school in Cittaducale, where the attendants were given an attendance certificate.

Figures 4-5. Forest firefighting field training in Pec/Peja, Kosovo

4. Conclusions

The review of the didactic-training activities of both courses can be considered positive on the basis of several aspects, especially:

- the high number of attendants of the first course held in “Villaggio Italia”
- the interest of the attendants during the activities, their attention and care
- the high operative ability during the practical phase of the course with the use of manual tools (in the practical part of the course)
- the high outcomes reached in the final evaluation tests (in both courses).

Moreover, it is to be considered:

- The establishment in Kosovo of a structure able to face the emergencies of forest fires, since everybody received the proper training and supplied with adequate equipment.
- This project was the first example of didactic-training initiative across Kosovo related to TMK/KPC in view of its transformation into a civil defence structure also providing education and equipment.
- The project is the first example (also at international level) of dealing with environment protection and natural resources safeguard, beyond the protection of forest lives in Kosovo at risk because of forest fires in the framework of “peace military activities"
- The project was the first civil-military cooperation example bearing positive professional exchanges among the Defence General Staff – III Division, Military Policy and Planning-Military Centre for Civil Defence, the Italian Army and the Corpo forestale dello Stato carrying out the initiative.
- It was the first mission abroad for the CFS on specific tasks (but “Missione Arcobaleno” where the CFS had civil defence and humanitarian aid tasks).

Figure 6. Handing over of the diploma

According to what aforementioned, it is clear that the “Project for the establishment and training of nucleus against forest fires in Pec/Peja - Kosovo”, carried out by the CFS fully reached its goal, that is, on one hand, contributing to the stabilization process in Kosovo increasing civil defence tasks of the TMK-KPC, and, on the other hand, establishing a structure (through the training and the supply of individual safety equipment and the division equipment for flames putting off) for the safety and protection of forest resources in Kosovo, potentially threatened by the risk of forest fires.

IFFN Contribution by

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Albania Country Report 2004

1. Description of the fire environment, fire regimes, ecological role of fire

Albania, despite its very small territory (28,750 km^2), is one of the European countries with rich vegetation, which originated during the Tertiary era. Today's vegetation of Albania is composed of endemic relic vegetation and of species that have invaded from neighbouring regions thought migration, having phytogenetic similarities with floristic elements of neighbouring countries. Albania is a mountainous country with higher topographic and climatic variety than the other European countries: 52% of it's surface is on elevation between 600 and 700 m above sea level with prevailing steep slopes (ca.30%). Thus, ca.90 % of its surface is subject to severe erosion. The northern, northeastern, southeastern and central areas are characterized by hilly-mountainous terrain; whereas the north-southern/costal area along the Adriatic and Ionian coast is lowland.

Climate extremes range from extreme cold winters in the northern, northeastern and southeastern areas to very hot and dry summer along the coast. Rainfall regimes vary from north to south and from coast to inland. There are fewer rainy days in the south that in the north, but months without rainfall can occur at any time of the year, as it is typical for the Mediterranean climate. Local precipitation differences lead to diverse vegetation patterns. Forests occupy 1.025 million ha standing volume of about 82 million m^3 and an average annual growth of 1.4 m^3 per ha (this is very low compared with many country of central Europe). The management regime of the forest areas is as follows:

- 460,950 ha are high forest (46% of the total forest area) consisting of 171,850 ha coniferous and 289,370 ha broadleaved species
- 332,250 ha coppice forests (29% - mainly oaks)
- 257,850 ha shrublands (25%)

Taking into account the functions of the forest areas, 193,000 ha perform a protective function while the rest (836,650 ha) are productive forests.

The forest species composition is as follows:

- 160,000 ha of beech (*Fagus silvatica*)
- 142,000 ha of pine (*Pinus* spp.)
- The rest is broadleaves 310,000 ha (34%)

Fire Impacts

The negative fire impacts are very large in the conifer forests and less in coppice and shrubs. The main negative impacts are the erosion after the fire occurrence in the area burned, the destruction of the regeneration cover, the influence in land structure and water regime circle. Farther more there are impacts on diminution of the forest productivity. With all the characteristics mentioned above the forest ecosystems in Albania are very sensitive from the fire. Only in the seaside forest protection belt, surface fires in pine have the role of maintenance and as a measure of controlling the fire propagation. In the sites affected by fire especially in the pine natural forests in the north of the country in the districts of Puke, Kukesi, Mirdita we can see that the vegetation cover after the fire is very different from the vegetation before it.

In the southern part of the country, traditionally for centuries, the fire is use as a tool of cleaning and regeneration of the pasture. In these sites the long use of fire has done big changes in the ecosystems. One of the main impacts is the installation of one years old grass plant and the disappear of the many years vegetation plants.

We have noted that the regeneration of the shrubs is very fast after the fires and it depends from the severity and the intensity of the fire in these sites. The main problem that appears in these sites is the erosion and the water regime in the first years. We have observed considerable damages in the fauna, and change of behaviour of animals and birds. We want to underline the fire impacts in the Albanian forest are negative in every ecosystem and land-use system they affect.

Summary Tables of natural and human influenced fire regimes

Table 1a. Summary table describing the natural and human-influenced fire regimes in different ecosystem types in Albania.

Ecosystem Type	Name / Designation[1]	Total Area of Ecosystem in the Country (x 1000ha)	Ecosystem Sensitivity[2]	Typical Fire Frequency (yrs) [3]	Typical Fire Size (ha) [4]	Fire Origin / Cause [5]
Wildfires (including wildfires burning within prescription)						
Forest						
Forest 1: Not intensively managed and protected.						
Forest 2: Intensively managed and / or protected (major ecological or economic assets at risk)	Conifers/ Broadleaves	460.950	FS/FM	2-3	2	Human causes
Forest 2: Intensively managed and / or protected (major ecological or economic assets at risk)	Coppice	332.250	FM	1-2	0.5	Human causes
Other Wooded Land						
Wooded Lands / Shrubland / Savanna 1: Not intensively managed and protected						
Wooded Lands / Scrubland / Savanna 2: Intensively managed and / or protected (major ecological or economic assets at risk)	Shrubs	257.850	FS	2-4	2-2.5	Human causes
Other Land						
Open Steppe / Grassland / Pastures (not included in Wooded Lands / Scrubland / Savanna) Both intensively and not intensively managed	Pastures	415.000	FS/FM	1	4-5	Human causes
Peat / Swamp / Wetland						
Indicate biome type (e.g. peat land, peat-swamp forest, marsh)						
Prescribed Burning						
Forestry, Conservation						
Indicate Ecosystem Type:						
Agricultural / Pastoral						
Agricultural lands / Pastures (straw burning, e.g. corn, wheat, rice paddies, sugar cane; slash and burn systems; pasture maintenance burning)	No data					

Notes: Ecosystem sensitivity classification: **FS** (fire sensitive ecosystem: fire has a detrimental effect on these ecosystems in terms of ecological and/or economic damage), **FM** (fire maintained ecosystem: fires are needed to maintain these ecosystems in terms of ecological and/or economic benefits; **FT** (fire tolerant ecosystem: fires have a minor impact on these ecosystems in terms of ecological and/or economic aspects). -- In Albania prescribed burning is not used. Thus, there are no statistics available.

Table 1b. Distribution of natural and human-influenced fires throughout the year.

Ecosystem Type	Wildfire Occurrence / Use of prescribed burning by Month and Percentage											
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Wildfires (including wildfires burning within prescription)												
Forest												
Forest 1: Not intensively managed and protected												
Forest 2: Intensively managed and / or protected (major ecological or economic assets at risk)	0.12	0.5	3.5	2.6	1.7	1.2	17	64	7	1.7	0.34	0.34
Other Wooded Land												
Wooded Lands / Shrubland / Savanna 1: Not intensively managed and protected (major ecological or economic assets at risk)	0.3	0.7	8.4	4.2	2.5	1.7	25	51	5	0.9	0.15	0.15
Wooded Lands / Shrubland / Savanna 2: Intensively managed and / or protected												

2. Fire statistical database: Wildfire and prescribed burning statistics for the period of 1988-2004

Table 2. Wildfire database 1988-2004. Data of the two 5-yr periods 1988-92 and 1998-2002 are highlighted because these periods are of key interest for the FAO Global Forest Resources Assessment 2005 (FRA-2005).

Year	Total No. of Fires on Forest, Other Wooded Land, & Other Land	Total Area Burned on Forest, Other Wooded Land, & Other Land	Area of Forest Burned	Thereof area of "Forest 2"	Thereof area of "Open Steppe / Grassland / Pastures"	Human Causes	Natural Causes	Unknown Causes
	no.	ha	ha	ha	ha	%of No.	% of No.	% of No.
1988	**121**	**256**				**100**		**60**
1989	**132**	**320**						
1990	**269**	**417**						
1991	**147**	**250**						
1992	**659**	**1011**						
1993	560	522						
1994	585	705						
1995	110	153						
1996	490	410						
1997	735	1847						
1998	**601**	**680**						
1999	**628**	**689**						
2000	**915**	**3675**						
2001	**327**	**1434**	**941**	**941**	**493**	**100**		**55**
2002	**140**	**690**	**650**	**650**	**40**	**99**	**1**	**63**
2003	771	6359	4419	4419	1948	95	5	57
2004	143	1473	491	491	982	100	0	40
Average	**431**	**1229**	**1625**	**1625**	**866**	**98.5**		**53.7**

Note: The data collected in Albania are different from the Global Wildland Fire Assessment 2004 system. Thus, the table cannot be completed properly. The Forest Service collects data only for the forest and pasture fire occurrence.

3. Financial losses due to wildfire impacts on people, property, and natural resources between 1988 up to 2004

In the fire sensitive ecosystems the ecological damages is very high. We have observed loss of species in sites that are prescribed from fire in a frequency of 1-2 years. The assessment is based on the on the studies of the sites by the forest service teams.

Two kind of values are taken into account when calculating the value of damages caused by forest fires:

- Foregone benefits: these benefits are out-weighted due to a fire damages. The damages vary quite a lot and are subject of differences existing in-between the characteristics and types of the forest stock where the fire occurs (the so-called forest fire typology). For some of the patterns, the cost-values is calculated on basis of the forest area affected by the fire and latter on will be aggregated on per ha basis while for other patterns these costs will are calculated on per ha basis;
- Fires suppression/rehabilitation related-investments/cost. These costs are necessary to be incurred for suppressing the fire and are calculated on per ha basis.

Evaluation of damages in economic or quantitative terms is essential as it is the background for establishing sound fire management programmes through better forest planning and silvicultural techniques as well as risk sharing approaches. Ecological losses cover a broad range of situations.

The multifunctional role of forests has been emphasized quite often over the last ten years in all international political processes dealing with forests. In particular, societal and environmental functions have been highlighted, although the wood production function remains important. Although, the valuation of non-marketable functions of forests, the so-called "positive externalities", is not easy from a methodological point of view; the fact that forest fires have affected these externalities, is important to take into consideration. Once all losses have been estimated, their conversion into expected loses, is obtained by incorporating hazard probability characteristics.

Foregone Benefits: Identification and Description

Benefits form a forest area that are foregone due to the occurrence of a fire can be classified in two groups:

- Direct benefits such as wood production, hunting and wildlife, watershed protection, climate moderations (air-pollution, microclimate effects) and
- Indirect benefits such as forest landscape, non-wood products, recreational values

Direct benefits

Wood production: A forest area affected by fire loose first of all, forest trees consisting in that area. DGFP has considerable data about the mean forest stock, selling prices and the age and pattern of different forest areas, thus is possible to quantify the wood production (industrial round-wood and fuel-wood) foregone due to a forest fire.

Hunting/Wildlife: Besides the amenity values derived from their contribution to the landscape, the forests provide some recreational opportunities in the form of hunting activities. The benefits from these activities could be measured by using values derived from the lease of hunting rights. The hunting potential of different forest areas is different due to inherent site characteristics and differences in their accessibility, some area are easily accessible and some others are very hard or quite impossible.

Watershed Protection: It is known that vegetative cover protects from erosion. The benefits due to watershed protection are quite significant especially in a country where forest areas are located mainly in mountainous landscapes. In addition, they provide improvements to hydrological conditions (which are small in on average and very hard to measure).

Climate Moderation: The forested areas are a good source to reduce air pollution (due to their potential to sequestrate the carbon emitted in the atmosphere) and creation of some micro-climatic conditions favourable for natural regeneration. Therefore, in case a forest area gets burned the carbon sequestration potential is decreased and the micro-climatic conditions considerably halter the natural regeneration.

Indirect benefits

Forest Visibility and Landscape: Visual impact of forests landscape is another important benefit to the national economy. Attractive forest landscapes are public goods that can be enjoyed by many people without detracting from the enjoyment of others. It is therefore needed to know the potential tourist population, their distribution and their willingness level to pay in order to determine the benefits. In general this is done through contingent valuations[1]. In case when forests are in close proximity to the population concentrations, they provide benefits to the local population in the form of recreational values. However, the magnitude of these benefits is not possible to be known, partly due to lack of data and partly due to difficulties in computing financially the benefits that might derive.

Non-Wood Products: besides simply timber, there are other products that are excerpted by the forested areas such as fodder, fruits and various medicinal and aromatic plants. Generally, forest fires destroy these benefits in short-terms; however in some cases production of non-timber products might increase in medium and/or long run.

We have made the economic evaluation for each lost benefit. We have divided the damages caused by the forest fires (the calculation of their economic values is the respective lost benefit) in two groups:

- Direct measurable foregone benefits, the damages for which there are known with a relatively high exactness (the quantitative as well as the economic and unitary values of the damage);
- Indirect measurable forgone benefits, the damages for which there are not exactly known nor the quantitative values and neither the economic and unitary values of the damage;

The main direct measurable forgone benefit is considered the wood material (as timber and fuel-wood), while, the indirect measurable foregone benefits are classified: NTFP, hunting and wildlife stock, climate moderation, watershed management and erosion control, loss of the landscape and the nature beauty.

The most human activities that have a strong impact are the forest harvesting, agriculture activities, the building activity mainly in the costal area etc. These impacts have negative influence on the fire regime.

The recreation activities have also influence in the fire regime. Other factors are: grazing in the forest, collecting of second forest products. These factors have a positive impact to the redaction of the fuel in the forests.

The number of fires has been increased during years since 1980. The following general statements attempt to explain the increasing of fire occurrence and fire damage:

- Vacuum of ownership, power and responsibilities
- Fires as a weapon against former decisions in land-use planning
- Land property disputes
- Consequences of market-oriented forestry operations
- Lack of access
- Lack of funding to pay personnel for fire suppression
- Lack of technical means for fire management
- Climate change
- The fires are occurring earlier in the year we explain this with the climate change and the people activities in the forest areas

1 Contingent valuation is a commonly used practice to obtain monetary estimations about the local consumption of goods and services for which there is no market. Survey respondents are asked for their willingness to pay or for their willingness to accept compensation for specified fluctuations in the level of the service/good offered to them.

Table 3. Summary of financial losses due to wildfire impacts on people, property, and natural resources between 1988 and 2004

Year	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Damage ($US)	3,120	2,553	3,724	12,000	3,283	21,740	40,000
Year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Damage ($US)	15,400	174,923	1,022,064	200,208	24,553	4,385,758	665,551

4. International cooperation

Until now there is not an international cooperation for the forest fire management. We are trying to make agreements with the neighbouring countries but until now it has been no contact. The only field of cooperation in international level are the training courses and workshops organised form different countries like Spain and Italy. We think that there is a big need for cooperation in international level, especially with the neighbour countries for sharing information, knowledge and if necessary to support each other with personnel and technique if necessary during the big fire situations.

5. Application of prescribed burning in the region to achieve management objectives (purposes, extent, results)

Prescribed burning is not used as a tool for fire management. We have no experience for that. The community is very sensitive and for the moment it can't be used in the forest area. We have no data on the prescribed burning in the agriculture land but sometimes we have had forest fires from the uncontrolled agriculture area.

6. Operational fire management system(s) and organization(s) present in the country or region

Table 4. Responsibilities of different stakeholders in fire management at various levels in the country.

	Government Organisations / Agencies	**Non-Government Organisations**	**Private Sector**	**Local Communities**	**Academia**	**Other**
National	Directorate General of Fores and Pasture			Ministry of Local Government	Academia of Science of Albania / Forest and Pasture Research Institute	Ministry of Defence/ Ministry of Public Order
Provincial	Forest District Service		Forest harvesting companies	Civil Emergencies office in Prefectures		Ground Troops
Municipal	Sector of Civil Emergencies			Civil Emergencies Sector		
Local	Volunteers			Fire fighters		
Other	Fire Fighter Service					

The Forest Service is responsible for the forest fire management. The Forest Service collaborates with the Directorate of Civil Emergencies, Fire Fighter Service, Military Units and other state agencies. Until now there is due to the recourses that they have it is very difficult to use them in forest fire. The last years, forest service has done significant investments for the logistic support of forest fire suppression and control but is still much to be done for the planning and logistic support measures.

The private sector is not involved for the fire management. Only the private companies that work in the forest harvesting are obliged to support in the fire operation suppression.

There are no non-government organizations involved in this field.

The local community is involved only in the forest areas that have passed to the community use.

The Forest Service finances all the operations regarding the forest fires.

In large fires situation the Forest Service calls the Directorate of Civil Emergencies for help; this is the state agency that has the authority to involve the other institutions recourses inside and outside the country. There is an inter-agency agreement between five institutions. Since its establishment the Directorate of Civil Emergencies is mandated to coordinate the efforts of all stakeholders.

There is no international agreement until now.

Figure 1. Fire burning in a pine forest on a steep slope.

6. Sustainable land-use practices employed in the country aimed at reducing wildfire hazards and wildfire risks

There is a lack of information for land use system. What the forest service does is the awareness campaigns for the damages related to the wildfires and the need for their help and support from the community. We have started to implement forest management practices for fire management purposes. There is much to be done in this direction because there is a lack of knowledge and experience in this direction.

7. Fire management / suppression technologies, training standards and facilities

There is no early warning system of the forest fires the only measure taken is the classification of the most exposed areas to the fire. Fire detection and monitoring is performed on the ground. Fire suppression equipment consists mostly of simple hand tools. During the last years we have received 28 complete firefighter units with full sets of protection and fire suppression tools. We have in use six vehicles adapted for forest fire suppression.

The information system is based on radio communication system used by the Forest Service.

National wildland fire management planning, preparedness

After the approve of the National Forest Fires Management Strategy, the DGFP has review the national management plan furthermore, every forest district directorate have review the local forest fire management plane according the new legal framework and new conditions.

These annually updated plans contain:

- Analysis of the causes of wildfires and factors that influence the spread of fire
- Fire statistics of the last year
- Forest fire risk areas and periods
- Actions for the forecast and the prevention of forest fires
- Entity and location of the means, equipments and human resources for the forest fire fighting
- Entity and location of the ways of access to the forests
- Technical fire prevention measures (fuel management, silvicultural and maintenance operations
- Training and information activities
- Finance plan

There is no training centre for forest fire fighters in Albania. The fire service intends to build up a training centre for urban fire fighters.

The Directorate General of Forest and Pasture has supported the training of some staff abroad. Their experience has been used in the training organised by the Forest Service for local field staff.

There is a lack of training staff; there is much to be done in this direction.

8. Public policies concerning fire

The legal framework has been completed in the last years, but there are needs for improvements in this direction. All the institutions, agencies, government and private sector are obliged by law to take precaution measures against fires and to assist in managing fire emergencies. The problem is the implementation of the law and the improvement of regulations.

9. Wildland fire research

There are no research in this field, except some studies and analysis. We have used the experience in the past years and the experience of other countries.

10. Needs and limitations

There is a lack of responsibility from the local government authorities regarding the measures that need to be done for the prevention and control of the forest and pasture fires. The local community generally is mobilized by the forest service not by the commune. There is nothing being done from the local government authorities regarding the sensitisation of the community and the precaution measures that must be taken during the burn of the agricultural fields after the harvesting of crops.

The forest service by law is the government organization for the management of the fires in forest and pasture, but this service has big limitations in personnel and finance support. So, it is very difficult for us to manage all the fires.

During the last years considerable efforts have been invested in the coordination of measures with other institutions. However, communication still needs to be improved. Regional forest fire management plans must be coordinated with the management plans of the civil emergency protection bodies at local level.

There is a need for international exchange of knowledge and experience.

There is need for financing the prevention measures including the silvicultural treatment of the forest for fuel managements.

11. Other

Examining the reasons of forest fires, it is revealed that 29% of forest fires arise from carelessness and negligence, 61% from unknown reasons, 9% from intentionally reasons and only 1% from unusual events and from lightning (Figure 1). However, it should be understood that even forest fires marked as "caused by unknown reasons" are considered as started by people. As these fires are not known exactly why they were started by and therefore, they are called as "unknown reasons". In this case, it can be concluded that people cause a great portion of the forest fires occurred in Albania. These values don't differ so much from the data of other Mediterranean countries.

Among the forest fires caused by negligence and carelessness, the most important ones are the fires arisen from cropland burning and clearing fields for agricultural purpose, cigarettes, picnic fires, and other fires set by shepherds and hunters. Among the fires occurring accidentally, the fires arisen from breaking off the electricity line are also important. Clear cutting for agricultural purposes and covering the tracks of criminal are intentional fires started by people. In Albania, people are a main factor causing the forest fires. This must be taken into consideration for planning forest fire prevention measures.

Besides the requirements for forestry related training of a part of society, it is necessary to expose the economic aspect of damage resulted from forest fires and therefore having a clearer picture on the financial values of damages created by fires and hopefully making aware the respective authorities for the need to get immediate and appropriate measures.

12. Date of report and address of rapporteur and key contact

Date of Finalizing the Country Report: 8 March 2005

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Croatia Country Report 2004
Global Wildland Fire Assessment 2004

1. Fire environment, fire regimes, ecological role of fire common to country

The typical occurrence of fire (fire regimes) in Croatia is determined by topography, altitude, climate and vegetation composition. Table 1 provides an overview of the natural fire hazard zones in the country.

Table 1. Categories of the natural conditions that determine fire hazard and risk in Croatia.

Natural Fire Hazard	Belts, sub-belts, bio-climates	Dominant forest vegetation
Very Low	Lowland (plains, valleys)	Semi-humid and humid forests and scrub-forest in various vegetation areas (forests of Pedunculate Oak (*Quercus robur*), willow, poplar, alder, etc.)
Low	Forests/steppe, hills (continental), low hills and low submontane, high hills and high submontane	Steppe-forest, various mesophyllous and mesothermic forests of sessile oak, Hungarian oak and bitter oak; beech and other broadleaf forests and shrubs
Moderate	High mountains and higher submontane	Different forests and shrubs of fir, spruce, pine (*Pinus sylvestris, Pinus leucodermis, Pinus peuce, Pinus mugo*), larch and other conifers
High	Hills (sub-Mediterranean)	Various thermophylforests, shrubs and scrubs of broadleaves (pubescent oak, Hungarian oak and other) and conifers (*Pinus* sp., *Cupressus* sp., *Juniperus* sp. and other)
Very High	Hills (Eumediterranean, thermo-Mediterranean, infra-Mediterranean)	Various xerophyllous and ultra-xerophyllous forests, maquis and garigues of evergreen broadleaves (oak, holly oak etc.) and conifers (*Pinus* sp., *Cupressus* sp., *Juniperus* sp. and other)

2. Narrative summary of major wildfire impacts on people, property, and natural resources during 1990s

Data on the impact of forest fires on people's health and their property during the 1990s are not available. Based on the Statute on Forest Management, the Statute on the Criteria for Forest Indemnity Price Lists, and the Programme for Managing a Forest Management Unit, the company managing state forests and other forest lands in Croatia (81% of total forest and forested land area) makes the calculation of all kinds of damage in the forests and forestland.

3. Fire database: Wildfire statistics of fire numbers, area burned and fire causes for the period of 1980-2002

The data on fire numbers and fire causes of 1980s are not available because the data of the Republic of Croatia were included in the summarized dataset of former Yugoslavia.

The fire numbers and causes of the period 1990-1999 have already been recorded in the fire database of the UNECE Timber Committee. The data presented in Table 2 are covering the period 2000-2004.

Table 2. Forest fire statistics of the Republic of Croatia covering the period 2000-2004.

Year	Total No. of fires on forest, other wooded land & other land	Total area burned on forest, other wooded land & other land	Area of forest burned	Area of other wooded land and other land burned	Human causes	Natural causes	Unknown causes
	no.	ha	ha	ha	no.	no.	no.
2000	7797	129883	27407	102476	6743	50	1004
2001	4024	27251	1818	25433	2924	32	1068
2002	4692	74945	5997	68948	3403	28	1261
2003	6924	77359	14155	63204	4803	65	2056
2004	2855	8988	1466	7522	1927	22	906
Average	**5258**	**37734**	**10169**	**53517**	**3960**	**39**	**1259**

4. Operational fire management system and organisations present in the country

The operational fire management system has been established by the Law on Fire Fighting and a number of legislation acts. Fire brigades are subordinated to local self-management, with financing also determined by the mentioned law. The law and the legislation acts determine the following:

- Assignment of individual fire brigades for particular fire-fighting tasks;
- Establishment of a National Committee for Fire Prevention and Control;
- Requirements to be met by firemen;
- Requirements to be met by fire brigade commanders;
- Relations during fire-fighting operations;
- Supervision of the fire-fighting systems;
- Education, training and improvement;
- Penal provisions.

Fire fighting is carried out by the following fire brigades:

- Public fire brigades of municipalities or cities (voluntary or professional);
- Voluntary fire brigades (societies);
- Professional national fire brigades;
- Voluntary national fire brigades;
- Intervention fire brigades of the Ministry of Home Affairs.

Preventive fire protection

The system of preventive fire protection has been determined by the Law on Fire Prevention and the supplementary acts. The Ministry of Home Affairs includes the Inspectorate of Interior Police – authorised for the tasks connected with fire prevention. In counties within individual police administrations there are also organisational units authorised for the tasks of fire prevention.

The Law on Fire Prevention prescribes the obligations of the local self-management units to enforce and take measures for improvements in fire prevention. The self-managing units are obliged to prepare the Plan of Fire Protection based on the fire hazard assessments. The Plan is a document on the basis of which preventive and operational fire/prevention measures are organized and enforced on the territory of local self-management.

The preventive forest fire protection measures are prescribed by the Statute on Forest Fire Prevention, which obliges the particular members of the society to actively take part in fire prevention. This consists, among others, of a list of forests with cartographic description and an estimate on the degree of fire hazard, the establishment of a fire detection/reconnaissance system, preventive forest cultivation, and educational/information activities.

The fire-fighting system at government level

The Ministry of Home Affairs is a departmental body for the tasks of fire prevention and fire fighting in terms of enforcing the following:

- Supervision of the fire prevention and fire-fighting systems
- Control of the more complex events
- Inter-agency co-ordination of fire prevention and suppression
- Preparation and passing of legal regulations
- Strategic planning for the acquisition of mechanization and equipment
- Control of aerial and land fire-fighting forces
- Communication with other countries in the field of fire prevention

Within the Ministry of Home Affairs there is the Directorate for Prevention and Rescue, which includes the Fire-Fighting Department. This Department carries out the integration of the tasks connected with the tasks listed above, and is directed by the Fire Chief. In accordance with the Law on Fire Fighting, the Fire Chief is responsible for the organization, qualification and intervention capability of firefighting on the territory of the whole country. The Fire Chief is in charge of the intervention fire brigades, conducts fire-fighting interventions in two or more counties, and those that include aerial fire fighting force. The Fire Chief, or his/her deputy, may order every fire brigade to intervene on the territory of the Republic of Croatia with a particular number of firemen and technical equipment, and may request the assistance of the military forces.

The fire-fighting system at county level

The Republic of Croatia consists of twenty counties and the City of Zagreb, which also has county status. In each of the counties there are active public fire brigades organized in county fire societies. In accordance with the Law on Fire Fighting, county fire commanders are subordinates of the fire commander in charge of the county fire operations system. The county fire commander conducts more complex interventions, and those in which aerial fire-fighting forces take part on the territory of his/her county.

Management of complex fire events

If an event passes the capabilities of a city or a municipality, the county fire commander (at county level) takes over the command of the intervention.

The Fire Chief, or the person authorised by him/her, may take command of every fire intervention, i.e. this happens in case of more complex interventions during forest fire suppression operations, or in accidents caused by hazardous materials (HAZMAT). In more complex events, a Chief Headquarters is established.

The National Fire Operation Center of the Ministry of Home Affairs is active throughout the year. The Center is directly connected with fire operation centres of other counties, which enables a fast flow of information and commands, without which efficient large-scale interventions would not be possible.

The center is formed for the realisation of the following tasks:

- Integration of conducting and commanding tasks during the extinguishing of more complex fires
- Control and co-ordination of aerial fire-fighting forces
- Monitoring of the intervention procedure
- Activating backup forces
- Data processing
- Communication with all institutions and individuals of the fire system
- Informing the media

The Center encompasses all the subjects required for activating the material, technical and staff resources. During the summer fire season, the Center is dislocated to the coastal region of the country, from where it controls fire fighting.

Intervention fire brigades

In concordance with the Law on Fire Fighting, four firebases in coastal Croatia (Zadar, Šibenik, Split, Dubrovnik) are established, in each of which a center of Intervention Fire Brigades is included. The Intervention Fire Brigades are subordinated to the chief fire commander, i.e. the person authorized by him/her. A fire brigade has a regular staff of 16 people who are fire instructors, and fire squad leaders during the season. Immediately before the fire season, the Intervention Fire Brigades are reinforced with professional firemen from the public fire brigades of the continental Croatia. In case of massive forest fires, the intervention fire brigades are transported in vehicles and helicopters to the fire site. The intervention fire brigades also encompass aerial fire-fighting forces.

The training of the Intervention Fire Brigades encompasses the following:

- Operational activity – forest fire suppression
- Work with technical mechanization and equipment
- Coordination of land and air brigades
- Command of fire fighting
- Topography
- Physical preparation
- First aid
- Training for helicopter landing

The Intervention Fire Brigades are equipped with the following technical outfit:

- Fire engine vehicles
- Light portable forest fire extinguishers
- Pipes and hoses
- Rubber water containers
- Mowers, chain saws
- Protective equipment

Aerial fire-fighting forces

The Republic of Croatia has four Canadair CL-415 aircrafts and one Air Tractor for aerial forest fire suppression. Besides, helicopters MI-8 are used for both fire extinguishing and the transportation of firemen and equipment.

During fire season, aircraft are based in coastal airports. In accordance with danger estimates, aircrafts are positioned in particular bases, so that the flight to the fire site is the shortest possible.

Besides the use of the fixed-wing aircraft CL-415 for aerial fire suppression, the use of helicopters with suspended water containers (helibuckets) has been developed in Croatia during the recent years. Helicopters additionally serve for the transportation of water in rubber reservoirs to the elevations above fire sites, the transport of firefighters, equipment and special fire engines.

The regional center for disaster control

The Pact on Stability for South Europe brought the initiative for forming the Regional Disaster Management Center (RDMC) for the Split-Dalmatia County. The geographic position of the RDMC is such that its activity covers the whole region of Slovenia, Bosnia & Herzegovina, the Adriatic Sea, Italy, Greece, Albania, Serbia & Montenegro, and Macedonia. The aim of establishing the RDMC is to form a co-operation in the field of planning, preparation, prevention, fast reacting, reducing the disaster consequences, including forest fire extinguishing in the area of southeast Europe.

The regional center is now in the phase of organization.

Fire mechanization and equipment

The fire brigades of the Republic of Croatia have altogether 2,500 fire engines, of which about 1,200 fire-extinguishing vehicles, 45 air-rescuing vehicles, 65 vehicles for technical interventions, and 1,190 other fire vehicles.

The role of the voluntary fire brigades

The Croatian Law on fire fighting regulates the status of the voluntary fire fighting, which is based on a long tradition. The efficiency of Croatian fire-fighting would be impossible without the voluntary fire-fighting societies, especially in the parts where professional brigades are distant, and when a large number of firemen are essential for extinguishing extensive forest fires.

Based on the Law on Fire Fighting, voluntary fire-fighting societies are associated into Fire Associations of cities and municipalities, i.e. County Fire Associations. The supreme association of voluntary fire-fighting in the Republic of Croatia is the Croatian Fire-Fighting Association, whose task is the promotion of the interests of voluntary firemen societies on the territory of the Republic of Croatia, and the representation of Croatian fire-fighting abroad.

Contact:
Hrvatska vatrogasna zajednica
Našička 14
10000 Zagreb
Republika Hrvatska

Tel: +385-1-3699033
Fax: +385-1-3025026
e-mail: zajednica@zg.hinet.hr
Internet address: www.hvz.hr

5. Use of prescribed fire in the region to achieve management objectives

Within the fighting tactics in the open space in the Republic of Croatia, particularly along the coast, the tactics of setting suppression fires (backfires) is rarely applied. The use of prescribed fire on agricultural lands, e.g. for soil preparation, is also not practiced. The reasons for this are the following:

- Rugged and uneven geomorphology
- According to this, varying distribution of forest associations depending on geographic width and the level above sea;
- The interweaving of forest and agricultural land with urban areas;
- Changeable climatic circumstances in the micro relief;
- Little experience in the mechanization and technology of this procedure;
- Insufficient number of educated specialist staff for the preparation, setting and control of prescribed fire;
- “Let burn” – in terms of deliberate burning of certain areas to favour others – is not compliant with the constitution of the Republic of Croatia and the protection of man’s property.

The proportion fire outbreaks caused by natural phenomena in open space (lightning) is only 1% in all country, although there are some locations on the Adriatic where this occurs more frequently than elsewhere.

The proportion of fire outbreaks caused by human factor in the Republic of Croatia is convincingly the highest (>95%). It is the biggest problem in fire prevention, especially when comes to illegal burning of weeds and other agricultural residues on tilled land and the uncultivated (abandoned, neglected) areas that are undergoing succession to brushland and forests.

6. Sustainable land-use practices employed in the country to reduce wildfire hazards and wildfire risks

According to the Law on Agricultural Land, such areas must be maintained for production. This is supported by the enforcement of a number of measures for reducing the development of weeds / succession on abandoned lands. Unfortunately, this is where it comes to the first and major fire prevention issue – the unsettled proprietary relations in private forest and agricultural areas, especially along the coast. This issue includes the inhomogeneous character of such land in terms of property, so that private land is frequently interwoven with the state-owned areas, making difficult the establishment of particular technical or preventive cultivation measures. The areas that are sufficiently wide (plains) to prevent the spreading of fire along the coast – which the most threatened region – are in the hinterland in only a few locations. Even such areas (frequently burnt, too) are under forests or low vegetation, and also with the above-mentioned problems, so that they cannot be converted into fire-safe (low fire hazard) areas.

7. Public policies concerning fire

The government of the Republic of Croatia makes yearly announcements of a Programme of Activities for the enforcement of special fire prevention measures that are of national interest. The Programme is the basis for the preparation of preventive and operational activities aimed at the protection of both coastal and continental vegetation.

The Programme prescribes the tasks with the terms of their completion for all ministries and other governmental bodies and local authorities. These tasks refer to the preventive activities for reducing the possibility of occurrence and the spreading of fires. One part of the programme has operational character, prescribing the tasks for those that actively take part in fire suppression. The carrier of the activity in this part is the Ministry of Home Affairs and the Croatian Fire Association.

Another important fact is that, apart from the Programme of Activities, there is the Plan of Interventions in case of large fires in the open space. This Plan determines detailed strategies of employing the forces for a more complex event.

Forests are managed in accordance with the Law on Forests, which provides the basic technical and cultivation prevention measures for forest fire prevention. In addition, there are acts of law for forest management, with the stipulations on management methods, the maintenance of the “forest order”, and the calculation of the damage caused by fire or other causes.

Agricultural land is managed in concordance with the Law on Agricultural Land, which stipulates the manners of treating land for the purpose of protecting the production capability of agricultural land. This, without doubt, includes fire prevention.

Some areas are protected by the constitutional and special legal regulations, and are managed on the basis of the Law on Environmental Protection.

ANNEX
National Database on Fire Suppression Responsibilities and Resources

1. Name of Country

The Republic of Croatia

2. Agencies responsible for Wildland Fire Prevention

According to the Croatian National Fire Prevention Program, there are many subjects that are integrally, each for its own department, responsible for the enforcement of fire prevention measures. The supreme organization for fire prevention supervision of these subjects is

Ministry of Home Affairs
Department of Inspection and Administration
Home Affairs Inspectorate
Ilica 335
10000 Zagreb
Republic of Croatia

Tel: +385-1-2391-570
Fax: +385-1-2391-493
e-mail: ssegdin@mup.hr

3. Agencies responsible for Wildland Fire Control

3.1. Central / National

National Protection and Rescue Directorate
Fire Service
Nehajska 5
10000 Zagreb
Republic of Croatia
Tel: +385-1-2391-550
Fax: +385-1-2391-492
e-mail: mjurin@mup.hr

Emergency contact:
Ministry of Home Affairs
Operation Communication Center (round-the-clock duty)
Utica Grada Vukovara 33
10000 Zagreb
Republic of Croatia
Tel: +385-1-6122305
+385-1-6122226
Fax: +385-1-6122644

Emergency contact:
National Protection and Rescue Directorate
Fire Service
National Fire Operation Center (round-the-clock duty)
Tkalčićeva 67
10000 Zagreb
Republic of Croatia
Tel: +385-1-6122221
+385-1-6122975
Fax: +385-1-6122804
e-mail: mjurin@mup.hr

3.2. Provincial/State

The only *focal point* is at national level. Emergency calls are made to the fire department by dialling 93. Preparations are being made for the introduction of the European emergency number 112.

4. Agencies responsible for Disaster Management

4.1. Central / National

National Protection and Rescue Directorate
Civil Defence Section
Nehajska 5
10000 Zagreb
Republic of Croatia
Tel: +385-1-2391-530
Fax: +385-1-2391-491
e-mail: akoncar@mup.hr

Emergency contact:
Ministry of Home Affairs
Operation Communication Center (round-the-clock duty)
Ulica Grada Vukovara 33
10000 Zagreb
Republic of Croatia
Tel: +385-1-6122305
+385-1-6122226
Fax: +385-1-6122644

Emergency contact:
National Information Centre (round-the-clock duty)
Tel: +385-1-4818911
+385-1-3784820
Fax: +385-1-4551511
+385-1-3784840

5. Focal point for Natural and technological Disasters to the United Nations

5.1 Central/National

National Protection and Rescue Directorate
Civil Protection Service
Nehajska 5
10000 Zagreb
Republic of Croatia
Tel. +385-1-2391-530
+385-1-2391-491
e-mail: akoncar@mup.hr

Emergency contact:
Ministry of Home Affairs
Operation Communication Center (round-the clock duty)
Ulica Grada Vukovara 33
10000 Zagreb
Republic of Croatia
Tel: +385-1-6122305
+385-1-6122226
Fax: +385-1-6122644

Emergency contact:

National Information Center (round-the-clock duty)
Tel: +385-1-4818911
+385-1-3784820
Fax: +385-1-4551511
+385-1-3784840

6. Bilateral and multilateral emergency assistance agreements

Agreements on multilateral assistance have been signed with the following countries:

- Republic of Slovenia
- Republic of Hungary
- Bosnia & Herzegovina
- Republic of Slovakia

Agreements ready for signing:

- Republic of Poland
- Republic of Austria

Agreement in negotiation stage:

- Russian Federation
- Ukraine
- Republic of Italy
- Republic of France

6. National Fire Information System

a. *Provider of real-time or near-real time fire situation reports*

The monitoring-information service, which is obligatory for legal bodies as given under item 7.b., submits fire situation reports to the competent Fire Unit.

b. *Fire detection/reconnaissance system*

The Statute on Fire Prevention stipulates that the following bodies must establish a fire detection/ reconnaissance service: legal bodies, that according to special regulations manage forests and forestlands; authorized persons of other real rights to forests and forest lands; counties, cities and municipalities with forests and forest lands owned by physical bodies. Based on the order of the authorized inspection bodies of the Ministry of Home Affairs, the fire detection service includes the legal bodies responsible for managing and maintenance of public roads, railway, and power-supply, and the legal bodies responsible for providing postal and telecommunication services. This service is established during summer fire season between 1 June and 15 September. At times of high and very high fire hazards classified as degree I, this service works round-the-clock. In cases of a very high fire danger index, the Ministry issues instructions on air investigation of the specially endangered parts of the Adriatic.

c. *Fire weather or fire-danger forecasts*

Together with the analysis of the forest fire prevention season, the National Hydrometeorological Institute prepares prediction maps of monthly and seasonal fire severity rating for the months of May, June, July, August, September (MSR and SSR), and cumulatively for the period June-September. These are supplied with daily graphs of the ISI index (Initial Spread Index) and the FWI (Fire Weather Index). Due to the long dry period in 2003, the analysis was exceptionally prolonged to May.

The National Hydro Meteorological Institute daily calculates the fire danger index in the open space, based on three meteorological stations.

The real prognostic index of the following day is calculated once a day – after 14 hours, for 19 locations on the Adriatic Sea and the coastland.

Weekly and semi-weekly weather forecasts for the Adriatic region and coastland are made twice a week (Mondays and Thursdays). Weekly forecasts are made separately for north Adriatic and Dalmatia, while the semi-weekly forecasts for north, central and south Adriatic are made with special comments on thunder possibilities.

d. *Decision-support system*

During large wildfire situations, upon request, the National Hydro Meteorological Institute gives special support to the Fire Operations Center of the Ministry of Home Affairs. This support includes

- Local weather forecasts for the burnt areas;
- Immediate communication of the forecaster on duty with the firemen on site;
- Provision of weather situation analyses for the Adriatic region and the medium-term weather forecast estimates.

e. *Relevant environmental and socio-economic conditions*

The applied FWI method accepts the meteorological circumstances and the moisture state of the dead forest inflammable material (dead fuel moisture).

In according to the Statute on Forest Fire Prevention, the legal bodies cited under item (b) are obliged to prepare a list of forests classified by fire danger degree, in concordance with the Standards for Forest Fire Estimates.

8. Wildland Fire Management Infrastructures and Equipment

Section 4 of the country report describes fire-fighting bases with equipment.

Since the integration into the European Union is of national interest to Croatia, the acceptance of the European norms in the field of fire fighting and prevention is in progress. This particularly applies to the fire-fighting mechanization (vehicles, extinguishers) and other devices and equipment (protection outfits, hoses and tools, etc.) The system of radio-communication in fire fighting works on two-meter frequency range (simplex and r-channels). The radio-communication system is under the authority of the Ministry of Marine Traffic and Communications. On more complex occasions, the radio-communication support is provided by the specialist services of the Ministry of Home Affairs.

7. Human Resources (for national use)

In the Republic of Croatia there are currently 1,908 active fire brigades with 65,217 active members. The major proportion of these consists of voluntary fire brigades (1,790). There are 55 professional fire brigades, mainly in cities and bigger municipalities, with 2,157 firemen.

In the industrial sector (enterprises, companies) there are 45 professional fire brigades with about 1000 professional firemen.

An important fact is that the firemen working in professional fire brigades and the members of the voluntary fire brigades respond to all kinds of fire and all kinds of technical interventions (forest fires, fires on buildings, accidents with hazardous materials). There are no fire brigades that would respond only to forest fires.

List of fire fighting personnel by counties

County	Number of professional firemen	Number of voluntary firemen
Zagreb	111	10.300
Krapina-Zagorje	37	5,600
Sisak-Moslavina	102	3,600
Karlovac	75	3,700
Varaždin	48	3,700
Koprivnica-Križevci	90	4,312
Bjelovar-Bilogora	70	6,400
Littoral-Goranian	233	4,312
Lika-Senj	32	260
Virovitica-Podravina	51	1,100
Požega-Slavonia	7	2,032
Slavonski Brod-Posavina	54	3,600
Zadar	164	400
Osijek-Baranja	123	4,100
Šibenik-Knin	78	390
Vukovar-Srijem	90	1,200
Split-Dalmatia	120	1,837
Istria	231	520
Dubrovnik-Neretva	92	675
Međimurje	48	6,541
City of Zagreb	311	1,593
Total	**2,157**	**63,060**

8. Equipment available for International Emergency Assistance

According to the Law on Fire-Fighting, intervention fire brigades have been formed, and are also supposed to help other countries, as defined by international agreements (see section “Intervention fire brigades” in the main report).

The intervention fire brigades also include fire air forces (see section “Aerial Fire-Fighting Forces” in the main report).

The forces can respond within eight hours from receiving the call for help. As a rule, help is offered to the countries that have signed the Agreement (see section 6) with the Republic of Croatia.

Sections 4 and 5 contain telephone numbers and contact addresses. An important point is that the aid requirement should go through the Croatian Ministry of Foreign Affairs, i.e. via Croatian embassies in the countries in question, unless the international agreement stipulates another manner of mutual communication.

Contact:

Ministry of Foreign Affairs
Trg Nikole Šubića Zrinskog 7.8
10000 Zagreb
Republic of Croatia
Tel: +385-1-4569964
Fax: +385-1-4920149
e-mail: mvp@mvp.hr
Internet address: www.mvp.hr

9. Human Resources (for international use)

According to the Law on Fire-Fighting, intervention fire brigades have been formed, and are also supposed to help other countries, as contained by the international agreement (see section “Intervention fire brigades” in the main report). Fifty firemen have been foreseen for the purpose of giving help to other countries. The intervention fire brigades also include aerial fire fighting forces (see section “Aerial Fire-Fighting Forces” in the main report).

12. Wildland Fire Management Training Facilities

In the School for Fire Fighting and Civil Defence there are programs of education, training and advanced training for firemen and other protection/rescue forces. The school holds examinations and issues certifications for fire engines and other mechanization and equipment.

National programs

- Qualification programs for firemen and fire technicians;
- Programs for training and advanced training of regular soldiers, non-commissioned and commissioned officers in the Croatian Army;
- Programs for training the members of the intervention civil defence fire brigades with the Ministry of Home Affairs.

National and international programs

- Programs for training the members of the intervention fire brigades.

13. Wildland Fire Research Institutions

Extensive research on the Mediterranean forest fires has been carried out for ten years at the Faculty of Forestry in Zagreb. A large number of collected data have been described and partly published. The data are currently being supplied with additional information and are being statistically processed.

Date of the report: March 2005

IFFN Contribution by

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Forest Fire Management in Cyprus

Introduction

Cyprus is the third largest island in Mediterranean with an area of 9251 km^2 (925,148 ha) and is situated at the northeastern end of the Mediterranean Basin. It is mostly a mountainous country with a typical intense Mediterranean climate that is characterized by hot, dry summers that last from May until October.

Most of the Cyprus forests are natural although some of the burned areas and bare lands were artificially reforested. Natural vegetation covers the 41.67% of the total area of Cyprus of which, 18.55% is high forest mainly composed of coniferous species, 13.63% is maquis vegetation (shrubs) and 9.49% is *garrigue* vegetation.

Fire Hazard

Fire in Cyprus, as in all Mediterranean countries, is by far the most destructive single agent threatening our forests. The fire hazard in our island is pretty high, especially during the summer period. This is because of the nature of the forests, the prevailing climatic conditions and the topographic conditions. Normally the fire season starts in May and ends in October, but occasionally it starts in April and is extended up to November.

The Nature of our Forests

The natural forests of Cyprus, as well as the newly established plantations, consist of thousands of hectares of resinous pine trees like the Calabrian pine *(Pinus brutia),* the Black pine *(Pinus nigra),* the Cedar *(Cedrus brevifolia*) and the Cypress *(Cupressus sempervirens).* The forests of Cyprus are characterised by open stands that enhances the formation of rich understory with shrubs and grasses, which during summer period dry quickly. The volume of the fuel is further increased by the accumulation of pine needles, deadwood etc. The quantity and continuity of the forest fuels enhances the rapid spreading of fires.

Even though extractives like gums, waxes, oils, and alcohol constitute a small fraction of the tree weight, they have special properties. Their high heat of combustion and volatility influence the way that the fuel burns. The pine over-story is always associated with under-story vegetation of bush species and other herbaceous plants, which dry out during the summer period.

Climatic Conditions

Various climatic agents like temperature, relative humidity, and precipitation affect fuel moisture. The long, hot and dry summers that last from May until October convert the pine under-story into a continuous sheet of dry and highly inflammable fuel mass. During the fire season the temperature fluctuates from 30° to 44°C increasing the risk of ignition to very high levels. The relative humidity, which affects considerably the fire environment, ranges between 30-65%. Rainfall during the fire season is very low and ranges between 0-50mm. Wind is a dominant factor of fire behaviour. It is one of the hardest elements to predict due to variability of wind speed and direction and the influences of topography, vegetation, and local conditions. Winds during the fire season are mostly northwesterly or northerly.

Topography

The principle geomorphologic features of Cyprus are the two main mountain ranges of Troodos and Pentadaktylos separated by a broad sedimentary plain of fertile agricultural land, the Mesaoria. The highest peak of the Troodos mountain range is 1952 meters a.s.l., whilst the Pentadaktylos mountain range highest peak is 1024 meters a.s.l.

Very steep slopes, vertical cliffs, deep gorges, narrow streams and long mountain ridges characterize the central core. The foothills are characterized by rounded or conical hills, usually with steep lateral slopes. These geomorphologic features contribute to rapid fire spread and to difficulties during fire suppression efforts. The steep slopes have a direct effect on flame length and rate of spread of a surface fire. When a fire burns up a steep slope it moves faster having higher scorch than when it burns at a level site. Also a steep gully gives a chimney effect to a fire. Moreover, the steep terrain reduces the effectiveness of forest roads and fire traces to stop fires.

Legal Responsibility

The Forestry Department is the agency responsible for the prevention and control of fires in the state forests or within a radius of 1km from the boundaries of the state forests. The Forestry Department is responsible for the following measures:

- fire prevention
- rapid fire detection, and
- the rapid intervention and effective control of forest fires.

Causes of Forest Fires

Most of the forest fires in Cyprus start outside the forests or near their boundaries and less frequently within the forests. Analysing the fire incidents for the period 2000 – 2003 indicates that the biggest percentage of forest fires in Cyprus and especially the most destructive ones are of human origin, attributed to:

1. Agricultural activities: Fires set by villagers in their own lands to burn grass, gorse or stubble without taking the necessary precautionary measures
2. Recreation: Fires caused by visitors, campers and picnickers who are careless with cooking and grilling fires, burning cigarette butts and matches, etc.
3. Military activities: Troops exercising with ammunition or explosives of any kind
4. Burning of rubbish: Fires escaping from non-organised rubbish dumps
5. Forestry operations: Fires caused by people or machines engaged in any activity associated with forest engineering and forest production,
6. Residence: The rise of the number of the country residences, compose a new cause of forest fires.
7. Arson
8. Other causes: These include e.g. hunting during the summer period, use of different tools and machinery, etc.

The percentage of causes of forest fires is provided in Figure 1.

Impacts of Forest Fires

Fire is by far the most destructive single agent, threatening the forests of Cyprus. Fires have many negative consequences the most important of which are:

- Endangering the safety of people and property
- Excessive soil erosion and – in some cases – subsequent flooding
- Serious economic losses, especially to the farmers
- Ecosystem degradation and loss of biodiversity
- Impairment of the aesthetic value of forests
- Damage of historical and cultural values

Forest Fire Management

The policy of the Forestry Department is to realize adequate protection of forests against fires and minimize the area burnt in case of a fire incident. For the reduction of the fire risk and the prevention of a fire outbreak, a series of separated but integrated programs are undertaken. These are:

A. Fire prevention and preparedness programme
B. Fuel management programme
C. Pre-suppression and suppression

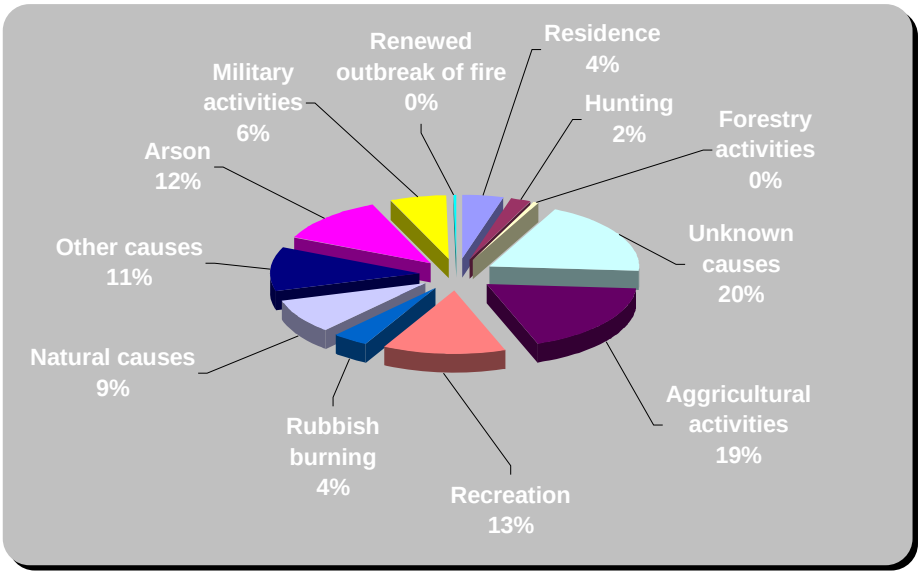

Figure 1. Causes of forest fires in Cyprus (2000-2003)

A. Fire prevention and preparedness programme

The prevention of forest fires is always preferable to the control. In order to reduce the risk of fire outbreaks a number of preventing measures are taken though:

1. Law enforcement
2. Education and public awareness
3. Provision of picnic and camping sites
4. Fire protection plans
5. Fire detection

Law Enforcement

The Cyprus forest Law prohibits the lighting of any fire in the forest or within a distance of 1km from the boundaries of the state forests. Any person who causes a forest fire shall be liable, in case of conviction, to imprisonment for a term not exceeding five years or to a fine not exceeding five thousand pounds (8500 euro), or to both such sentences.

Education and public awareness

Since the majority of forest fires in Cyprus are of human origin, the Forestry Department makes every effort to gain the support and co-operation of the general public through a well planned and directed publicity and educational programme, including:

- Talks and interviews of forest officials through the mass media
- Special programmes through the radio and TV services
- Publication of texts and articles in the press and magazines

- Lectures and film projection at schools, the police, army, clubs and other organised groups
- Visits and education of the farmers owing land at the delimitation line of the forest
- Production and distribution to the public of relative leaflets and stickers
- The degree of fire hazard is broadcasted through the radio and the TV several times a day and preferably immediately after the news and the weather broadcast. It is also indicated in special sign posts located at the main forest stations and warn the visitors of the forests
- Posters and signposts, which warn the public about the danger of forest fires, are placed at conspicuous places of roads, picnic and camping sites and villages
- Production and distribution to elementary and secondary schools of special leaflets and
- The "Save our Forest Week" is celebrated every year. A "Save the Forest Day" is also celebrated in all schools in co-operation with Ministry of Education.

Provision of picnic places

To reduce the danger and incidents of forest fires coming from picnickers and forest visitors, picnic places in the forest have been established, where picnickers are concentrated instead of being scattered out without any supervision. These sites attract people by providing them a number of facilities such as fire places (where they can safely build a fire for cooking purposes), benches and tables, potable water, playgrounds etc.

Fire protection plans
For more effective fire management in the countryside, a National Fire Protection Plan was prepared by the Forestry Department in co-operation with the Police Fire Service. The existing fire prevention measures and proposals for construction of new, supplementary infrastructure are the main elements of this Plan. The project started in 2001 and is expected to be completed in 2006. In addition, the implementation of the Rural Development Program 2004-2006 will improve considerably the protection measures taken in the countryside.

Fire Detection

- <u>Fire lookout stations</u>

Today, 13 lookout stations are found in panoramic places at peaks of mountains ensuring maximum coverage of the forest. All lookout stations are linked to the existing telephone and radiotelephone network of the Forestry Department. During the fire season, these are manned on a 24-hour basis. The watchers come from various forest villages and they are familiar with the forest. Thus, in case of a fire, they can locate it accurately and guide the firemen to get to the fire as rapid as possible. Furthermore, 16 temporary lookout stations (fire engines) are stationed at various areas of high danger that are hidden and cannot be viewed from the permanent lookout stations.

Apart from the look out stations, arrangements are made for reporting of forest fires by the civil aviation, Army Air Force and other services. Reporting of fires is also done by the public using the number 1407. All calls made by the public for this purpose are free of charge.

- <u>Ground Patrols</u>

Ground patrol is an old but effective form of detection and intervention relying on systematic patrol. During the fire season regular patrolling is done especially along the delimitation line where most of the forest fires starts. All patrols have threefold missions these being policing and public information, detection of forest fires and fire suppression. Most of these patrols are using light brigades and in case of a fire they intervene rapidly. Each patrol has its own sector and route, which is planned in advance. The patrols are constantly in touch with the look out stations and other patrolling units and with the headquarters of the Division.

- <u>Telecommunication System</u>

For communication purposes the Forest Department maintains its own telephone and radiotelephone system. All forest stations and lookout stations are linked to it. All vehicles are equipped with mobile radiotelephones and each forester has his own portable radiotelephone. Within the forest, at strategic

points, there are emergency telephones, which are also linked to this system. This system plays an important role in the coordination of activities regarding forest fire protection.

Today, Cyprus is introducing the state of the art technology of the Automatic Fire Detection Systems. In 2004, one such a system was installed at the Akamas forest – a high valued forest area to be declared as National Forest Park. With the assistance of this system it will be feasible to further minimize the time from the outbreak of a fire to its detection and the first alert, which is critical for the management of the suppression process.

The project was supported by FAO technical assistance and is co-financed by European Union through pre-accession aid.

B. Fuel management programme

The Forestry Department proceeds on a regular basis on various vegetation treatments with the aim to reduce the risk of ignition and the spreading rate of forest fires. Some of these treatments include pruning, cleanings, removal of both herbaceous and woody vegetation along roads, planting fire resistant species, prescribed burnings, controlled grazing, mixing of conifers and broadleaves and seeding of species with low biomass.

C. Pre-suppression and suppression

The main measures in pre- suppression and suppression used in Cyprus are the following:

Construction of roads

For efficient forest management in general and especially for fire protection the Forestry Department maintains a good road network.
Forest areas that were inaccessible in the past are now accessible by the construction of new roads. These roads are planned in such a way to give quick access to all parts of the forest especially during a fire incident.

Construction of firebreaks

Firebreaks are usually constructed on ridges and other natural features. Their width ranges from 6 to 30 meters depending on the nature of vegetation and adjacent crown of standing trees. Priority is given to the construction of firebreaks on gentle ridges along which vehicles and fire brigades can travel in the event of a fire.

Fire fighting task force

During the fire season, 180 persons (labourers) are recruited and form the fire fighting body. This body is split into groups of 10 to 15 men and are distributed in various strategic points in the forest. Each group is provided with off-road vehicles and at least with one fire brigade and other necessary equipment for fire fighting. These crews carry out various forestry operations near roads and points where communication is possible at any time. When a fire breaks out, they are the first to go.
Forestry Staff
Apart from the fire fighting squads, an adequate number of foresters remains stand-by on a 24 hours basis at all forest stations during the fire season. In case of a fire, these forest officials along with the local fire fighters are the first to reach the fire, until new forces arrive.
During the summer, forestry works are organized in such a way so that the officers and labourers are found at various strategic points in the forest. The foresters in charge of these operations are continuously in contact with the divisional headquarters and since they are equipped with the necessary tools, they can move to the fire without delay. In this way, the time of intervention and the area burnt is significantly reduced.

Training

Fighting of forest fires is a joint task for forest officials and fire fighters. Local training is organised at the Cyprus Forestry College through lectures, demonstrations and film projections, and includes:

- Judging of fire situations and deciding where to attack the fire
- Fire suppression in groups
- Training on modern fire engines
- Construction of firebreaks, etc.

Training abroad is organised through fellowships and study tours for training on new fire fighting equipment and techniques.

Fire fighting equipment

Fire fighting is a difficult and complicated job and requires the combination of both manual and mechanical means. Some years ago, fire fighting in Cyprus was done mainly using manual means and methods. Most fire fighting today in Cyprus is done with the use of water. A good number of fire engines with a capacity ranging between 1000 and 12,000 litres of water are maintained. Most of these brigades are equipped with low and high-pressure pumps. Using high pressure the amount of water needed to extinguish a fire is significantly reduced.

Apart from fire brigades, a number of crawler tractors are also maintained. These tractors, during the fire season, are removed from other works and are used for construction of roads and fire breaks. During weekends, these bulldozers are moved to loading points, so that in case of a fire can be loaded and transported to the fire immediately.

Availability of water for fire fighting is achieved through the construction of concrete water tanks at strategic points along forest roads where springs are found. Each tank has a capacity of 90 m^3 water for fire fighting can also be supplied through hydrants, which are fixed on pipelines carrying water from the forest to the villages. Water can also be taken from the existing dams found within or near the forest and from small pools, which are created along perennial streams by constructing access roots.

Fire fighting from the air has been practiced in the recent years in Cyprus with excellent results. Helicopters are the most suitable means of transport for rapidly overcoming altitudes and distances. For this purpose, two medium-size helicopters of a payload of 5 tons each are hired every summer.Army and police helicopters are also used when needed for transportation of men and equipment and for co-ordinating fire fighting from the air.

Conclusions

As a result of the measures mentioned above we managed to reduce both the time of intervention and the area burnt each year. The average time of response during fire incidents for the period 2000 - 2003 was only 12.5 minutes.
Despite the great efforts and the good results of recent years, the problem of fires still exists and will always constitute a permanent threat for the forests of Cyprus. For this reason and in order to reduce the fire danger to the minimum possible, the continues vigilance as well as the persistent upgrading both of infrastructure and personnel training, following the evolution of the technology and its capabilities, are a top priority matter of the Department of Forests.

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Fire Situation in Hungary

Forest Area and Ownership in Hungary

The total forest area in Hungary is 2 million hectares (ha), the forest cover index is 20.5 % of the total country area. The highest forest density is found in low mountain ranges, whereas in the lowlands it is typical to find mosaic land use structure (Figure 1). Approximately 600.000 ha of the Hungarian forests were planted between 1950 and 1980. Before the recent political changes 99% of the forests were in state ownership.

During the complicated process of change in the political system, a basic change in forest ownership relations took place, and as a result of this change approx. 730,000 ha of forests became privately owned. The state owned forestry had to adapt to the new economic situation. The new ownership structure henceforward has an important role in forestry and in wildfire management, too. In the new owner structure the communal-forests are nearly missing, and the ratio of small private forest-ownerships is very high. More than 1/3 of the forest estate are smaller than 1 ha, and ¾ are smaller than 5 ha. 40 percent of the private forest owners live in town, and have just indirect contact with their forests. Two percent do not know the size of their forests! More than 14 percent of the Hungarian forests are of inordinate ownership, meaning that these areas have owners but the owners do not report themselves at the forest-office.

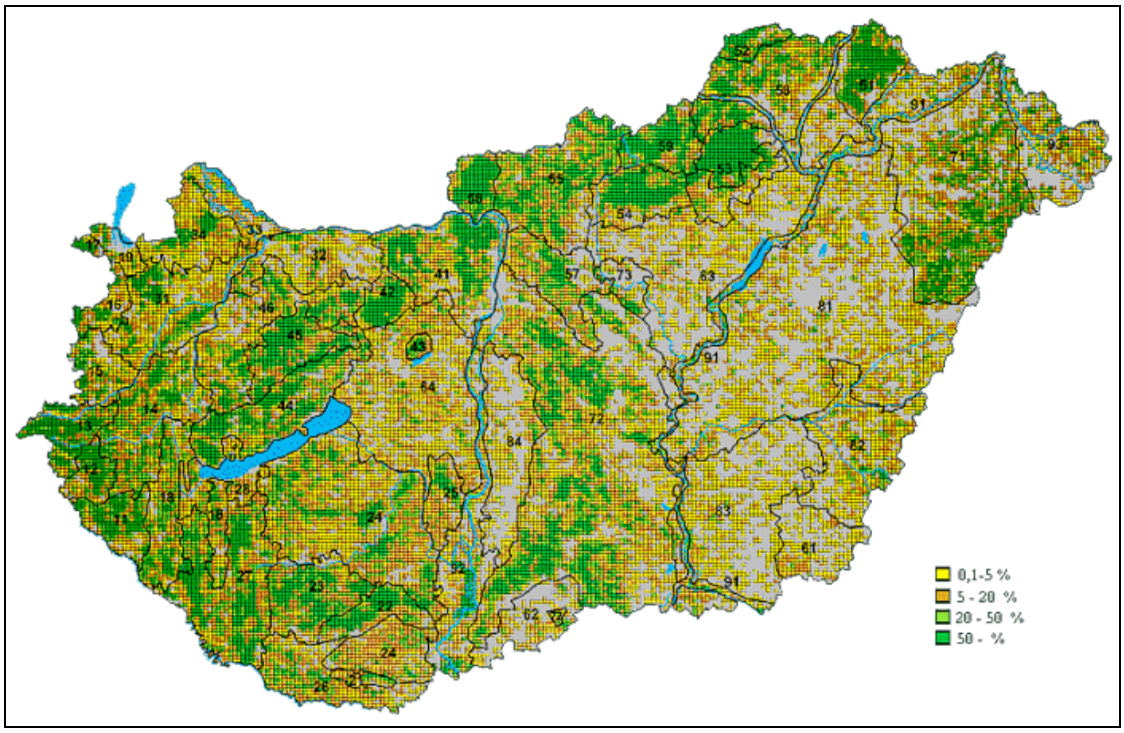

Figure 1. Forest cover index of Hungary. Source: National Forest Service of Hungary

One of the characteristic features of Hungarian forest stand composition is the absolute dominance of broadleaved forests. They make up a total of 85% of the total forest area; coniferous forests contribute to 15%. Significant broadleaf species are oak (*Quercus petrea, Q. robur*) and Turkey oak (*Quercus cerris*), black locust (*Robinia pseudoacacia*) and poplar species (*Populus* sp.). The most important conifer species are Scots pine (*Pinus sylvestris*) and Austrian pine (*Pinus nigra*) (Figure 2). The pine stands are occupying the area of the poorest sand-soils in the Hungarian lowlands and the dolomitic bleaks in the Hungarian lower mountain ranges. Nearly 65% of all fires are started in broadleaved stands. 50% of all fires in broadleaved stands are in oak and Turkey oak forests.

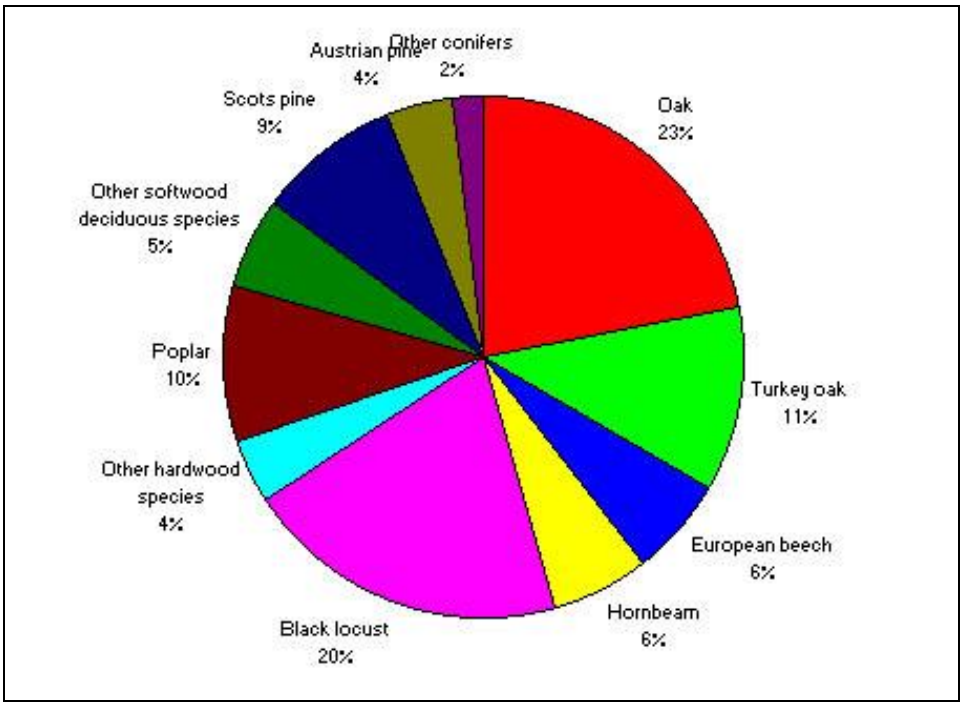

Figure 2. Distribution of forest area in Hungary by species group

More than 59 % of the Hungarian forests are younger than 40 years. This is mainly due to the forest plantation programme of the last 40 years, as well as due to the fast-growing tree species like black locust, willow and poplar, which account for a high proportion of this age group. Forest stands between 40-60 years make up 16.6%, 60-80 years 10.9 %, and stands older than 80 years 10.9% of the total forest area. Approximately 60% of all forest fires are observed in stands not older than 20 years, and 90% in stand not older than 60 years.

Fire Statistics

Fire data gathering has been imprecise in Hungary. The causes were the many institutional alterations, and the rapid change in forest ownership structure. For the period 1990-2001 statistical fire data include only the number of forest fires as well as some data on area burned in state-owned forests (Table 1). Data on fires occurring outside of forests were not gathered.

In 2005 the concept for a new data gathering system was agreed by the Hungarian Forest Service (HFS) and the Hungarian Disaster Recovery Service (HDRS). However, the implementation of the new system needs a common information platform and appropriate legal changes (Figure 3).

In the new system the HDRS delivers the location of fires to the HFS, who completes the data with burned area and forest stand information. In the future it must become an integrated fire data gathering system, in which the different agencies can add diverse data segments on forest fires. Despite this new system, information on the burned area outside of forests (such as grass and bush land, mainly in private ownership) is not gathered. Just the number of non-forest fires is available.

Fire causes

In Hungary 99% of the wildfires are caused by humans. Most fires are started by negligence. Only a small part of fires are caused by arson. Typical forest fire causes are the incompletely extinguished fires of hikers, and the illicit agricultural fires.

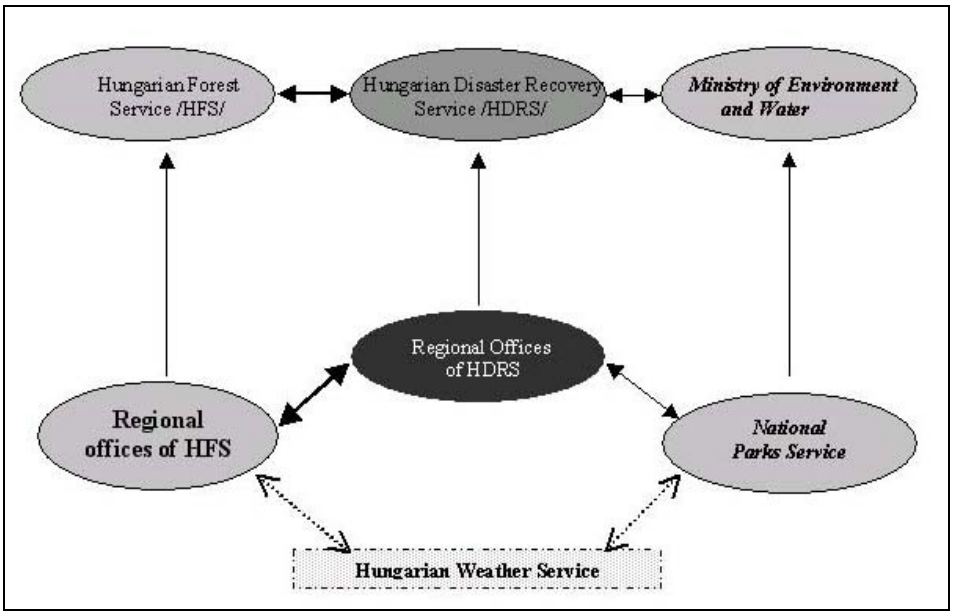

Figure 3. Conception of the new wildland fire data gathering system for Hungary

Table 1. Wildland fire statistical data for Hungary 1991-2002

Year	Number of Forest Fires	Number fires on other lands	Total burned forest area (ha)	Burned area in state-owned forests (ha)
1991	646			
1992	2452	3264		1480
1993	1188	4818		947
1994	555			592
1995	542			399
1996	514			407
1997	770			403
1998	854	3750		726
1999	229	1021	1309	289
2000	811		2599	799
2001	419			419
2002	382		1226	

Fire characteristics

In Hungary wildland fires can be classified in five representative groups of characteristic fire regimes. Each group has distinct fuel types, fire size and fire characteristics:

Spring fires in broadleaved stands (oak, turkey oak, black locust and poplar regeneration and plantations). The fires are not region specific, but depend on the fuel type. The fire size is seldom larger than 5 ha, but usually destroys the young stands. The cause of the relatively small average burned area is partly the Hungarian Forestry Act, which defines 5 ha as the maximal size of clear-cutting area. The resulting mosaic age structure is advantageous: Once the fire reaches the older stands in the neighbourhood, the prevailing fuel type with higher fuel moisture will decrease the fire spread and intensity. Thus fire suppression will be easier. However, in several territories where the size of coherent young stand areas comes up to 100 ha, fires cause more control problems.

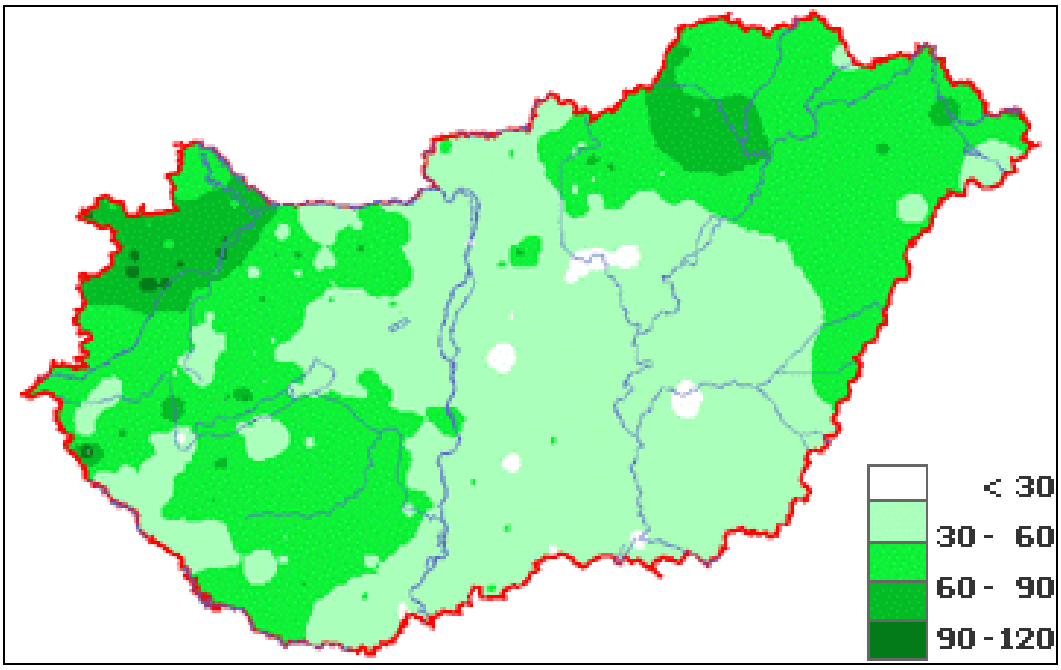

Figure 4. Average precipitation (mm) in the first 3 months of the year in Hungary. The distribution pattern of rainfall below 60 mm reveals the risk of early spring fires. Source: Hungarian Weather Service.

Summer fires in broadleaved stands occur during the hot and dry continental summer in broadleaved and coniferous stands. The fires in the broadleaved stands (mostly oak stands) are surface fires with low intensity but with high fire spread. The broadleaved stands are characterized by a thin duff and timber litter layer with a low total surface fuel load. Due to this characteristic the fires do not develop into crown fires in these stands.

There are more problems with the coniferous stands (Scots and Austrian pines) in the Hungarian lowlands. Surface fires in those stands mostly develop into crown fires, a phenomenon attributed to:

- Needles of the pines decompose very slowly
- High fuel loads
- Fuels dry very fast due to the specific site conditions
- Duff layers, often reaching a depth of 50 cm, burn with high intensity and result in crown fires
- The average lower crown height in stands on sandy and dolomitic-bleak dominated sites are 10-15m

These crown fires can only stop outside of pine stands, with the help of natural barriers or broadleaf stands. Fires in these stands not only cause high economic damages, e.g. reforestation costs. On these extremely poor forest sites stand-replacement fires contribute significantly to site degradation because only after 1 to 2 generations of undisturbed pine stands a reforestation with other species is possible.

Summer fires in juniper-poplar stands. These associations are under natural protection, and are not managed. In these stands the dominant fuel is juniper (*Juniperus communis*). Wildfires in junipers can be characterized as bush fires with medium intensity and high fire spread. After the fire the species ratio in the area changes due to fire intolerance of junipers.

Grassland fires in summer and autumn. The occurrence of these fires is high and mainly in the lowland plains, but unfortunately the state statistics do not provide statistical information. The average fire size is 20-50 ha, with a trend of increased over the last decade. Some large fires between 1500-8000 ha occurred. These fires have high spread rate with a wide fire front and low intensity. In the mosaic landscape of the lowland plains the grass fires ignite small bush, reed and forest areas and cause high spot fire potential. Large grassland fires generate smoke pollution problems at the rural-urban interface.

Peatland fires in very dry summers. Fires burning in desiccated organic terrain usually start as surface fires, e.g. grass fires that are penetrating into the dry organic layers. As in other parts pf the world, these fires difficult to control. Effective suppression tactics include trench construction and flooding of the area.

Responsibilities Around Wildland Fire

The Hungarian forest-act classifies the stands in three categories. The first category (high danger) comprises

- Dry oak stands (*Orno Querco pubescenti cerris*) in the mountains
- Young and middle age conifer stands in the lowlands
- Park forests in the lowlands
- Broadleaf regeneration and plantation stands in the lowlands
- Stands with recreational-oriented use in the lowlands
- Stands in neighbourhood of railways and main roads in the lowlands

In the second category (medium danger) are

- Conifer stands
- Other park forests
- Regeneration and plantation stands
- Stands in neighbourhood of railways and main roads

The third category (low danger) refers to all other stands.

Fire prevention in Hungary is the duty of the forest owners. According to the Forest Act „the forest owner must provide for conditions of wildland fire prevention". According to the Decree of the Ministry of Interior on Fire Protection „the forest owners must organize early warning systems and initial attack crews in the high fire risk periods." This law environment was sufficient when the state forest ownership was close to 99 %. Under the actual ownership structure, however, it is not adequate anymore.

Fire fighting in practice is the responsibility of the professional and volunteer fire-fighter brigades. Together with the Civil Protection Service they are integrated under the Disaster Recovery Service. In the country there are 110 professional and app. 40 volunteer structural firehouses. This firehouse-density and the fire fighting resources is enough to fight structural fires, but if more small wildfires burn in the operation area of a firehouse the resources become limited and the response times will be longer.

Early warning and observation

Formerly in Hungary no special fire weather index and fire weather forecast was in operational use. This was a disadvantage both for the fire professionals and for the PR activities. With the help of fire weather forecasts the personnel of the fire and forest service would be in the position to be prepared and to allocate resources for fire suppression. Without a fire weather index it is difficult to communicate the fire risk period to the general public. Furthermore the current legal regulations can impose only general fire bans, which do not consider the variability of fire weather.

Currently the weather panel of the Canadian spatial fire management system is tested under Hungarian conditions. With additional innovations the fire weather raster maps will be used together with fuel and fire behaviour models and the digital forest GIS database of the Forest Service for modelling large fire incidents (Figure 5).

The system of forest area observation is aimed at possibly early detection of fires:

- The main observation method is the lookout patrol (ground fire detection). After the forestry act the forest owners must organize the patrolling. This works well in state forest areas. However, the small private owners do not have time or money to organize the patrolling. Fortunately most high-risk stands remain in state ownership, which are not localized separately but are intermixed with private forest lands. Thus, patrols by the state authorities are also observing the fires in private areas.

- Aerial patrol (aerial fire detection) is used only in high-risk periods in the lowlands, to control the nature conservation areas.
- Tower-based observation will be expanded in the near future. Instead of building new lookout towers, the available towers of the mobile phone communication system will be used. This will also ensure an easy data transfer.

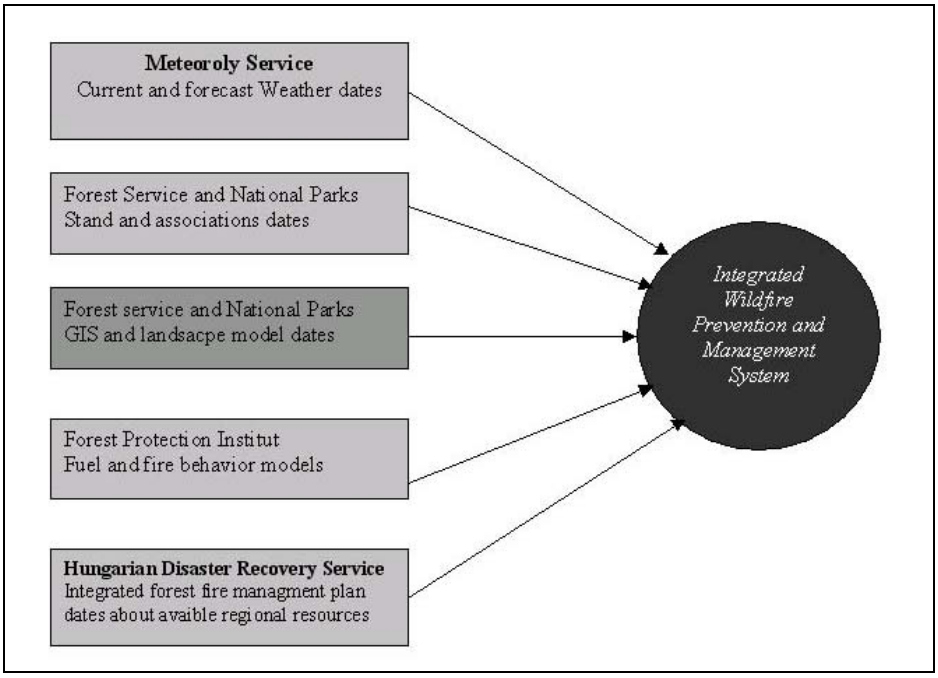

Figure 5. Concept of the Integrated Wildfire Information and Decision Support System

Equipment

Fire fighting is mainly the responsibility of the Fire Service. Fire Service staff is well trained and equipped for fighting structural fires and other disaster situations, including fires in hazardous materials. They are however not adequately trained and equipped for wildland fire suppression. This is not a question of will but of costs. The engines are for structural use and are difficult to operate in the field. They are not equipped for wildland fire operations. Even though the forest offices and the national park services have light vehicles (which could better be used in off-road conditions), they have no fire fighting equipment, and the staff is not trained. Furthermore light personal protection equipment for wildland fire fighting is missing. Heavy equipment such as tractors, dozers and ploughs usually belong to the Forest Service and to its contractors.

As mentioned before, the heavy fire engines are not able to approach the fires on difficult terrain or access routes of lower quality and size, and they are not equipped to build a longer mobile waterline in the field. Because of missing training and special firing equipment, burnout and backfire techniques are not used in fire suppression.

The cheapest solution to upgrade wildland fire equipment would be to supply the 4WD vehicles of forest offices and national parks with slip-on units and other special light equipment. In addition a new training standard should be developed, which would make the work between the different agencies more efficient.

Aerial fire fighting capacity is available in a limited way. Some contractors have small agriculture airplanes. However, they are used only for larger fires and not for initial attack. Besides those airplanes helicopters of the army with *Bambi* buckets are used to fight bigger fires. Small airplanes and helicopters are used in some cases. Since they do not belong to the Forest Service or to the Fire Service hence the requisition needs a longer time. However in my esteem it is unlikely that Hungary should large water bombers, therefore cooperation with neighbouring countries would play an important role in case of extreme fire situations.

Prescribed burning

At the moment prescribed burning is not practiced in Hungary. The Nature Protection act does not permit the use of fire. However starting next year the first experiments to test the effects of prescribed fires in Hungarian vegetation types will be carried out. The prescribed fires will be used in partly managed non-forested areas, such as grass and bush lands, where other management methods were abandoned due to high costs. In these areas that are often under the rules of nature conservation the fuel loads have increased continuously in the last decades. Well-planned and performed prescribed burning operations could be an adequate and cost-effective management method for these areas. Requirements are that the regional land and forest management offices are well equipped for fire fighting and prescribed burning activities. The biggest difficulty will be to manage the prescribed burning together with fire prevention public relation programs. A close cooperation with the European Fire in Nature Conservation Network (EFNCN) is envisaged.

Conclusions

The major, most difficult task in connection with wildland fires probably is not the fire suppression and the fire fighting in the field, but creating cooperation between all agencies and landowners concerned with wildland fire. It is not sufficient to set up this cooperation at the administrative level only, but it must be effective on the operational level, too. The new fire data-gathering directive of the European Union, and the progressive approach of the new forest fire protection decree was a good indicator for starting this cooperation in Hungary.

With complementary help of the European Union structural financial support hopefully projects can be started in the next years addressing the following subjects:

- Improvement of fire fighting equipment
- Modernization of forest roads and water supply systems
- Subsidies for forest management in stands of low economic value
- Integration of the private forest owners in wildfire prevention
- Research in fire management

Besides the projects on the national level collaboration in research and in operation on regional and international level would be very important. With help of the UNISDR Regional Southeast Europe Wildland Fire Network not only a fast information exchange can be ensured, but financial support can be saved, too.

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Country Report Turkey
Global Wildland Fire Assessment 2004

1. Description of the fire environment, fire regimes, ecological role of fire

Turkey is a country with a land mass of 77.079 million hectares, of which 20.749 million hectares are forested, representing about 26 per cent of country's total land area. About 12 million ha of forested lands are subjected to and under the threat of forest fires. Fire has always had a pervasive influence on Turkish forests and their management, consuming thousands of hectares of forest land annually resulting in high suppression costs and causing great damages in lost timber, real estate and recreational values, and even loss of life.

Forest fire activity in the country is highly correlated with weather conditions, land use practices and vegetation associations (Canakcioglu and Ozkazanc, 1997). Most fires occur where the Mediterranean climate is predominant with high temperatures and low to nonexistent precipitation during fire season. Land-use practices over the centuries, vegetation types specific to the region and the climate have created a special fire regime across the country. But knowledge about the human impact on fire and fire regimes and about the correlation of land use and fire regimes is highly limited. Although it is generally accepted that maquis vegetation formation spread along the Aegean and Mediterranean Regions up to 250-300 m a.s.l. is sustained and maintained by mainly the presence of fires, no genuine attempt has been made to understand the role of fire in these fire-maintained and fire-tolerant ecosystems. Unofficially however, fire has been used in *Pinus brutia* stands after harvesting for seedbed creation and fuel reduction purposes.

Recent statistics indicate however that the country is experiencing an ever-increasing wildland fire problem, indicating a shift in fire regimes. Supporting this statement is the fact that the number of fires has doubled in recent years. While natural fires play an important role in many of the forest types, the increasing frequency of recent fires has transformed the fire from nature’s tool to nature’s threat, resulting in a dramatic decline in the quality of forests with the average fire cycle, in some localities, having been reduced to as little as 9 to 25 years (Neyişçi 1986). Given the status of the socio-economic situation and tourism in the country, it is not very difficult to conclude that the fire risk will steadily increase, resulting in more areas being affected negatively from wildfires.

1.1. Summary Tables of natural and human influenced fire regimes

Tables 1a and 1b provide a general overview of the natural and human-influenced fire regimes present in the country. The tables are organized by different ecosystem types.

Table 1a. Summary table describing the natural and human-influenced fire regimes in different ecosystem types in Turkey.

Ecosystem Type	Name / Designation[1]	Total Area of Ecosystem in the Country (x 1000ha)	Ecosystem Sensitivity[2]	Typical Fire Frequency (yrs) [3]	Typical Fire Size (ha)[4]	Fire Origin / Cause [5]
Wildfires (including wildfires burning within prescription)						
Forest						
Forest 1: Not intensively managed and protected.						
Forest 2: Intensively managed and / or protected (major ecological or economic assets at risk)	Forest (*Pinus brutia*)	7.668[1] (4.130)	FS, FT	25-35	6.5	Mixed
Other Wooded Land						
Wooded Lands / Shrubland / Savanna 1: Not intensively managed and protected	Maquis	1.463	FT, FM	9-15	6.5	Mixed
Wooded Lands / Shrubland / Savanna 2: Intensively managed and / or protected (major ecological or economic assets at risk)	-	-	-	-	-	
Other Land						
Open Steppe / Grassland / Pastures (not included in Wooded Lands / Shrubland / Savanna) Both intensively and not intensively managed	-	-	-	-	-	
Peat / Swamp / Wetland						
Indicate biome type (e.g. peatland, peat-swamp forest, marsh)	-	-	-	-	-	
Prescribed Burning						
Forestry, Conservation						
Indicate Ecosystem Type:	Conservation Burning	3,700[2] -	-	-	-	
Agricultural / Pastoral						
Agricultural lands / Pastures (straw burning, e.g. corn, wheat, rice paddies, sugar cane; slash and burn systems; pasture maintenance burning)	Agricultural lands Burning	66.878[3] 26.174	-	-	-	Human

[1] Represents first-degree fire sensitive areas.
[2] Forested conservation areas.
[3] About 30% of all agricultural lands are subjected to residue burning.

Note: This table distinguishes between **wildfires** (uncontrolled, accidental or intentional ignition mainly not planned and in most cases unwanted; however, natural and human-caused wildfires burning within prescription are included here) and **prescribed burning** (fires intentionally set to obtain desired effects in ecosystem manipulation, land use, land-use change, etc.).

[1] Name or designation of plant association / ecosystem (if there are several corresponding to one sub-category, you may add extra lines)
[2] indicate whether the ecosystem is fire-sensitive, fire-maintained or fire-tolerant. Use the following suffix letters to indicate: **FS** (fire sensitive ecosystem: fire has a detrimental effect on these ecosystems in terms of ecological and/or economic damage), **FM** (fire maintained ecosystem: fires are needed to maintain these ecosystems in terms of ecological and/or economic benefits; **FT** (fire tolerant ecosystem: fires have a minor impact on these ecosystems in terms of ecological and/or economic aspects)
[3] approximate fire return interval in years, average number of years between fires
[4] approximate mean or typical area affected by a single wildfire or prescribed burning fire in hectares
[5] specify if either natural, human-caused, or mixed

Table 1b. Summary table describing the distribution of natural and human-influenced fires in Turkey throughout the year.

Ecosystem Type	Wildfire Occurrence / Use of prescribed burning by Month and Percentage											
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Wildfires (including wildfires burning within prescription)												
Forest												
Forest 1: Not intensively managed and protected (upper: % of number of fires; lower: % of area burned)	1.0 0.5	1.4 0.5	4.0 1.9	3.9 1.1	4.4 1.0	10.6 6.4	21.0 32.6	21.6 27.8	16.6 11.4	9.6 3.7	4.7 2.3	1.2 0.8
Forest 2: Intensively managed and / or protected (major ecological or economic assets at risk)	-	-	-	-	-	-	-	-	-	-	-	-
Other Wooded Land												
Wooded Lands / Shrubland / Savanna 1: Not intensively managed and protected (major ecological or economic assets at risk)	-	-	-	-	-	-	-	-	-	-	-	-
Wooded Lands / Shrubland / Savanna 2: Intensively managed and / or protected	-	-	-	-	-	-	-	-	-	-	-	-
Other Land												
Open Steppe / Grassland / Pastures (not included in Wooded Lands / Shrubland / Savanna) Both intensively and not intensively managed	-	-	-	-	-	-	-	-	-	-	-	-
Peat / Swamp / Wetland												
Indicate biome type (e.g. peat-swamp forest, moorland, marsh)	-	-	-	-	-	-	-	-	-	-	-	-
Prescribed Burning												
Forestry, Conservation												
Indicate Ecosystem Type:	-	-	-	-	-	-	-	-	-	-	-	-
Agricultural / Pastoral												
Agricultural lands / Pastures (straw burning, e.g. corn, wheat, rice paddies, sugar cane; slash and burn systems; pasture maintenance burning)	-	-	-	-	-	-	-	-	-	-	-	-

[1] Values are for percentage of number of all fires regardless of ecosystem type (numbers in parentheses represent monthly percent values of area burned). These data will assist to evaluate regional to global fire patterns that are important for environmental assessments or decision-making. The percentage (%) of vegetation affected by fire by month (totalling 100% for each line) is indicated.

1.2 Narrative of influences on the fire regimes of the country

Forest fire is a recurring phenomenon in and has a major impact on the sustainability of Turkish forests. Fires are an integral part of many forest ecosystems and of complex social, economic, ecological and environmental origin. However, Fire has always been treated marginally and attitudes toward fire have evolved around an effective fire protection policy with a strong emphasis on fire control with little or no regard given to the ecological effects or the underlying causes of fires, and fire research concentrated mainly on the prediction and the immediate effects of fires on flora, fauna and soil. As a result, in terms of fire control, success has been quite satisfactory. However, the policy of fire control or total fire exclusion has changed ecosystem structures in large areas such that fire danger determined by fuel conditions has been exacerbated.

The damage incurred by fires is assessed on the basis of area and stand type within which fires occur. Assessments are mostly made in economic terms, i.e., wood burned, money spent for suppression and planting etc. No scheme is available for assessing the ecological and social aspects of fires.

Along with the population increase in the country, demographic movements and other social and economical issues play an important role in overall forest fire problem. These involve communication and transportation networks, power lines, wildland/urban interface, recreation/tourism, and land ownership (cadastral) problems.

Fire regimes are highly affected and gradually changing as a result of excessive and increasing human activities. Of the activities of man, tourism is becoming the most important risk factor ever to change the fire regimes. Given the status of the socio-economic situation and tourism in the country, it is not very difficult to conclude that the fire risk will steadily increase, resulting in more areas being negatively affected from wildfires. Statistics indicate that the number of fires has doubled in recent years, indicating an alarming increase in the frequency of fires and thus a dramatic decline in the quality of forests with an average fire cycle, in some localities, having been reduced to as little as 9 to 25 years (Neyişçi 1986, Alexandrian and Esnault 1997). The increase in the incidence of fires, however, is not the only factor that changes the fire regime. The increased and effective use of technology in transportation, communication and fire suppression has contributed considerably to decreasing the average area burned to as low as 6 ha per fire or the total are burned to 4000 to 5000 ha per year.

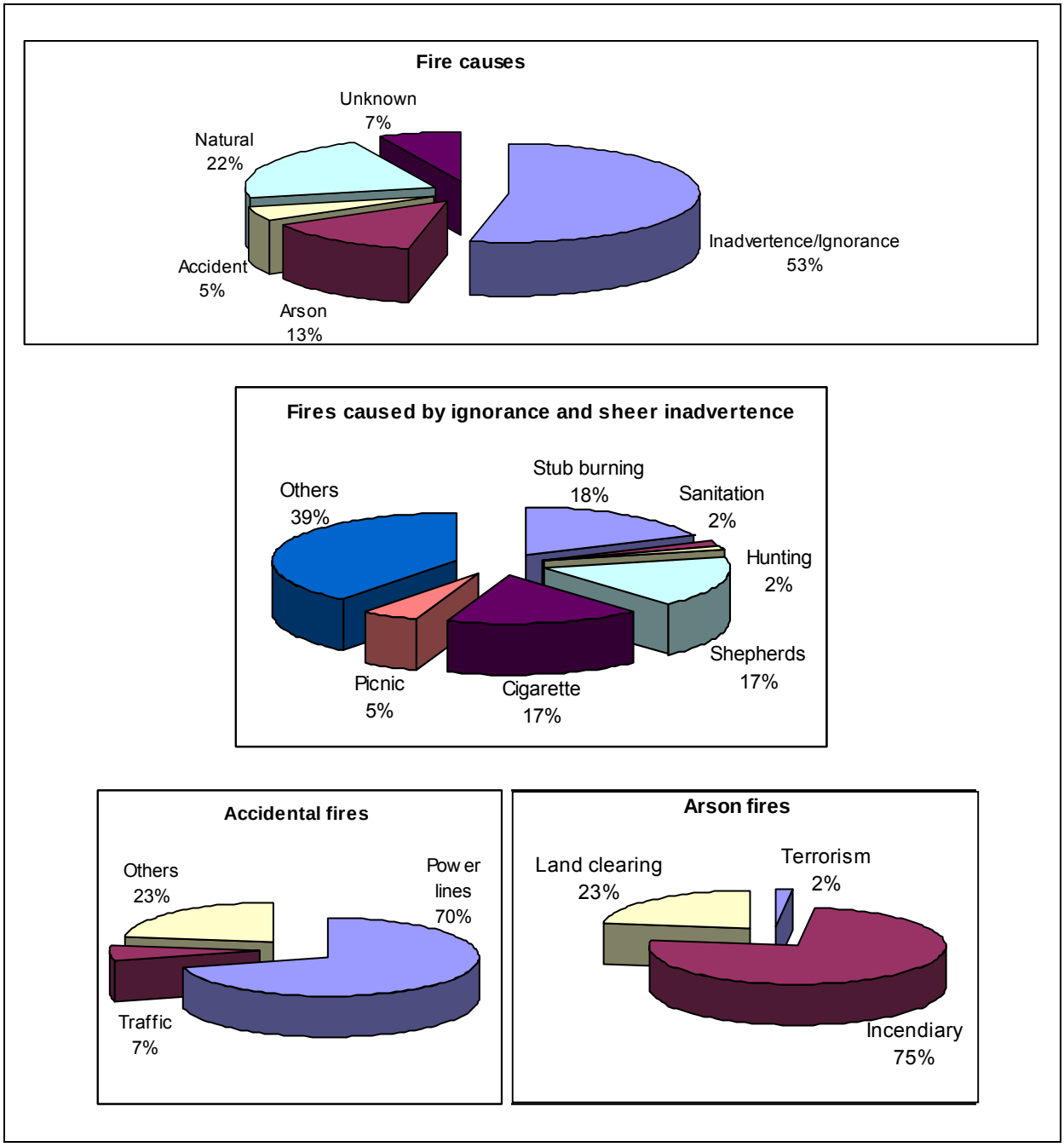
Fire seasons seem to be correlated well with fire weather and fuel conditions. No significant change and/or shift have been observed over the last several decades. Shifts are due mainly to fire hazard conditions (i.e., fuel conditions and weather).

2. Fire statistical database: Wildfire and prescribed burning statistics for the period of 1988-2004

In accordance with the format of the Global Wildland Fire Assessment 2004 statistical data for the years 1988 to 2002 (including the two 5-yr periods 1988-92 and 1998-2002 that are of interest for the FAO Global Forest Resources Assessment 2005 [FRA-2005]) are provided in Table 2. Detailed analysis of fire causes in the period 1997-2004 is provided in Tables 1 to 4.

Table 2. Wildfire database 1988-2004 for Turkey. Data of the two 5-yr periods 1988-92 and 1998-2002 are highlighted because these periods are of key interest for FRA-2005.

Year	Total No. of Fires on Forest, Other Wooded Land, & Other Land No.	Total Area Burned on Forest, Other Wooded Land, & Other Land ha	Area of Forest Burned ha	Thereof area of "Forest 2" ha	Area of Other Wooded Land Burned ha	Thereof area of "Wooded Lands / Shrubland / Savanna 1" ha	Human Causes % of No.	Natural Causes % of No.	Unknown Causes % of No.
1988	**1372**	**18210**	**18210**						
1989	**1633**	**13099**	**13099**						
1990	**1750**	**13742**	**13742**						
1991	**1481**	**8081**	**8081**				**52**	**2.3**	**46**
1992	**2117**	**12232**	**12232**				**40**	**2.6**	**57**
1993	2545	15393	15393				**50**	**1.5**	**48**
1994	3239	38128	38128				36	4	60
1995	7676	7676	7676				48	7	45
1996	1645	14922	14922				55	3	42
1997	1339	6316	5803	5714	89	558	66	6	28
1998	**1932**	**6764**	**5717**	**5444**	**273**	**1047**	**73**	**3**	**24**
1999	**2075**	**5804**	**3979**	**3843**	**136**	**825**	**69**	**10**	**21**
2000	**2353**	**26352**	**24580**	**22607**	**1973**	**1773**	**73**	**6**	**18**
2001	**2631**	**7394**	**5990**	**5682**	**308**	**1404**	**69**	**7**	**21**
2002	**1471**	**8413**	**6100**	**6020**	**80**	**915**	**76**	**12**	**18**
2003	2177	6644	6644	5662	715	268	73.35	21.14	5.51
2004	1762	4876	4876	3623	466	45	72.34	7.26	20.4
Average	2306	12591	12069	7324	505	854	61	7	32



Figures 1-4. Supplement information to Table 2: Fire causes for the period 1997-2004.

3. Narrative summary of major wildfire impacts on people, property, and natural resources between 1988 up to 2004

Since there is not yet an international standard in place to define economic and ecological damages caused by fire, Tables 1a and 2a are not asking for such information. However, in Turkey some figures are available at national level, including individual fires resulting in extraordinary damages that have been recorded.

Since 1988, 58 people have lost their lives in 40 different forest fires. Of those, one was the Regional Director, 2 were district managers, 2 district officers, 2 forest engineers, 1 division director, 3 forest rangers, 5 pilots, 3 bulldozer operators, 4 drivers, 2 soldiers, 1 villager, and 32 fire workers.

There have been occasions where fires threatened several villages and their inhabitants. As a precautionary measure some villages were evacuated temporarily. Fires burned some houses and destroyed some animals.

Table 3 provides an overview of large fires in Turkey between 1988 and 2002.

Table 3. Large fires since 1988.

Regional Directorate	Date	Area burned (ha)	Fire Cause
Çanakkale	25.07.1994	4049	Stubble burning
Muğla	27.07.1996	1438	Unknown
Muğla	27.07.1996	7090	Negligence
Antalya	21.07.1997	1715	Negligence
Muğla	11.08.1997	1385	Negligence
Adana	30.09.1999	1200	Arson
Bursa	05.04.2000	1970	Negligence
Balıkesir	05.04.2000	1267	Power lines
Adana	03.08.2000	3138	Negligence
Denizli	13.07.2000	1459	Negligence
Antalya	03.08.2000	2102	Arson
Çanakkale	01.09.2000	1689	Negligence
Balıkesir	12.08.2002	3573	Unknown
Muğla	15.08.2002	1776	Power lines

4. Application of prescribed burning in the region to achieve management objectives (purposes, extent, results)

Although there is an increasing awareness as to the use of fires to meet some management objectives such as seedbed preparation and slash removal, fires have never been incorporated into overall fire management planning. Except for the (illegal) burning of agricultural fields after harvest, slash burning of pruned trees on roadsides is perhaps the only activity that involves fire. New developments in fire studies, changing attitudes toward fire and appreciation of the role of fires in our ecosystems make one believe, however, that it will not be too long before fire is employed in overall land/fire management planning.

5. Operational fire management system(s) and organization(s) present in the country or region

Fire management in Turkey is a federal responsibility. Duties are carried out by the state forest enterprises functioning under regional directorates. Fire control policies have been developed around a strong emphasis on total fire control as a response to destructive fires. Regardless of the high costs involved, it is the forest service department's responsibility and policy that all the required activities are planned and implemented immediately. In no time, however, have the beneficial use and ecological

role of fire been incorporated in fire management planning process. So, fire management deals mainly with fire prevention and control activities.

Risk is associated with ignition, and risk abatement involves raising the level of awareness of general public and various responsibility groups to the dangers of ignition and subsequent forest fires through education and enforcement. It is of the opinion of the forestry service that a strongly favourable public opinion is a vital necessity in any effort to reduce the number of people-caused fires. All the available communication avenues have increasingly been utilized for this purpose. These involve the utilization of the mass media and local media outlets of radio, television, newspaper and magazines, education programs in the schools, military bases, service clubs, signs, and personal contacts. Also, fire law enforcement has been a potentially valuable technique for forest fire prevention since the laws have a potential to educate the public as well as deter the negligent or malicious from destructive behaviour.

Non-governmental organizations help raise the level of awareness of general public and various responsibility groups to the dangers of ignition and subsequent forest fires through education and conducting/supporting relevant activities. These activities involve seminars, TV and radio programmes, practical field work, and suggestions brought to the attention of policy makers.

Local people are responsible by law to immediately to respond to a fire situation when and if requested. The response of the local people and communities to a fire has risen considerably in recent years. This has mostly been a result of the changing attitudes towards forest resources and of the success of the public awareness campaigns.

Academia has a very important role in all aspects of fire management. However, their effectiveness has been fairly limited. Only in recent years, however, have the scientific studies been increasingly conducted and the results obtained put into practice. The most important step in this regard has been taken for the establishment of a National Fire Danger Rating System.

Organizational systems or procedures used in large fire situations and the collaboration on different levels (local, national, international)

Since 1997, there have been substantial improvements in the handling of forest fires. A Fire Command Center (FCC) established in 1997 under the General Directorate of Forestry (GDF), Forest Protection Unit is responsible for all fire management issues, ranging from prevention activities to fire suppression and other related issues. As part of the activities of FCC, a more comprehensive national database on forest fires is being created containing information on all aspects of forest fires. Information gathered on the location and cause of fires is used to develop fire prevention techniques and prevention planning. Important/large fire situations requiring inter-regional cooperation are handled with the help of the FCC. The Forest Protection Unit of the GDF with the help of the FCC handles all inter-agency or international agreements/procedures.

6. Sustainable land-use practices employed in the country aimed at reducing wildfire hazards and wildfire risks

Despite the high cost involved in the construction and maintenance, firebreaks and fuel breaks have been widely used to break the continuity of forest fuels. Fuel breaks have been constructed along and around the high fire risk and hazard areas such as camp grounds, disposal sites, settlements, major highways, railroads and in and around plantations and productive forests. Although very labour-intensive, the practice of clearing and burning surface fuels within 15-20 m on each side of forest stands along major highways is a usual one. As a general rule, fire breaks constructed in plantations and naturally regenerated areas are supported by some fire resistant species (especially *Cupressus sempervirens* var. *pyramidalis*). These species are planted along the firebreaks with up to five rows. In areas close to settlements or critical areas, such species as stone pine (*Pinus pinea*) have been heavily utilized (planted) in place of other species. The local people look after these areas by pruning the trees and cleaning underneath and harvest their cones. Not only this practice help maintain an important fire resistant zone but also provide for the local people an opportunity to make a living. One other activity worth mentioning concerning fuel modifications is the charcoal production using some bush species that would not normally be harvested or utilized (Serez et. al., 1997). Those who produce charcoal purchase the wood they cut for a very low price (about 1/10 of what they sell charcoal for). Again, this benefits both forests and people.

Although illegal in forested areas, especially in plantations and naturally regenerated areas, grazing is another land use practices that reduce fire hazard in many localities. Providing it is kept in predetermined or known areas, grazing is allowed by the officials as a precautionary measure. Tensions between the officials and shepherds and between shepherds themselves have been the cause of many fire incidences over the years.

7. Fire management / suppression technologies, training standards and facilities

Technologies and systems

Fire management relies on early detection, fast initial attack and powerful suppression. Each region has been provided with sufficient resources and man-power to combat forest fires. Available resources include:

- 135 fire trucks
- 12 helicopters
- 11 fixed-wing airplanes
- 882 fire lookout towers
- 8472 radios
- 650 initial attack crews (of 12-15 men), and
- 120 standby forces (of 40-50 men)

As needed new resources are being added and new technologies adopted. These forces are allocated to each district based on fire danger levels and area in question.

Fire monitoring is made through 882 fire lookout towers scattered across fire-prone areas. At times of high fire risk, motorized ground troops and sometimes helicopters are used for fire monitoring purposes and for deterring the mischief-maker. Public reports have also become one of the most important information sources for fire incidences. This is mainly ascribable to the promotion and the general acceptance of emergency telephone number 177 by the public as the number to call in case of a forest fire.

Except for utilizing the daily temperature and relative humidity to rate fire danger, no system is in place for fire danger rating. However, Some initial steps have been recently taken to establish a fire weather index system in one of the fire sensitive regions. A network of automated weather stations will be established soon for the system. The system will generate current fire danger levels based on past and present fire weather conditions, and fire danger levels for the future based on forecast weather conditions.

Information dissemination will also be made on the internet once the information system has been completed.

National wildland fire management planning, preparedness

Fire management involves fire prevention and pre-suppression activities. Every State Forest Enterprise has a fire management plan in which all maps of the area in question; resources available and activities to be done are listed for the plan period. State Forest Enterprise is responsible to carry out all activities according to the plan.

Wildland fire management training

Fire workers and technical personnel are trained every year for up to two months. There are two training centres for fire workers where they take theoretical courses and attend seminars given by lecturers and fire experts. The main load of the training lies on the practical field work. Workers are trained to efficiently use the equipment they have. This involves wireless radio communication, chainsaw, hand tools and hose operations, water and retardant use, fire truck/engine and bulldozer operations etc.

8. Public policies concerning fire

A political decision might influence fire regimes in a way that can scarcely be foreseen when released. Unfortunately, fire has always been treated marginally, based on the simple assumption that it is always bad. Thus, the policy of *total fire control* or *fire exclusion* has been adopted for several decades with no regards to the ecological effects of fire on forest ecosystems. As a result, in terms of fire control, success has been quite satisfactory. However, the policy of fire control or total fire exclusion has changed ecosystem structures in large areas such that fire danger determined by fuel conditions has been exacerbated.

Land ownership boundaries or borders separating public and private lands are not completely delineated in Turkey. So, there are always ownership disputes and conflicts in and around forests and protected areas.

Tourism is becoming one of the fastest growing sectors in the economy. However, government incentives for tourism have been creating new problems for the sustainability of forest and other natural resources. The relative increase in the number of fires in recent years is clearly an indication of this situation.

Parallel to these, demographic movements and other relevant social and economic issues also play an important role in overall forest fire problem.

About 8.8 million people live in 17,445 villages in or near forests (Anonymous 1991). Socio-economic life standards of most of these people are well below the national average. People with low income and low life standards see the forests as an earning ground for their sustenance. So, people set fire in the forest to create jobs that will earn them some provision or manipulate vegetation to improve and produce useful plants for their animals to feed on.

Because of the socio-economic constraints and relatively high rate of population increase, many people leave their villages or towns for larger cities with a hope of finding better jobs. Depopulation of these areas naturally results in a population increase and eventually overpopulation of larger urban areas. The lack of the necessary infrastructure and jobs results in an abnormal growth of such urban areas. This results in ill-developed residential areas at the wildland/urban interface. Unfortunately, laws concerning these areas and policies adopted in the past have even worsened the situation. The change of the definition of “forest” or amendments made to it has not helped to solve the problem, either.

The instability in the government and fast change of leadership at the government level, and the expectation of the public from the new leadership an amnesty after every national election, have exacerbated the already bad situation and perhaps encouraged them.

In addition to all these, policies concerning communication and transportation networks, and power lines passing through forested areas also create problems.

To help solve these problems, the following measures are suggested:

- Demographic and political analyses should be carried out,
- Inquiries in behaviour of individuals and societies made,
- Inventories of urbanisation completed,
- Plans of development formulated, and
- A broad cooperation of social scientists and geographers realized.

9. Wildland Fire Research

Fire is one of the areas that has received the least attention in Turkey. There have been very few studies concerning fire behaviour, fire ecology or the role of fire in Turkish forest ecosystems (Bilgili and Saglam 2003; Bilgili et al. 2003; Neyişçi 1989a,b; Neyişçi and Cengiz 1985). Recently, however, attempts have been made to establish a national fire danger rating system. Initial work has been completed and weather measurements started. Based on the litter moisture and weather measurements in a standard fuel type (red pine, *Pinus brutia*), Turkish Fire Weather Index System will

be developed. Fire behaviour experiments have been conducted in several fuel types. Results of the experiments will constitute the first steps towards achieving the goal of the development of fire behaviour prediction system. Also, the use of Geographical Information Systems (GIS) in fire management is being increasingly utilized. But, all these attempts have been very limited for the reasons that there has been a lack of cooperation between universities and research institutions within the forestry sector, and a lack of mechanisms to support research projects undertaken by other units. But despite the lack of the necessary means to conduct fire research, these recent developments have been the result of genuine cooperation between Karadeniz Technical University, Faculty of Forestry and the General Directorate of Forestry.

Gaps / deficits that need to be addressed in the country for better wildland fire research

Almost all areas of fire research should have a priority. But the lack of research facilities and researchers makes it almost impossible. Except for a few studies, forest research institutions have never conducted a fire related study. There is no fire research laboratory in the country.

10. Needs and Limitations

Forest fires are a recurring phenomenon in and have a major impact on the sustainability of Turkish forests with complex social, economical, ecological and environmental aspects. Yet, fire policies were formulated in such a way as to exclude fire on the assumption that it is always bad. Currently practiced total fire control policy has been followed by some successes with prospects. But it may not be as proper and appealing as it is thought, considering the large fires of recent history have been a result of the policy of total fire exclusion in those areas. In addition, pressures brought about by certain realities of ecology and economics, and our increased demands for multiple resources require the development of new policies and attitudes toward fire. At the same time, increasing complexity and sustainable forestry will require a deeper understanding of fire and development of more effective management systems. Effective management systems will not prove successful in any place unless they include the demands and acknowledge the role of the fire and society on forests. In this regard following points may be worth mentioning:

- The formulation of national and regional policies should address forest fires as an integral component of ecosystems and land-use.
- Flexibility in policy implementation, and clear and measurable policy objectives are needed to minimize the adverse effects of uncontrolled fires and maximize the benefits from fire prevention or from the controlled use of fires.
- Involvement of all stakeholders in policy development is a must. Especially in the case of fires when almost all fires are started by humans.
- Favourable policies must be adopted for all aspects of fire management (prevention, suppression and fire use) based on local conditions.
- Land-use policies should promote fire prevention and not contribute to deforestation or the degradation of forest resources
- Personnel policies should be realistic and fire research should have a priority.

11. Date of Report

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IFFN Contribution by

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Fire Management and Associated Public Policies in Turkey

Abstract

This report presents and discusses the underlying causes, past and current status of forest fires, and associated fire management policies in Turkey. Forest fire is a recurrent and multifaceted phenomenon stemming from complex social, economical, ecological and environmental origin. Fire policies were formulated in such a way as to exclude fire on the assumption that it is always bad. However, currently practiced total fire control policy may not be as proper and appealing as it is thought, considering the large fires of recent history have been a result of the policy of total fire exclusion. In addition, pressures brought about by certain realities of ecology and economics, and our increased demands for multiple resources require the development of new policies and attitudes toward fire. At the same time, increasing complexity and sustainable forestry will require a deeper understanding of fire and development of more effective management systems. Effective management systems will not prove successful unless they include the demands and acknowledge the role of fire and society in forests. In this regard, Turkish forestry presents great challenges to the society in general and the forest service and fire researchers in particular.

Introduction

Turkey is a country with a land mass of 77,079 million hectares (ha), of which 20,749 million ha are forested, representing about 26 per cent of country's total land area. About 12 million ha of forested lands is subjected to and under the threat of forest fires. Most fires occur where Mediterranean climate with high temperatures and low to nonexistent precipitation during fire season is predominant in the southern and western Anatolia. In the period 1937-2004, a total of 76,255 fires burned a total of 1,561,026 ha of forest land. This represents 1121 fires on 22,956 ha annually with an average area burned per fire of 20.28 hectares (Figure 1). Although there has been a gradual increase in the number of fires in recent years, due to the increased and effective use of technology in transportation, communication and fire suppression, area burned has been cut substantially and kept at 6 ha on average (Figure 2).

Fire has always had a pervasive influence on Turkish forests and their management, consuming thousands of hectares of forest land annually resulting in high suppression costs and causing great damages in lost timber, real estate and recreational values, and even loss of life. Recent statistics indicate that the country is experiencing an ever increasing wildland fire problem. Supporting this statement is the fact that the number of fires has doubled in recent years. While natural fires play an important role in many of the forest types, the increasing frequency of recent fires has transformed the fire from nature's tool to nature's threat, resulting in a dramatic decline in the quality of forests with the average fire cycle, in some localities, having been reduced to as little as 9 to 25 years (Neyisci 1986, Alexandrian and Esnault, 1997). Given the status of the socio-economic situation and tourism in the country, it is not very difficult to conclude that the fire risk will steadily increase, resulting in more areas being affected negatively from wildfires.

When analysed with respect to fire causes, it is seen that fire in the country is of a very complex and multifaceted phenomenon involving social, cultural, economical, historical and psychological aspects, and is marked by a prevalence of fires of human origin, with reliable estimates being up to 95 to 97% (OGM 2003). However, fire protection agencies have evolved around an effective fire protection policy with a strong emphasis on fire control with little or no regard given to underlying causes of fires, and fire research concentrated mainly on the prediction (Bilgili et al., 2001; Bilgili 2003; Bilgili and Sağlam 2003) and the immediate effects of fires on flora, fauna and soil (Bilgili et al., 2003; Neyisci, 1989a,b; Neyisci and Cengiz, 1985).

The objective of this paper is to present and analyze the causes of forest fires and public policies affecting forest fire problems in Turkish forests

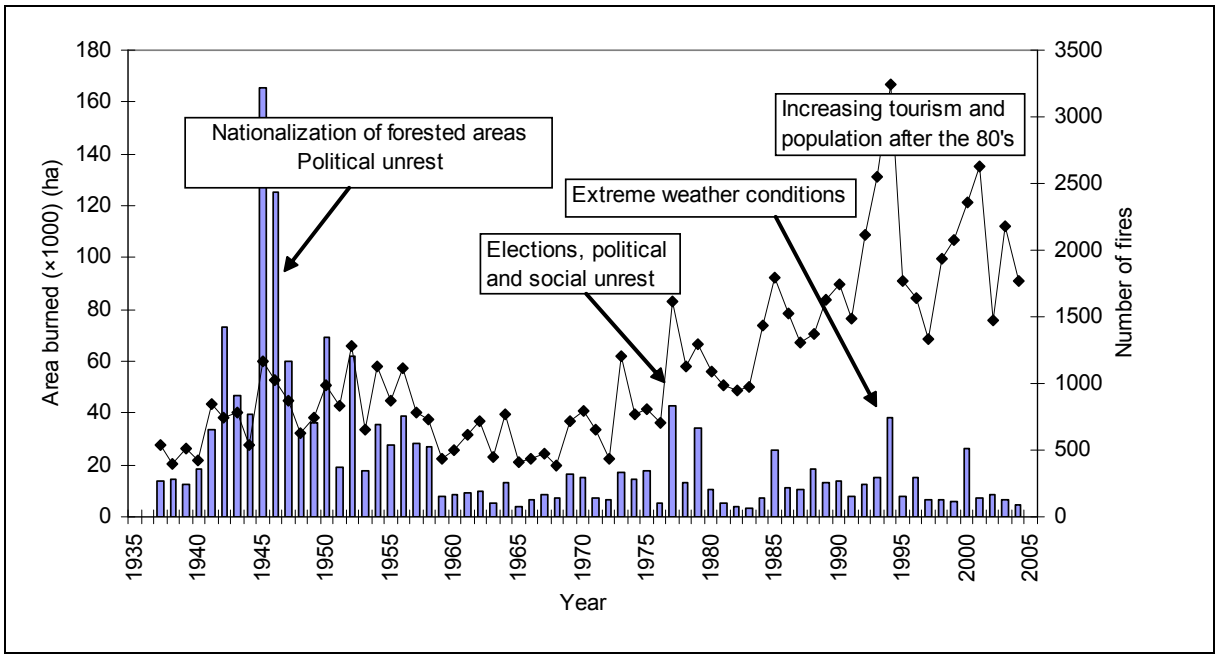

Figure 1. Area burned and number of fires for the period 1937-2004.

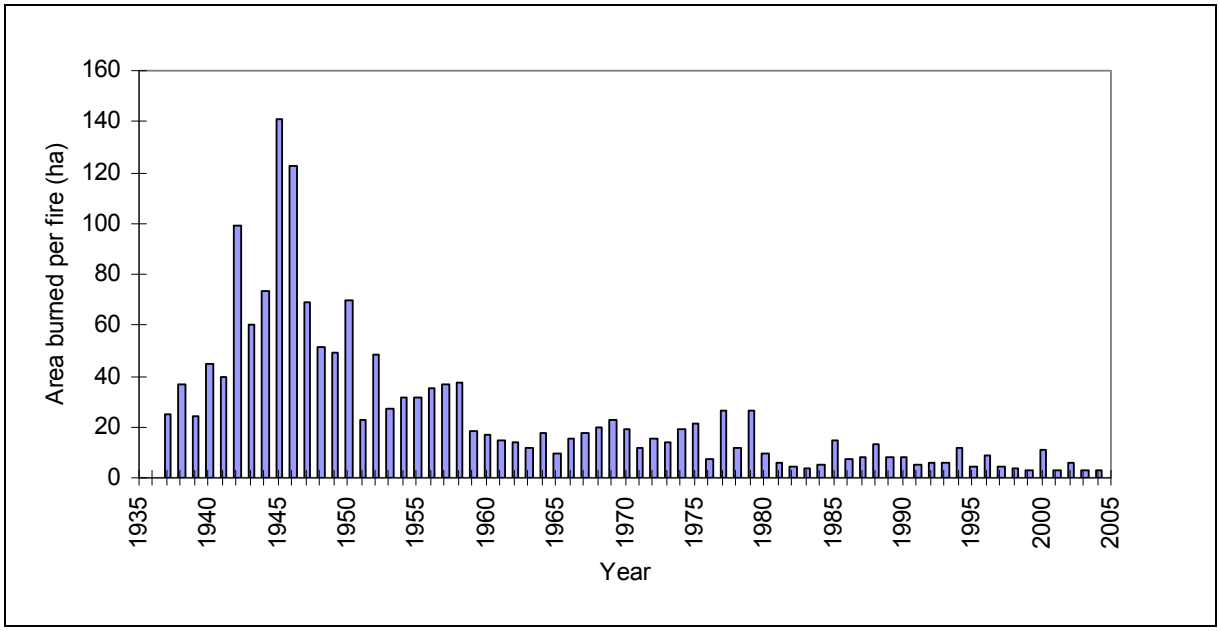

Figure 2. Area burned per fire for the period 1937-2004.

Fire Causes

The majority of forest fires in Turkey are caused by people. People-caused fires account for 94 to 97% of all fires, while natural agents are responsible for the remaining 3 to 6%. People-caused fires can be examined under three broad categories – voluntary, involuntary, and unknown fires. Of the people-caused fires, according to the recent statistics, 14 per cent is classified as arson, 58 per cent as negligence and carelessness, 5 per cent accident, and 23 per cent as unknown (OGM, 2003) (Figure 3). The majority of fires are often caused by people through sheer inadvertence or accident. These types of fires usually occur in and around recreation areas and camp sites, at wildland/urban interface or along major highways. Arson fires are set for several reasons. About 8.8 million people live in 17,445 villages in or near forests (Anonymous, 1991). Socio-economic life standards of most of these people are well below the national average. People with low income and low life standards see the forests as an earning ground for their sustenance. So, people set fire in the forest to create jobs that

will earn them some provision or manipulate vegetation to improve and produce useful plants for their animals to graze. Personal conflicts between people and forestry officials or between shepherds or different villagers have also been reported to be a cause for fires.

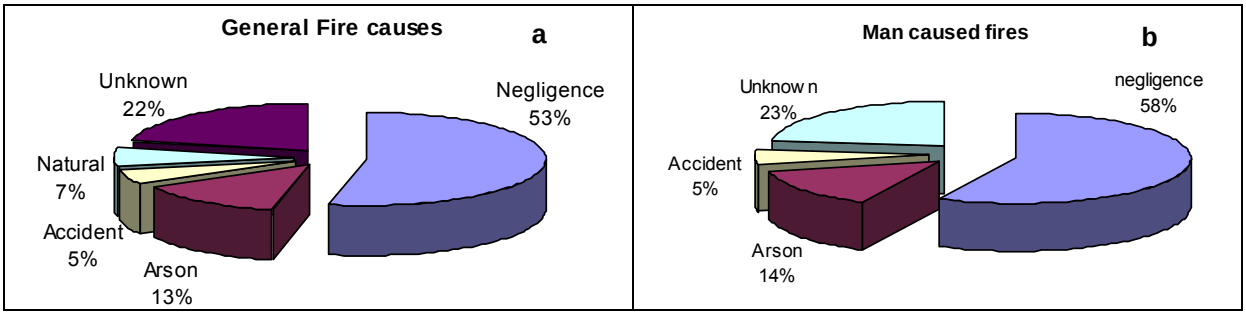

Figure 3. Fire incidences by causes, (a) general, (b) human-caused fires.

When examined in detail, it is very obvious that fire causes are closely related with land management activities, standards of living, population dynamics (Mol et al., 1997) and associated policies. Thus, to better understand the underlying causes of fires, the subject should be examined in relation to these factors.

Land Use and Vegetation

Forest fire activity in the country is highly correlated with weather conditions, land use and vegetation associations (Canakcioglu and Ozkazanc, 1997). Land use is the general term for human activities on earth surface. It includes agriculture, silviculture, pasture, settlements, networks of communication, recreation areas, and so on. The manner in which the land is used in Turkey is usually a combination of tradition and history, economic constraints, technical and financial possibilities, natural delimitations, cultural and psychological motivations, the means of land possession, and politics. Three main land use types prevail in the country, namely forestry, pastoralism and agriculture.

Extensive and intensive forestry practices have transformed the natural fire regimes in many forest ecosystems. By planting or harvesting woods, by collecting fuel biomass, by fighting wildfires, and by setting woodlands on fire both purposely and accidentally, the natural equilibrium of the forest ecosystems has been disturbed and replaced by rather human-made ones.

In Turkey, **pastoralism** still plays an important role. Though rarely, setting fire to natural forest is a way to gain pasture land, while repetitious grazing selects plant species and prevents maturation of vegetation. Overgrazing has been recognized as one of the most destructive processes.

The third area-wide land use in Turkey is **agriculture**. Agriculture and associated debris or residue burning is a very important problem. Policies concerning residue burning, for example, have proved to be useless. Culturally people burn off agricultural residues, assuming that it is good for their field, but there is a strict ban on residue burning with penalties being very severe. Moreover, The migration of the rural population from peripheral regions into cities and the abandonment of traditional agriculture have made possible the reinstallation of brush and forest lands – and with them the return of fire risk.

Forestry, livestock farming, and agriculture – as area-wide activities – Influence to a highest degree the actual fire regimes. These activities are dependent on social and economic factors. Determination and analysis of these factors should be a major task for the research community.

Population

Population and land use are correlated systems. Land use is determined by not only the quantity of human beings, but also their distribution and the quality of their action and interaction. Settlements and communication networks cover more and more of the country's surface. Metropolitan areas expand while at the same time rural homes are mostly constructed within woodlands. The wildland/residential interface shows an increasing disaster risk.

The new tendency of residential urbanization and tourism in "natural" woodlands has raised the peril of careless ignition. Additionally, criminals have discovered in arson a means of reaching their aims (vengeance, delinquency and speculation). There is substantial evidence that social and political unrest leads to an increase of arson fires (Figure 1).

In order to effectively prevent wildland fires, the reasons why they exist and spread have to be clarified. Demographical and political analyses, inquiries in behaviour of individuals and societies, inventories of urbanization, and plans of development need to be carried out. This requires a broad cooperation of various social scientists and geographers. Moreover, the results of such a research should be prepared in forms not only suitable for integration into research models but also for teaching and raising public awareness.

Culture and History

Historically and culturally man has played a major role in shaping forest landscapes in Anatolia. But the effects of anthropogenic fire on the environment have long been neglected and not really considered in the formulation of policies. Being conscious of the importance of human impact on fire regimes, it is hard to understand why overall fire research has neglected the cultural and historical aspect of the topic for such a long time. "An understanding of fire history is necessary to ascertain future effects of anthropogenic fire on the environment and atmosphere. Such studies should include the cumulative influences of past burning practices and current fire regimes, and they should seek to establish trends that can be projected into future scenarios for societies and the ecosystems they inhabit" (Kauffman et al., 1993).

Socio-Economics and Policy

"Forest fires are not an autonomous phenomenon, but a symptom of socio-economic problems" (Vélez, 1993). Depopulation of rural areas, the relinquishing of traditional agriculture, pasture, silviculture, recreational activities, tourism, urbanization, cadastre, arson, and so forth are the results of the socio-economic situation that confronts the Turkish population, and these considerations must frame any policy of fire management.

A political decision might influence fire regimes in a way that can scarcely be foreseen when released. Unfortunately, fire has always been treated marginally, based on the simple assumption that it is always bad. Thus, the policy of total fire control, or fire exclusion has been adopted for several decades with no regards to the ecological effects of fire on forest ecosystems. As a result, the policy of fire control or total fire exclusion has changed ecosystem structures in large areas such that fire danger determined by fuel conditions has been exacerbated.

Land ownership boundaries or borders separating public and private lands are not completely delineated in Turkey. So, there are always ownership disputes and conflicts in and around forests and protected areas.

Tourism is becoming one of the fastest growing sectors in the economy. However, government incentives for tourism have been creating new problems for the sustainability of forest and other natural resources. The relative increase in the number of fires in recent years is clearly an indication of this situation.

Because of the socio-economic constraints and relatively high rate of population increase, many people leave their villages or towns for larger cities with a hope of finding better jobs. Depopulation of these areas naturally results in a population increase and eventually overpopulation of larger urban areas. The lack of the necessary infrastructure and jobs results in an abnormal growth of such urban areas. This results in ill-developed residential areas at the wildland/urban interface. Unfortunately, laws concerning these areas and policies adopted in the past have even worsened the situation. The change of the definition of “forest” or amendments made to it has not helped to solve the problem, either.

The instability in the government and fast change of leadership at the government level, and the expectation of the public from the new leadership an amnesty after every national election, have exacerbated the already bad situation and perhaps encouraged them.

Parallel to the population increase, demographic movements, and public policies, other social and economical issues also play an important role in overall forest fire problem. These involve:

- Communication and transportation networks
- Power lines
- Wildland/urban interface
- Recreation/tourism
- Cadastre

In this regard the following activities should be carried out:

- Demographic and political analyses
- Inquiries about attitude and behaviour of individuals and society
- Complete inventories of urbanisation
- Formulation of development plans
- Realization of a broad cooperation between social scientists and geographers

Fire Management

Fire management in Turkey is a federal responsibility. Duties are carried out by the state forest enterprises functioning under regional directorates. Fire control policies have been developed around a strong emphasis on total fire control as a response to destructive fires. Regardless of the high costs involved, it is the forest service department's responsibility and policy that all the required activities are planned and implemented immediately. In no time, however, have the beneficial use and ecological role of fire been incorporated in fire management planning process. So, fire management deals mainly with fire prevention and control activities. Every State Forest Enterprise has a fire management plan in which all maps of the area in question; resources available and activities to be done are listed for the plan period.

Fire management involves fire prevention and suppression activities. Fire prevention deals with risk abatement and hazard reduction. Risk is associated with ignition, and risk abatement involves raising the level of awareness of general public and various responsibility groups to the dangers of ignition and subsequent forest fires through education and enforcement. It is of the opinion of the forestry service that a strongly favourable public opinion is a vital necessity in any effort to reduce the number of people-caused fires. All the available communication avenues have increasingly been utilized for this purpose. These involve the utilization of the mass media and local media outlets of radio, television, newspaper and magazines, education programs in the schools, military bases, service clubs, signs, and personal contacts. Also, fire law enforcement has been a potentially valuable technique for forest fire prevention since the laws have a potential to educate the public as well as deter the negligent or malicious from destructive behaviour.

Although the role of all stakeholders and interest groups such as non-governmental organizations, local people and academia in overall fire management planning is acknowledged, their contribution to management, policy and program planning has been extremely limited. In this regard, non-governmental organizations help raise the level of awareness of general public and various responsibility groups to the dangers of ignition and subsequent forest fires through education and conducting/supporting relevant activities. These activities involve seminars, TV and radio programs, practical field work, and suggestions brought to the attention of policy makers.

Local people are responsible by law to immediately respond to a fire situation when and if requested. The response of the local people and communities to a fire has risen considerably in recent years. This has mostly been a result of the changing attitudes towards forest fires and of the success of the public awareness campaigns.

Academia has a very important role in all aspects of fire management. However, their effectiveness has been fairly limited. Only in recent years, however, have the scientific studies been increasingly conducted and the results obtained put into practice. The most important step in this regard has been step taken for the establishment of a National Fire Danger Rating System.

Since 1997, there have been substantial improvements in the handling of forest fires. A Fire Command Center (FCC) established in 1997 under the General Directorate of Forestry (GDF), Forest Protection Unit is responsible for all fire management issues, ranging from prevention activities to fire suppression and other related issues. As part of the activities of FCC, a more comprehensive national database on forest fires is being created containing information on all aspects of forest fires. Information gathered on the location and cause of fires is used to develop fire prevention techniques and prevention planning. Important/large fire situations requiring inter-regional cooperation are handled with the help of FCC. All inter-agency or international agreements/procedures are handled by the Forest Protection Unit of GDF with the help of FCC.

As for the fire hazard reduction, fuel modification activities are practiced in all fire prone areas. Despite the high cost involved in the construction and maintenance, firebreaks and fuel brakes have been widely used to break the continuity of forest fuels. Fuel brakes have been constructed along and around the high fire risk and hazard areas such as camp grounds, disposal sites, settlements, major highways, railroads and in and around plantations and productive forests. Although very labour intensive, the practice of clearing and burning surface fuels within 15-20 m on each side of forest stands along major highways is a usual one. As a general rule, fire breaks constructed in plantations and naturally regenerated areas are supported by some fire resistant species (especially *Cupressus sempervirens* ssp*. pyramidalis*). These species are planted along the firebreaks with up to five rows. In areas close to settlements or critical areas, such species as stone pine (*Pinus pinea*) have been heavily utilized (planted) in place of other species. The local people look after these areas to harvest their cones. Not only this practice help maintain an important fire resistant zone but also provide for the local people an opportunity to make a living. One other activity worth mentioning concerning fuel modifications is the charcoal production using some bush species that would not normally be harvested or utilized (Serez et. al., 1997). Those who produce charcoal purchase the wood they cut for a very low price (about 1/10 of what they sell charcoal for). Again, this benefits both forests and people.

Although illegal in forested areas, especially in plantations and naturally regenerated areas, grazing is another land use practices that reduce fire hazard in many localities. Providing it is kept in predetermined or known areas, grazing is allowed by the officials as a precautionary measure. Tensions between the officials and shepherds and between shepherds themselves have been the cause of many fire incidences over the years.

Fire management also relies on early detection, fast initial attack and powerful suppression. Each region has been provided with sufficient resources and manpower to combat forest fires. Available resources include 135 fire trucks, 12 helicopters, 11 airplanes, 882 fire lookout towers, 8472 radios, 650 initial attack crews (of 12-15 men), and 120 standby fire response teams (of 40-50 men). As needed, new resources are being added and new technologies adopted. These forces are allocated to each district based on fire danger levels and area in question.

Fire monitoring is made through 882 fire lookout towers scattered across fire-prone areas. At times of high fire risk, motorized ground troops and sometimes helicopters are used for fire monitoring purposes and for deterring the mischief-maker. Public reports have also become one of the most important information sources for fire incidences. This is mainly ascribable to the promotion and the general acceptance of 177 by the public as the number to call in case of a forest fire.

Except for utilizing the daily temperature and relative humidity to rate fire danger, no system is in place for fire danger rating. However, Some initial steps have been recently taken to establish a fire weather index system in one of the fire sensitive regions. A network of automated weather stations will be established soon for the system. The system will generate current fire danger levels based on past and present fire weather conditions, and fire danger levels for the future based on forecast weather conditions.

Fire workers and technical personnel are trained every year for up to two months. There are two training centres for fire workers where they take theoretical courses and attend seminars given by lecturers and fire experts. The main load of the training lies on the practical field work. Workers are trained to efficiently use the equipment they have. This involves wireless radio communication, chainsaw, hand tools and hose operations, water and retardant use, fire truck/engine and bulldozer operations etc.

Fire Research

Fire is one of the areas that has received the least attention in Turkey. All areas of fire research require attention. But the lack of research facilities and of researchers makes it almost an impossibility. There is no fire research laboratory in the country. There has been very few studies concerning fire behaviour, fire ecology or the role of fire in Turkish forest ecosystems (Bilgili and Saglam, 2003; Bilgili et al., 2003; Neyişçi, 1989a,b; Neyişçi and Cengiz, 1985). Recently, however, attempts have been made to establish a national fire danger rating system. Initial work has been completed and weather measurements started. Based on the litter moisture and weather measurements in a standard fuel type (Red Pine: *Pinus brutia*), Turkish Fire Weather Index System will be developed. Fire behaviour experiments have been conducted in several fuel types. Results of the experiments will constitute the first steps towards achieving the goal of the development of fire behaviour prediction system. Also, the use of Geographical Information Systems (GIS) in fire management is being increasingly utilized. But, all these attempts have been very limited for the reasons that there has been a lack of cooperation between universities and research institutions within the forestry sector, and a lack of mechanisms to support research projects undertaken by other units. But despite the lack of the necessary means to conduct fire research, these recent developments have been the result of genuine cooperation between Karadeniz Technical University, Faculty of Forestry and the General Directorate of Forestry.

Conclusions

Forest fires are a recurring phenomenon in and have a major impact on the sustainability of Turkish forests with complex social, economical, ecological and environmental aspects. Yet, fire policies were formulated in such a way as to exclude fire on the assumption that it is always bad. Currently practiced total fire control policy has been followed by some successes with prospects. But it may not be as proper and appealing as it is thought, considering the large fires of recent history have been a result of the policy of total fire exclusion in those areas. In addition, pressures brought about by certain realities of ecology and economics, and our increased demands for multiple resources require the development of new policies and attitudes toward fire. At the same time, increasing complexity and sustainable forestry will require a deeper understanding of fire and development of more effective management systems. Effective management systems will not prove successful unless they include the demands and acknowledge the role of the fire and society on forests. In this regard following points may be worth mentioning:

- The formulation of national and regional policies should address forest fires as an integral component of ecosystems and land-use.
- Flexibility in policy implementation, and clear and measurable policy objectives are needed to minimize the adverse effects of uncontrolled fires and maximize the benefits from fire prevention or from the controlled use of fires.
- Involvement of all stakeholders in policy development is a must. Especially in the case of fires when almost all fires are started by humans.
- Favourable policies must be adopted for all aspects of fire management (prevention, suppression and fire use) based on local conditions.
- Land-use policies should promote fire prevention and not contribute to deforestation or the degradation of forest resources.
- Personnel policies should be realistic and fire research should have a priority.

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Determination of the Basic Principles of a Fire Prevention Plan: The Case Study Manavgat, Turkey

Abstract

This study evaluates fire risk and danger using Geographical Information Systems (GIS) at Manavgat forest conservancy. For the study, digital maps scaled 1:25,000 were drawn to show stand types, road communication, power lines, fire breaks, landscape relief, arable lands and urban areas. These major factors effecting fire occurrence and fire spread were also loaded in a database. In total, 270 sample plots were chosen in the study area to represent various stand types by means of GPS. In each sample plot, measurements of litter and living fuel were made to determine fuel load. Data were gathered from Antalya meteorological office on local climate and from statistical office on urban and rural settlement. Information on past forest fires were also collected from forestry department records. This information were loaded on GIS, which included date, location (geographic coordinates), forest compartment number, acreage, stand types. Interrelation of forest fires to stand type and vegetation cover was studied in terms of these factors. The study area was divided into 136 parts by a grid of 3x3 km in order to evaluate statistical data. Number of fires and fire-denuded area were taken as dependent variables. While fuel load characteristics, forest area, population, roads, residential areas etc. total 30 parameters were used as independent variables on each square. Regression analyses were made in order to calculate fire risk (number of fires), fire danger (area burned). Areas with high fire risk and danger were determined by regression equations.

1. Introduction

Forest fires are a recurrent phenomenon in Turkish forests. Fifty eight percent (12 million ha) of forestland of Turkey is in a fire sensitive zone. This zone is approximately 1700 km long with a depth of 160 km in the inland, starting from K. Maraş and extending up to Istanbul. Forests in this zone can be divided into five different risk degrees; the highest is 35% followed by 23%, 22%, 15% and 5%, referring to OGM (2002).

Between 1937 and 2002, a total of 72,316 forest fires occurred and 1,549,506 ha were burned. During the last ten years 2100 forest fires were recorded annually with 13,726 ha burned annually and an average of 6.5 ha burned per fire. Despite the increases in the number of fires, total and per fire area decreased in the last decade. This shows that there is a linear interrelation between the population growth and number of forest fire (tourism and recreation activities, human necessity etc.). Decreases in the area per fire can be attributed to the technological developments, consciousness about the importance of the forest, efficiency in the use of resources (communication, aircrafts, irrigators).

In a report prepared in the year 1999 by FAO on Turkey is specified that the expenditures made between the years 1993-1998 for fighting the fires was found on a much more superior level than the damages caused as a result of the fires (OGM 1999). As a result of this circumstances, depends on stable and changeable factors, fire risk and danger must be reveal especially on sensitive forestland. On the other hand the qualified fire plans must include the side plans, which will protect the potential regional future fires and sensitivity of our regional forests to reduce the cost of fire fighting.

The purpose of this paper is to investigate and analyze fire danger and fire risk in Manavgat forests using GIS.

2. Material and methods

2.1 Study area

Manavgat is located in the province of Antalya. Fifty four percent (53.68 % / 48,483 ha) of the conservancy area is forested. A total of 555 fires were reported in the unit between 1978 and 2002, affecting an area of 2,908 ha. The study area falls in one of the most fire sensitive areas. Manavgat Region has 2.6 times higher fire danger and 1.9 times higher burnt space than the average of the region.

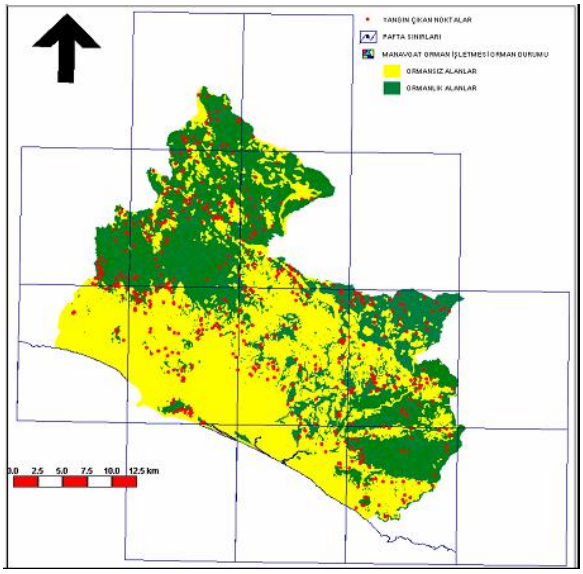

Figure 1. Forested (green) and non-forested (yellow) areas and fire incidences in Manavgat.

2.2 Method

In this study, GIS softwares like Geomedia Professional 4.0, Microstation 95, MF Wofks and IRAS/C are used. Digital and topographic maps (1:25,000 scale) from the General Directorate of Mapping and stand maps of Manavgat were obtained. All maps are rectified according to European 1950 and Universal Transverse Mercator datums.

Some parameters which affect the fire risk and danger, and others needed for prevention and suppression like stand types, stand closure, diameter class, tree species, roads, communication lines, fire and fuel breaks, power lines, landscape relief, arable lands, urban areas, water resources etc. were determined on rectified topographic maps. In addition fire departments and watch towers have been marked also.

A total of 270 sample plots were taken in the study area for the determination of fuel types based on stand age, closure and other stand characteristics. Five fuel classes were established based on the local fuel conditions. For this purpose, maquis and degraded Calabrian Pine (*Pinus brutia*) stands up to 600 m a.s.l. are designated M1, high fire risk areas consisting of young natural and plantation forests as M2, young stands with natural pruning as M3, stands with fuels breaking vertically as M4, and old Calabrian Pine together other tree species stands are designated as M5.

The study area was divided into 136 parts by a grid of 3x3 km in order to evaluate statistical data. 128 of which included forest and is used in the calculations. Two dependent and 21 independent variables were used in the analyses. These variables in each square included forest area (FA), forest area percentage (FAP), non-forest area percentage (NFAP), stand index (SI), agricultural area percentage (AAP), percentage of settlement area (SAP), agricultural and settlement areas border with forest (ASB), population (P), total road (TR), forest area per capita (FAPC), agricultural area per capita (AAPC), interrelation per capita (IPC), road length per capita (RLPC), powerline (PL), average altitude of forest on each square (AAF in Sq.), frequency of wildfire (WF), average slope of square forest (ASF), slope effect on wildfire (SEWF), slope and direction effect on wildfire (SDEWF).

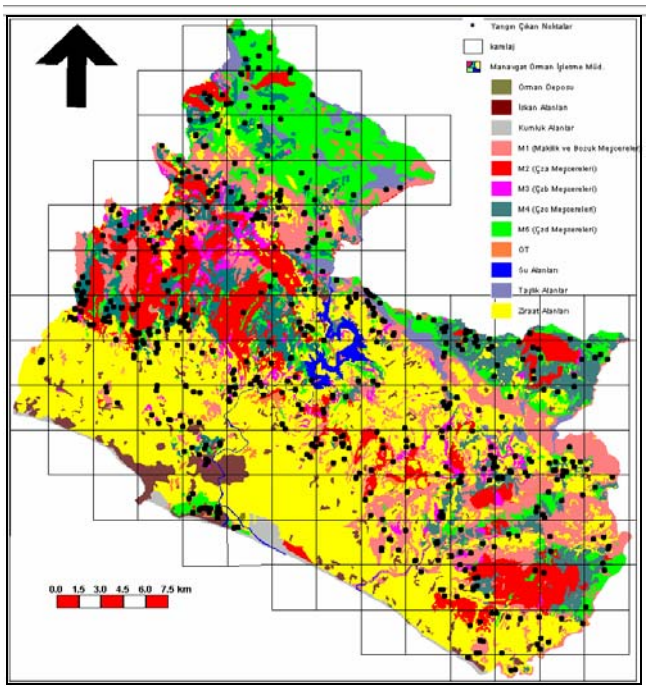

Figure 2. Classified fuel types, non-forested areas (yellow) and the past fires over the Grid system.

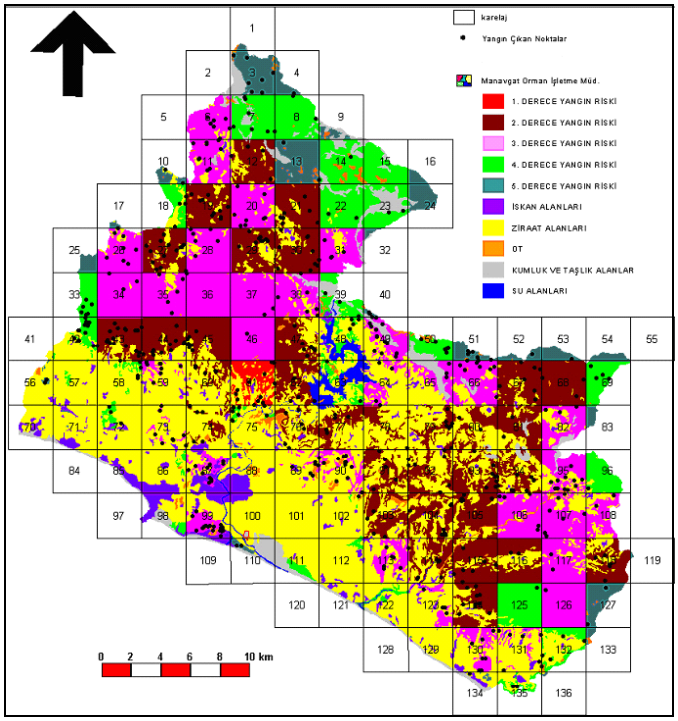

Figure 3. Fire risk map for the study area.

Construction of fire risk and fire danger maps

Using the independent variables, fire risk and danger for 136 squares are calculated and classified. In the classifications, non-forest areas were assigned “0” value. For the other squares, fire risk and danger values were calculated using the regression equations. Difference between minimum and maximum values is divided into 5 and the interval value is found. Depending on this interval values, 5 different classes were obtained for fire risk and danger.

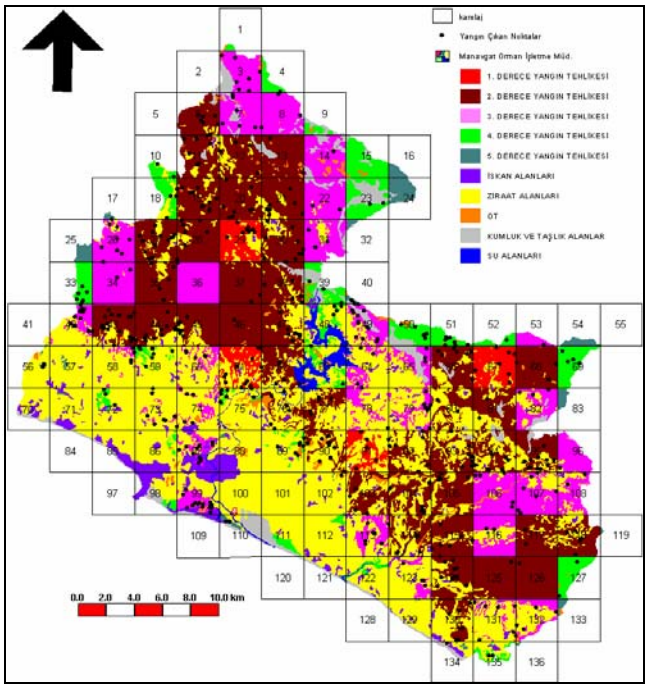

Figure 4. Fire danger map for the study area.

3. Results and discussions

3.1 Statistical analyses of the fire risk

In the analyses, fire risk and number of fires were used as dependent variable and forest areas, percentage of forest, agricultural settlements, without forest areas, total roads, agricultural and settlement areas bordering with the forest, population, forests per capita, agricultural land per capita, rate between population and interrelation, road length per capita, power lines, frequency of wildfire altitude and forest altitude were used as independent variables. Using the Backward method, dependent and independent variables were evaluated for direct regression analyses and reliability level is found as 90-95%. Agricultural and settlement areas bordering with the forest and total road variables had the highest correlation.

The model including the independent variables forest area, total road, rate between population and interrelation, per capita forest area was accepted as the regression model. The model explained 50.3 percent of the observed variation. The regression equation was:

Y= 10.972 +0.01126*Forest area + 0.0002334*Total road + 0.0002993*rate between population and interrelation – 0.101*forest area per capita

Using this equation, fire risk points are calculated, minimum and maximum points are found for each square. Interim values of fire are shown in Table 1.

Table 1. Forest fire risk values

Fire Risk Classes	Fire Risk Level	Classification values	Colour
1	Very high	31.9 – 37.1	Red
2	High	26.7 – 31.8	Bordeaux
3	Medium	21.5 – 26.6	Viola
4	Low	16.3 – 21.4	Light green
5	Very low	11.0 – 16.2	Dark green

3.2 Statistical findings about the fire danger

In the analyses, fire danger, burned area were used as dependent variable and forest area, without forest area, total roads, agricultural and settlement areas bordering with the forest, population, average slope of the forest square, slope effect on wildfire, slope and direction affect on wildfire, stand index and forest altitude as independent variables. Using Backward method, dependent and independent variables were evaluated for direct regression analyses and reliability level was found 90-95 %. Analyses showed that forest area (0.501), agricultural and settlement areas bordering with the forest (0.456), total road (0.400) and slope and direction affect on wildfire (0.376) variables had high correlation.

Model which included forest area, total roads, rate between population and interrelation, altitude frequency, forest altitude, slope and direction affect on wildfire and stand index variables was accepted as the regression model. The model explained 44.5 percent of the observed variation. The regression equation was:

Y= 4.051 + 0.0006179*Forest area + 0.00007899*Total roads + 0.0001678*rate between population and interrelation – 0.00528*altitude frequency + 0.007756*forest altitude + 1.107*slope and direction affect on wildfire + 0.309*stand index

Using this equation, fire risk points were calculated, and minimum and maximum points found for each square. Interim values obtained for the fire risk map are shown in Table 2.

Table 2. Forest fire danger values

Fire Danger Classes	Fire Danger Level	Classification values	Colour
1	Very high	22.1 – 25.0	Red
2	High	19.1 –22.0	Bordeaux
3	Medium	16.5 – 19.2	Viola
4	Low	13.7 – 16.4	Light green
5	Very low	10.8 – 13.6	Dark green

3.3 To obtain fire risk and danger maps

Using the results of the regression equation, fire risk and danger classification maps were made. The area was classified as a first-degree fire sensitive area. This classification agrees well with the one by Yücel (1987).

Total land area is 90,314 ha, of which 48,483 ha are forested. When whole area is considered first-degree fire sensitive, there exist many disadvantages for fire fighting. So, in order to make a better classification, whole area divided by 5 different sensitivity classes for fire risk and danger. With this information it will become easier to set up an effective fire fighting organization and improve fire suppression efficiency.

4. Conclusions and suggestions

The findings from this study carried out in Manavgat Local Forest Directorate are parallel to previous studies. It was found that there were a linear correlation between fire risk and some parameters such as population, population activities, agricultural activities, roads, etc. Since there was a close relationship between the fire frequencies and road density, it became clear that we should be more selective in construction of roads within the forest. Given the recent fires of high destruction at the wildland urban interface in many countries, prevention measures should be taken in and around forest settlements, tourism facilities and secondary residences.

The purpose of the study is to establish primarily fire resistant forests by making use of GIS technology. It is also within the framework of this study to determine the higher fire risk and danger areas under certain conditions using non- or slow changing criteria such as vegetation types, amounts of flash fuel, steepness, exposure and altitude, and fast changing criteria such as climatological data.

Such a pre-estimation may greatly hinder the start of wildfires and may increase the effectiveness of fire suppression activities and at the same time decreases the fire fighting costs. Whereas the interest shown in extinguishment of the fires and the huge investments made in this direction are accepted wholeheartedly, the budgetary allocations of the investments are not sufficient for the activities directed towards the prevention of the fire. The determination of the risk and danger classes will create a firm support to those who defend this thesis.

The databases for fuels and the topographic particularities in this study would be of assistance in making fire behaviour and simulation models. Besides, particularly the data obtained from the GIS environment could be easily used in different forestry studies.

It has become evident that there is an insufficiency of information required in the form of the fire register cards used in the course of this study. The preparation of the fire cards as stand document through a disposition would be an important phase in working out the fire control policies at the regional and national level. A more comprehensive fire database should be established.

Fire risk and danger maps obtained as an output of the project will constitute a basis for the development of justifiable understanding of the fire in the operation field. This study is capable of becoming an example for localities similar in various respects.

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Determination of Fire Danger Based on Weather Measurements Using GIS: A Case Study in Southern and Western Turkey

Abstract

This study presents fire danger for fire prone areas in southern and western part of Turkey. Fire danger was determined based on statistical models developed to predict fuel moisture contents based on weather conditions in normally stocked, even-aged red pine and black pine stands. Geographical Information Systems (GIS) was used to analyze and report the results of the study.

In the case study, fuel moisture contents for 13 different regions were calculated based on daily weather data for the last 11 years during the fire season (April to October). Then digital fire danger maps were produced using GIS. Fire danger was divided into four groups based on fuel moisture contents; low (>%30), moderate (%20-30), high (%10-20), and extreme (%0-10). This way, day to day changes of fire danger among the regions could easily be mapped. The results obtained should be invaluable in all phases of fire management planning.

Introduction

Forest fires have a profound effect on and one of the most important factors threatening the continuity of forest resources in Turkey. The ability to predict fire danger in any area and make the fire planning based on this prediction is extremely important in overall fire management planning. In order to predict fire danger, it is necessary to have comprehensive knowledge of fuel characteristics and fire weather effects on fire danger. The conditions required for a successful fire ignition are related to moisture contents of fine fuel and duff layer on the forest floor (Olsen, 1960; Schroeder, Buck, 1970; Montgomery and Cheo, 1971; Countryman, 1974).

In the recent years, many countries have had their systems set up to calculate fire danger potential based mostly on fire weather measurements. These systems are generally called “Fire Danger Rating System (FDRS). Fire Danger Rating Systems developed to predict fire potential and rate fire danger are decision support tools for fire organizations through providing the needed information. For the system to function properly, information gathered should be accurate, timely and in a usable form. Existing forest inventories have been prepared for necessities of varies forest services and so have different forms. Here, systems are required to collect, store, integrate, manipulate, analyze, and display spatially oriented information in a form necessary for wildland fire planning. In this regard, GIS, which have many application fields, can be quite useful (Bilgili, 1999). One of the most important features of GIS is that due to its capability of spatial analysis and manipulation, it is a decision support tool for fire planning, management and decision-making. Simple or complex, GIS can store, manage, analyze and manipulate geographical information which, otherwise, is not possible to realize by classical methods (Bilgili et al., 2002). GIS could be used effectively for fire prevention, fuel management, pre-suppression and suppression planning.

In this study, fire danger situations were determined for fire prone areas in the southern and western part of Turkey using statistical models (Sağlam, 2002) which were developed to predict fire danger based on the relationships between weather and fuel moisture contents in normally stocked even-aged red pine and black pine stands. Fire danger situations were mapped using GIS and suggestions presented for overall fire management planning.

Material and Methods

This study presents fire danger situation for 13 different regions based on models developed to predict fuel moisture content in standard fuel types and assessments on digital map produced using GIS.

The location of meteorological stations, daily meteorological data derived from these stations and the digital map coverage obtained from completed project (GISLAB, 2002) were entered into the GIS, and fuel moisture contents of 13 different region were calculated using fuel moisture prediction models (Sağlam, 2002). Then, fire danger situation maps were produced using the database. Fire danger was divided into four groups based on fuel moisture contents; low (>%30), moderate (%20-30), high (%10-

20), extreme (%0-10). Finally, daily fire danger situations were determined based on meteorological parameters for different regions. Arc/Info™ and Arc/View™ GIS software (ESRI, 1993; 1996) were used to store, analyze and display the results.

Results

Fire danger between the neighbouring regions showed differences during the same days. Figure 1a shows that fire danger calculated based on Fine Fuel Moisture Content (FFMC) was high and extreme on 2 May on Aegean and Mediterranean coasts while it was low and moderate in the inner part of Aegean and Marmara regions. For 6 May fire danger generally increased in some areas, which previously had low level of fire danger on 2 May, especially in the inner part of Aegean region while fire danger decreased in the Mediterranean region (Figure 1b). On the following day, on 7 May, fire danger decreased in some parts of Aegean and Mediterranean coast (Figure 1c).

According to Duff Moisture Contents (DMC) calculations, on 2 May, fire danger was moderate only in Mersin province in the Mediterranean region and low in the others (Figure 1d). In some of these regions, high and extreme fire dangers occurred on 6 May and 7 May (Figures 1e and 1f).

As for the month of July, The fire danger and ignition potential were relatively higher as expected. According to the FFMC, fire danger was high and extreme in the Aegean and Mediterranean regions on 1 July and 5 July (Figures 2a and 2b) but low in the upper portion of Aegean and Marmara regions on 6 July (Figure 2c). According to DMC, especially on 5 July, high fire danger was noted in the part of Aegean and Mediterranean coast (Figure 2e).

According to FFMC, the assessment of fire danger situation with respect to region for September indicated that fire danger was higher in Mediterranean region than in Aegean on 8 September, and fire danger was low especially in the inner part of Aegean and Marmara region (Figure 3a). As for 11 and 15 September, fire danger was high and extreme on the south of Marmara, Aegean and Mediterranean coast (Figures 3b and 3c). Figure 3d shows that fire danger that was calculated based on DMC was high only on the Mediterranean coast, and moderate in other areas on 8 September. For 11 September, in the whole area fire danger was low and moderate (Figure 3e), and for 11 September, no danger was present except for the province of Izmir, Adana and Mersin (Figure 3f).

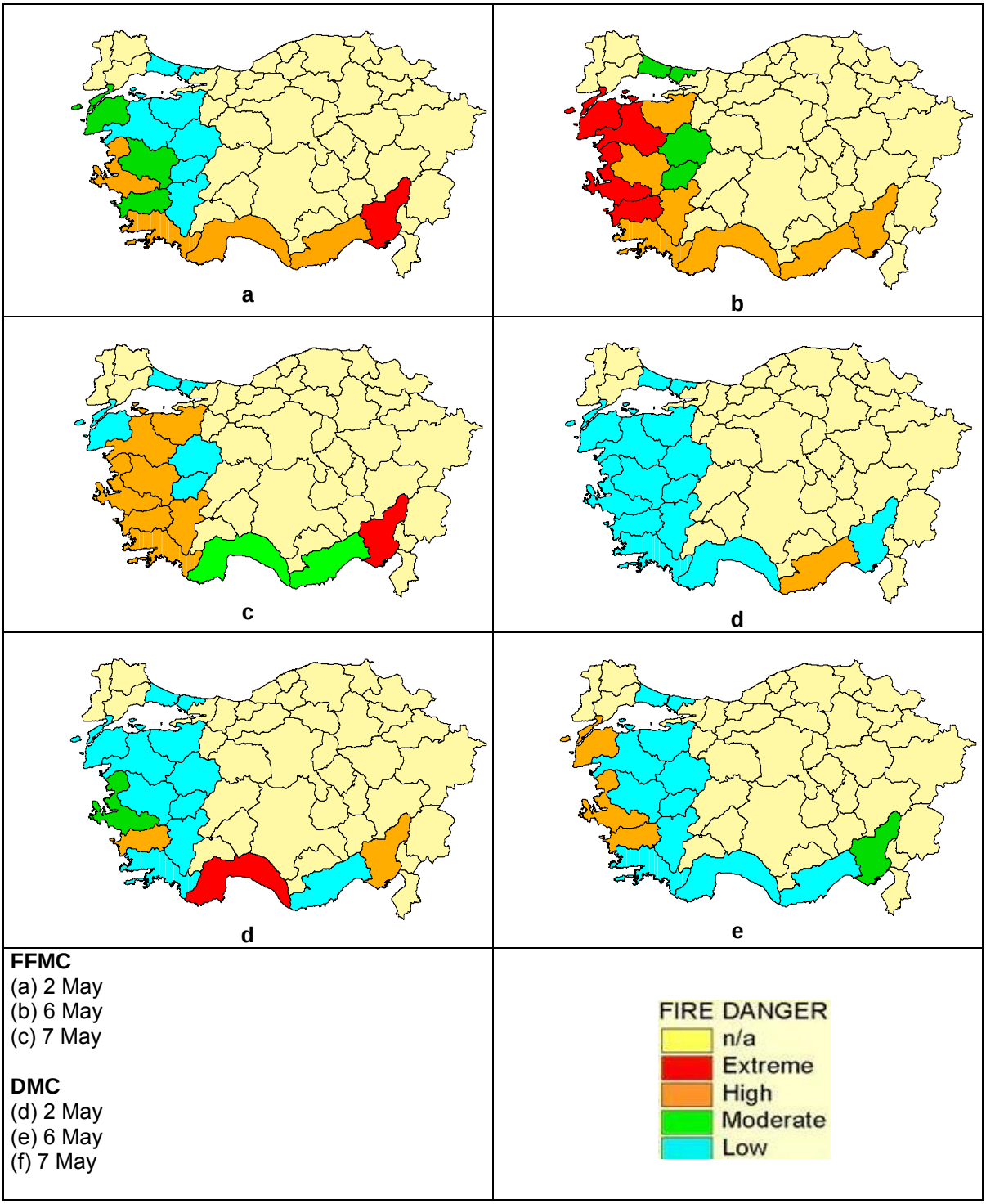

Figure 1. Fire danger situations based on Fine Fuel Moisture Content (FFMC) and Duff Moisture Content (DMC) in early May in Southern and Western Anatolia, Turkey.

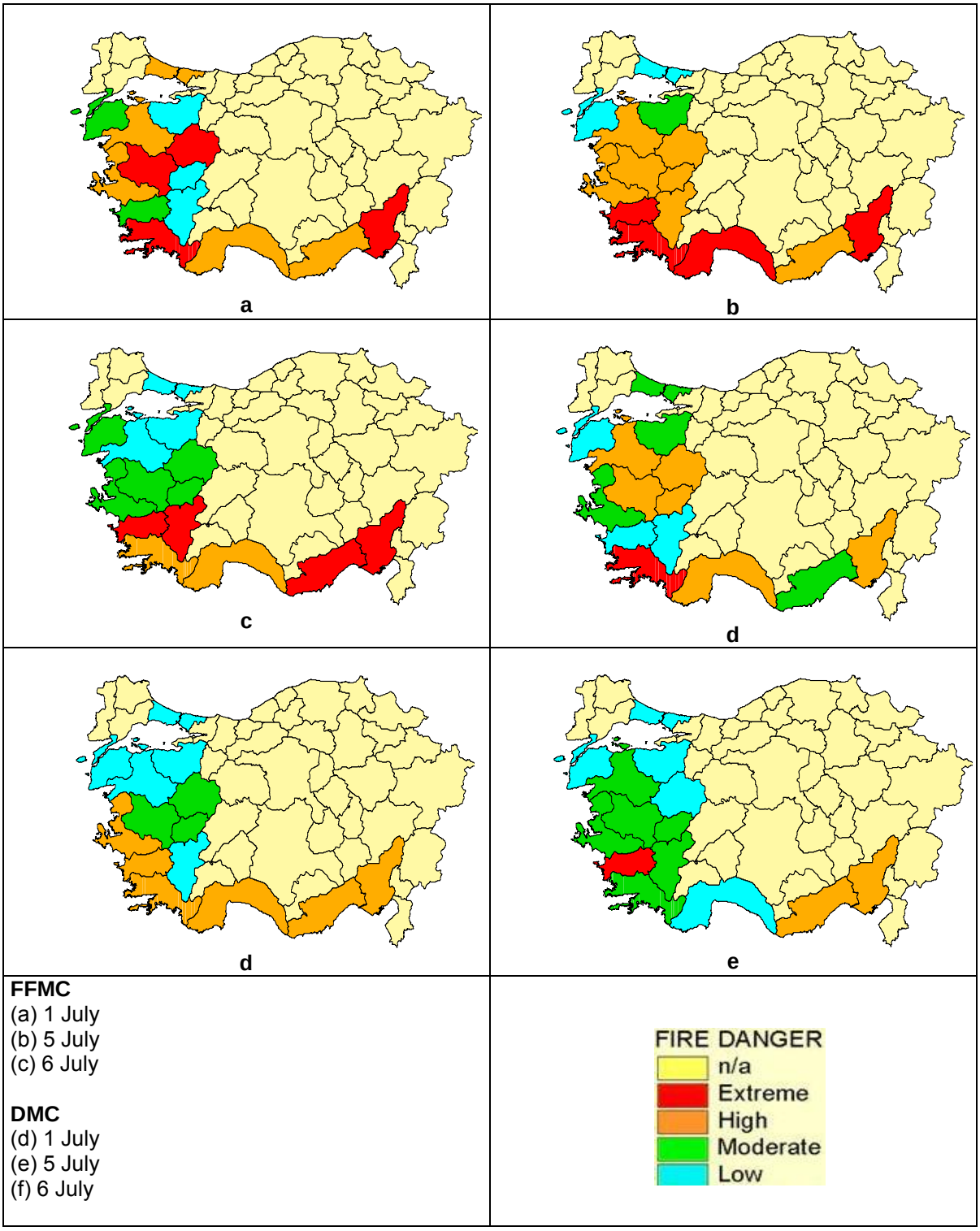

Figure 2. Fire danger situations based on Fine Fuel Moisture Content (FFMC) and Duff Moisture Content (DMC) in early July in Southern and Western Anatolia, Turkey.

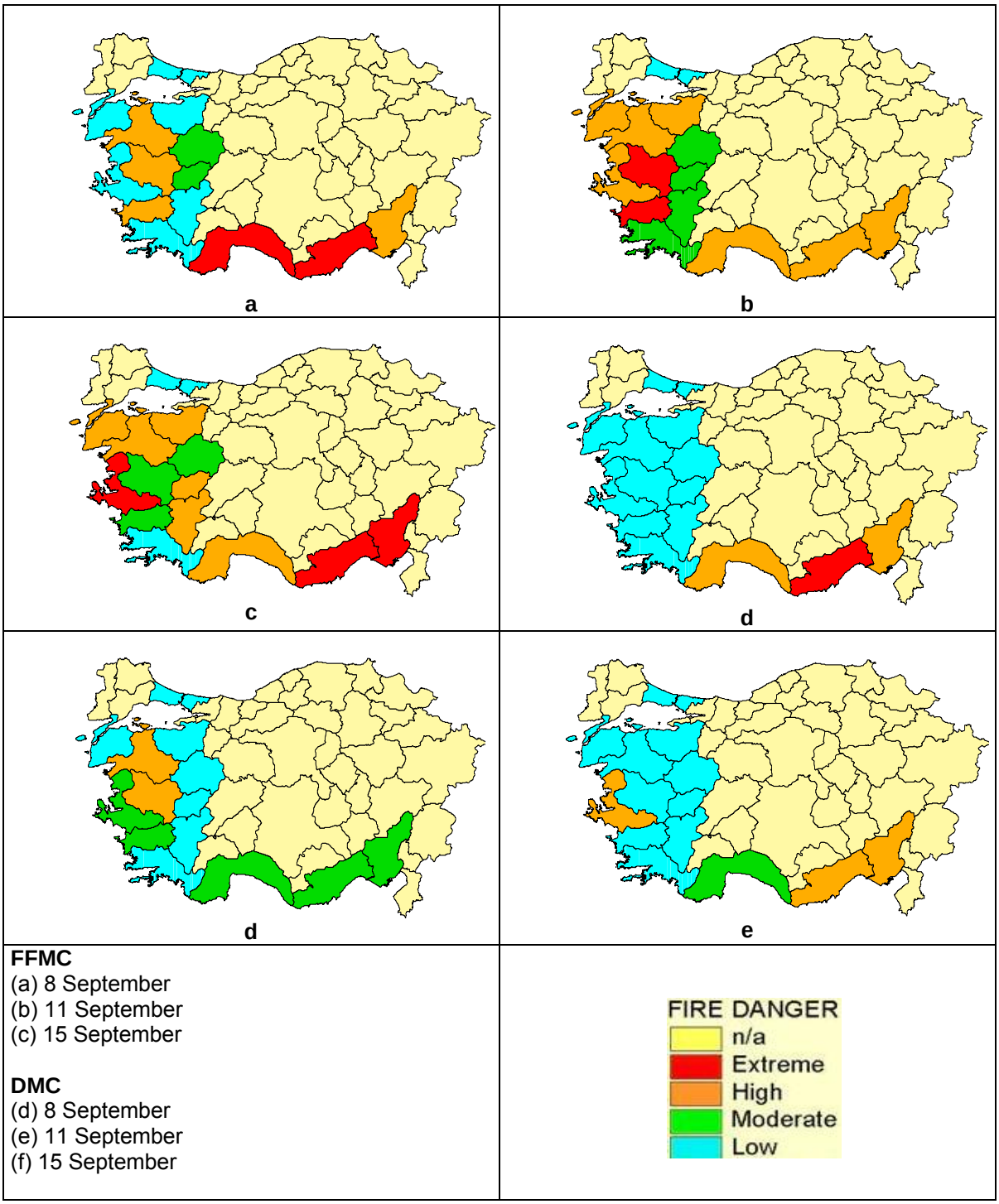

Figure 3. Fire danger situations based on Fine Fuel Moisture Content (FFMC) and Duff Moisture Content (DMC) in September in Southern and Western Anatolia, Turkey.

Discussion

In this study, fire danger situations were determined for the fire prone areas in the southern and western part of Turkey using statistical models which were developed to predict fire danger based on the relationships between weather and fuel moisture contents. Great differences occurred in fire danger, especially in ignition probability as exemplified by the FFMC, on different days in different

regions. These differences were a result of the variations in weather. The results presented in this study clearly shows that fire danger rating is extremely important and should, therefore, be a part of any fire organization.

Fire danger situation for an area where meteorological parameters are available can easily be determined and then presented to fire organizations. But, predictions are only as good as the quality of the weather measurements used in the predictions. It is, however, difficult to obtain fire weather measurements in many areas of Turkey since the network of meteorological stations do not effectively represent the whole area in question. Thus, the fire weather network should immediately be completed in all fire prone areas of the country.

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A Critical Approach to the Calculation Method of Economic Value of Forest Fire Damages in Turkish Forestry: A Case of Forest Enterprise From Mediterranean Region

Abstract

The paper presents an approach to calculate fire damage in a forest area from the forest economics standpoint. The damage calculated using the approach presented here and the one determined by the State Forest Enterprise were compared for a burned area in Kumluca State Forest Enterprise, Antalya. When the land revenue from area, the general administration costs and the alternative costs of the labour used for extinguishing the fire (out of SFE's staff) are taken in to consideration, it seems that about 26.6 billion Turkish Liras (TL) (= $US 42,980) have been ignored. This is approximately 12 % of the compensation value calculated by SFE.

Keywords: Sustainable forestry, Turkish forestry, Forest fires, Economic value of forest fire damages.

1. Introduction

Today, the rapid population increase and technological developments increase the importance of effective, productive and most importantly sustainable use of forest resources. At this point, sustainable forestry plays a key role in attaining the goal of sustainable development. However, there are some biotic and abiotic factors affecting the sustainable forestry (Türker et al., 2001a).

Turkish forests are under the threat of many factors such as forest fires, insect, fungus, storm, snow, pollution and illegal uses. As in all other countries of the Mediterranean basin, forest fires are one of the most important destruction factors both environmentally and economically. In Turkey, 58% of forests have sensitive characteristics regarding the forest fire (GDF, 2002).

In Turkey, the calculation method of fire damage is quite inadequate in its current application. Because the General Directorate of Forestry (GDF) is only taking into consideration the market value of products burned and the suppression and reforestation costs. So, there are some criticisms from the interest groups, especially Non-Government Organisations (Türker et al., 2002).

The purpose of this paper is to propose an approach to calculate fire damage.

2. Materials and Methods

Along with the relevant literature on forest fires and statistical information in Turkish forestry, the management records of an area burned in 2000 in Kumluca State Forest Enterprise, Antalya were also used as a research material in this study.

In the study, firstly some basic theoretical information is given about the determination of approximate value of forest fire damage from a forest economics standpoint, and then the economic value of forest fire damage is determined. Lastly, to evaluate the current method in Turkish forestry, economic value of the forest fire damage calculated for a sample area has been re-calculated by also taking into consideration some of additional cost items that should be calculated and the result has been compared with previous result.

3. Findings

3.1 Determination Methods of Forest Fire Damages

3.1.1 Determination of Approximate Damage Value in a Forest Fire from Forest Economics Perspective

The types of damage can be classified as below (Firat 1971; Acun 1976; Firat and Miraboğlu 1977):

- Damage arisen from cutting the stands in the fire area earlier
- The loss of revenue obtained from the land during the years when it is unplanted
- The share of the burned land in administrative expenditures during the years when it is unplanted
- The level of damage caused by fire to the surrounding forests
- The loss from problems in management plans and decreases in non-wood forest products
- The cost for changing or redesigning the management plans
- The damages to the wildlife
- The decrease socio-cultural services of forests
- Damage caused by fire in environmental values
- Damage caused by fire in recreational services
- Damage caused by fire in watershed
- Reforestation costs
- Damages occurred out of forest

3.1.2 Currently used Method of Forest Fire Damages in Turkish Forestry

The damage value at the end of forest fires is calculated as follows (Türker, 1997; Anonymous, 2002; GDF, 2000; Türker et al., 2001a; Türker et al., 2002):

- After fire, a technical person on site prepares a Fire Damage Report. The damage level of seedlings, growing stock damaged by fire, the necessity of reforestation and also level of reforestation, the percentage of non-valuable part of growing stock burned by fire and the feeding expenditures made for people who work in forest fire are calculated based on the values in this report.
- The growing stock obtained after fire and not valued in market is classified as timber, mine pole etc. and its volume is determined in terms of volume according to current values in the management plan.
- The market value of growing stock damage is calculated by multiplying these volume values with the unit price determined by the relevant SFE according to Forest Law No: 6831 and article 112, by extracting the harvesting, transportation and stacking costs from the average value of auction sales in the relevant year.
- Then, the reforestation costs are calculated by multiplying the amount of the area which must be reforested after fire with the unit cost of reforestation determined by the relevant SFE according to Forest Law No: 6831 and article 114.
- On the other hand, costs of fire suppression (costs for machine use and food for workers) are calculated according to the Fire Damage Report.

In brief, the total damage cost arisen from a forest fire for a forest enterprise is the sum of market value of output burned by fire, reforestation cost, suppression cost and expenditures for the workers including the expenses of petrol and oil etc. necessary for cars. The decreases in the economic, environmental and social values due to burning is not taken into consideration in the calculations.

3.2 Economic Evaluations of Forest Fire Damages in Turkish Forestry: Kumluca SFE Example

3.2.1 Calculation of Forest Fire Damages with Current Application: Kumluca SFE Example

Here, a 417 ha forested area burned in 2000 is used as an example. The types of damage and values calculated by the relevant SFE are shown in Table 1 (Anonymous, 2000).

Table1. Types and Values of Damages caused by Forest Fire according to SFE

Damage Types	Damage Values	
	(x 1000 TL)	$US [1]
Timber Damage	80 352 000	129 991
Reforestation Cost	118 932 570	192 405
Extinguishing Cost [2]	27 981 695	45 268
Total Damage Value	227 266 265	367 664

[1] 1 $US = ~620,000 TL (as of time of writing the manuscript)
[2] Extinguishing costs include food, fuel, and premium for workers and helicopter costs etc.

The damage types taken into account were timber damage, reforestation cost and extinguishing cost. Since there were no seedlings in the burned area, any damage calculation related to the seedlings was not made.

3.2.2 Damage Types Added to Damage Calculations

As a result of comparing the method currently applied by GDF in Turkish forestry to determine the economic value of damage occurred after fire with a new method developed from a forest economics standpoint, it is possible to state the following evaluations (Firat, 1971; Acun, 1976; Ünal, 1990; Türker, 1997; Türker et al., 2001a; Türker et al., 2002).

3.2.2.1 Deprived Revenues While Forestland Unplanted Following the Fire

In the current application, after fire, the loss of revenue, which the SFE will be left without revenues from the forestland during the years that might be unplanted, is not included in the damage value. In another word, after a fire, if the forest area burned by fire cannot be replanted by SFE for any reason, the revenue from forest area for the years the land remain unplanted should be included in the damage calculation.

This is calculated by using the following formula (Firat and Miraboğlu 1977; Miraboğlu 1979):

$$K_0 = \frac{B(1.0P^n - 1)}{1.0P^n}$$

Where; K_0 is the revenue from the land for empty years, B land value, n period that the forest area remained empty after fire, p interest rate.

Here, B land value is a value used by GDF to use for land allocations and calculated as equivalent of the loss arisen from destruction of forest area and the decrease in the performance capacity of site. This value was calculated for the year of 2000 as 400 million TL/ha. Research area remained empty for 2 years (n) and P interest rate is taken as 3 %. According to these data, the revenue from the land for empty years can be calculated as follows:

$$K_0 = \frac{400000000(1.03^2 - 1)}{1.03^2} = 22{,}961{,}636 \text{ TL / ha}$$

As the forest area burned by fire is 417 ha, the total revenue from the land is as follows:

417 x 22,961,636 = 9,575,002,212 TL (= $US 15,490)

3.2.2.2 General Administration Costs While Forestland Unplanted Following the Fire

In the current application, the share of the forest area in general administration cost is not reflected in fire damage costs. After forest fires, if it is impossible that the forest areas burned by fire are replanted by SFE, the share of forest area in the general administration expenditures which the SFE must spend every year should also be reflected in fire damage costs. But, these items have also been ignored in the calculation of fire damage value.

It is also possible to calculate the share of the forest area burned by fire in the general administration expenditures for empty years as follows:

$$K_0 = \frac{v(1.0P^n - 1)}{0.0P \times 1.0P^n}$$

Where, K_0 is the capital value of the general administration expenditures spend during empty years after fire, *v* annual general administration expenditure per ha and *p* forestry interest rate.

The general administration cost has been calculated as 4,587,707 TL/ha for Kumluca SFE in 2000 (Anonymous, 2000). As the area has been remained 2 years as unplanted and interest rate is accepted as 3%, the administration cost per ha is

$$K_0 = \frac{4587707(1.03^2 - 1)}{0.03 \times 1.03^2} = 8{,}778{,}427 \text{ TL / ha}$$

Then, as total area is about 417 ha, the share of the forest area in the general administration costs is

8,778,427 x 417 = 3,660,604,059 TL (= $US 5,922)

3.2.2.3 Alternative Labour Costs

In current application of Forest Damage Report, the expenditures done for work machines used for fire suppression and food costs for suppression workers have been calculated. Thus, the damage value is under its real value. Furthermore, the alternative costs of labour force, motor/less vehicles, helicopter, chemicals etc. used in extinguishing the forest fires should be calculated.

Tens, some times, hundreds of people, soldiers, obliged person and the other citizens, work night and day to extinguish forest fires. To determine the reel cost of forest fire suppressions, the alternative costs of this labour force must be included in the calculation of forest damage value.

179 people including soldiers, forest villagers, and dweller in surrounding places, worked in example forest fire. The alternative labour costs of these persons can be determined by the formula (Türker et al., 2001a):

$$ALC = P \times W \times T \times D$$

Where; *ALC* is alternative labour cost, *P* the number of person worked in forest fire, *W* average wage per hour, *T* average working time in a day, *D* the number of working day.

Of 513 people who worked in the fire, just 334 persons are employees of the SFE, the remaining (A) 179 are not (Anonymous, 2000). According to the data provided by State Institute of Statistic, the average wage per hour for December of 1999 was 1 330 000 TL (SPO, 2000). And also, (C) 8 hours is accepted as the average working time in a day. Since the fire was put out in 7 days, the number of working day is accepted (D) 7 days. Using these data, the alternative labour cost is calculated as:

ALC = 179 x 1,330,000 x 8 x 7 = 13,331,920,000 TL (= $US 21,568)

3.2.2.4 Some Other Damage Types

When the damage value concerning the growing stock is calculated in Fire Damage Reports prepared by the SFEs, only cutting value of growing stock is taken into account. This value may indicate true results for mature stands. But it will not be appropriate for other stands that are midway through the developmental stages. Because the growing cost value stock calculated for young stands or the growing stock expectation value for the stands at the middle ages will be more than the calculated growing stock cutting value.

In our example, the cutting age for the stand in management plan is 60 year and burned stand age is about 40 or 50 years. Thus, cutting value of growing stock found in Fire Damage Reports prepared by the SFEs can be substituted for the damage value for growing stock after fire. Similarly, the costs of

physical and moral damages incurred during the fire should be added to the fire suppression costs. In addition, the every kind of health expenditures must also be added. The cost of every kind of protective measures to be taken and staff and equipments to be appointed should be subjected to the calculations. If the backfire technique is used to prevent the current forest fire, the damages arisen from second fire should also be added to the compensation. Such items were not added to the calculations in this study, as simply these were not present.

One other deficiency in the Fire Damage Reports prepared by the SFEs is that the loss of non-wood forest products is not reflected to the calculation of fire damage compensation. To eliminate this deficiency, firstly, the inventories of national forests' secondary products or non-wood forest products should be completed and according to the type of annual or periodic utilisation from these resources, the revenue deprived by the SFE should be subjected to the compensation. As there is no available inventory of non-wood forest products for the forest area burned by fire as well as for all over the country, such a calculation couldn't be realised.

3.2.3 Comparison of Current Calculation with that of the proposed Calculation

When the land revenue from area, the general administration costs and the alternative costs of the labour used for extinguishing the fire (out of SFE's staff) are taken in to consideration, it seems that about 26.6 billion TL ($US 42,980) have been ignored. This is approximately 12 % of the compensation value calculated by SFE. When the other items mentioned above are added to the damage value in future, it is obvious that the reel damage value would reach greater values. Adding the suggested damage types to the damage calculation caused damage value per ha to increase from $US 882 to $US 985.

Table 2. Comparison of Current Calculation with Suggested Calculation

Damage Types		Damage Values		
		(000 TL)	**$**	**$/ha**
Current Application	Damage Value Calculated by Kumluca SFE	227 266 265	367 664	882
Added Damages	Deprived Land Revenues	9 575 002	15 490	37
	General Administration Costs	3 660 604	5 922	14
	Alternative Labour Costs	13 331 920	21 568	51
	Total Added Damage Values	26 567 56	42 980	103
Total Damage Value		253 833 791	410644	985

4. Conclusion and Recommendations

There is some negativity such as clearing for agricultural purposes, illegal cuttings, grazing, forest fires etc. obstructing the management of forest resources according to the multiple use and sustainability principles in Turkey. The forest fire is one of the negativities occurred in Turkish forestry (Türker et al., 2001).

The cost of damage occurred as a result of forest fires was calculated as US$ 9,604,402 for the whole country in 2002 in Turkey (GDF, 2002). However, this amount indicates only minimum damage because of the reasons mentioned above.

In Turkey, people are a main factor causing the forest fires. In this case, it is important that human being must be taken into consideration for the protection of forests from fires. Especially, the training of a part of society related to the forests is required. Also it is necessary to determine the economic aspect of fire damage (Türker et al., 2001a).

It is seen that the damage value reaches to 26.6 billion TL (US $ 42,980). This is about 12 % of the damage value (227.3 billion TL = $US 367,664) calculated by using current application for the sample forest area. This is just a result of adding the three items to the damage value calculation. However, as

the other items that cannot be added to the calculation because of various reasons are taken into account, the damage value in question will reach to greater figures.

On the other hand, the forest fires are also a negative externality for forest resources and forest management activities. In this case, the compensation value calculated according to this approach will indicate the minimum compensation value, although all cost items are taken into account. Because, that a forest area is destroyed by fires, it means that it will be deprived of many positive externalities such as erosion prevention, regulation of water regime, carbon storage etc. provided by that forest area (Türker et al., 2001b). Consequently, considering the positive externalities deprived as a result of forest fire, it is seen that the calculation of real compensation value is very difficult and the amount calculated shows only minimum value of compensation.

In the calculation of current fire damage compensation in Turkish forest management, in the short run, a few items might be added to the calculation by using available inventories. In the middle and long run, other cost items can also be added to the calculation when transforming into intensive forest management practices. To reflect this damage calculation approach into current application, related legal framework should be revised.

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The Impact of Forest Fire Damages on the Total Economic Value of Forest Resources in Turkey

Abstract

Forests like other natural resources perform a set of functions to meet the needs of people. It is usually impossible to state the monetary value of all goods and services provided by forest resources in most countries. These goods and services are generally called as non-market goods and services. Therefore, the valuation of non-market goods and services as a research area is receiving greater importance rapidly in Turkey as well as in other countries.

The sum of all values, which a natural resource has, is accepted as Total Economic Value (TEV). There is no definite and rigid rules about the components of TEV and therefore, many different approaches have been discussed about this concept. In another word, the items forming the TEV are classified into main and sub-components such as positive and negative externalities or use, non-use, option, existence and bequest values.

The negative externalities such as erosion, forest fires and illicit fuelwood consumption have a negative impact on the TEV of Turkish forest resources. The economic value of negative externalities reduce the TEV from $US 1,071,087,995 to $US 897,480,458. According to the result of this study, the impact of forest fire damage is 5% of total negative externalities.

In this study, the TEV concept will be reviewed briefly for Turkish forestry, and then the negative externalities of Turkish forests as its TEV components will be presented and lastly the negative impact of forest fire damages currently calculated and to be calculated by adding some new items on the TEV of Turkish forest resources will be discussed as far as possible from the social-economic and environmental points of views.

1. Introduction

Forests like other natural resources perform a set of functions to meet the needs of people. It is usually impossible to state the monetary value of all goods and services provided by forest resources in most countries. These goods and services are generally called as non-market goods and services. Therefore, the valuation of non-market goods and services as a research area is getting importance rapidly in Turkey as well as in other countries.

The sum of all values, which a natural resource has, is accepted as Total Economic Value (TEV). There are no definite and rigid rules about the components of TEV and therefore, many different approaches have been discussed about this concept. In another word, the items forming the TEV are classified into main and sub-components such as positive and negative externalities or use, non-use, option, existence and bequest values (Perman et al., 1995; Adamowicz, 1995; Merlo and Briales, 2000; Türker et al., 2003a).

As the forests occupy so much space in the World, forestry necessarily involves positive and negative externalities. As sustainable natural resource, forests produce many positive externalities or external economies, such as regulation of climate, conservation of biodiversity, carbon storage, erosion control and other non-wood values. Conversely such biotic and abiotic events as faulty management practices, erosion, avalanche, forest fires, are examples of negative externalities to forestry (Türker et al. 2003b).

Forest fires are one of the most important destruction factors causing the big losses of forest economics and the national economy by destroying the Turkish forest resources. About 58 % of Turkish forests are sensitive to forest fire (GDF 1999).

Although the extents of threats and damages constituted by the forest fires occurring in Turkey are extremely important, the calculation method of fire damage compensation and the relevant damage varieties subject to the compensation are quite inadequate in current application. Because the General Directorate of Forestry (GDF), which is the most important organization that all forest management activities are undertaken as connected to the Ministry of Forestry, is taking into consideration the market value of products burned in the relevant area and the costs of reforestation and extinguishing

relating to the burned area in the calculation of fire compensation (GDF 1999). Therefore, there are some opinions and criticisms arisen from the target groups, which are directly or indirectly interested in forestry, especially Non-Government Organizations about the very low amount of fire damage calculated by the GDF (Türker et al., 2001).

On the other hand, forest fires, which are accepted as a negative externality of forest resource, have been thought to have a decreasing effect on the TEV of forest resources being discussed. Therefore, it is a must to accurately evaluate the fire damage on the economical value of forests. Because, the correct calculation of compensation value arisen from the fire damage is crucial task for forest manager in order to lead in to right directions. Both in Turkey and Worldwide, negative and positive externalities of forests and forestry should be determined to promote sustainable forestry and sustainable development. Forest management and administrative activities should involve these externalities. Furthermore, sustainability and multiple-use principles should be pursued (Türker et al., 2003b). In this study, the TEV concept will be reviewed briefly for Turkish forestry, and then the negative externalities of Turkish forests as its TEV components will be presented and lastly the negative impact of forest fire damages currently calculated and to be calculated by adding some new items on the TEV of Turkish forest resources will be discussed as far as possible from the social-economic and environmental points of views.

2. Total Economic Value of Turkish Forests

The value of Turkish forests annual outputs, calculated with all the reserves previously expressed, first of all limitation to values that have been calculated and neglect of many other values, can be summarized according to the components of TEV in Table 1.

Table 1. Forest Values by TEV Categories

Components of TEV	Type of Outputs	Value ($US)	%
Direct Use Values	Wood Forest Products	449,815,000	41.9
	Non-Wood Forest Products	86,044,495	8.0
	Grazing	225,000,000	21.0
	Hunting	17,800,000	1.7
	Angling	20,148,000	1.9
	Recreation	2,000,000	0.2
Indirect Use Values	Carbon storage	158,400,000	14.8
Option Value	Pharmaceuticals	112,500,000	10.5
Existence Value	Biodiversity Conservation	1,380,000	0.1
Positive TEV Components		**1,071,087,995**	**100.0**
Negative Externalities	Erosion	-125,000,000	72.0
	Forest fires	***-8,607,537***	***5.0***
	Illicit fuelwood	-40,000,000	23.0
Negative TEV Components		**-173,607,537**	**100.00**
TEV		**897,480,458**	**-**

Sources: Türker et al. (2002a) and Bann and Clemens (2001)

As seen in Table 1, the shares of erosion, forest fires and illicit fuelwood consumption in the negative TEV components, which are the negative externalities of Turkish forest resources, are 72.0%, 5.0 %, and 23.0% respectively. In this case, the biggest share in the negative TEV components of Turkish forest resources is erosion and the second one is illicit fuelwood consumption. The impact of forest fires on the total economic value of forest resources in Turkey is about 5% of total negative externalities.

3. Negative Externalities as a Total Economic Value Components of Turkish Forests

After mankind passed to settled life, they constitute pressure on the forests in order to expand their living area, to gain arable land and to graze their animals. Previously they see the forests as wood raw

material source and easily obtainable land by cutting forests. But, today, they recognized many ecological benefits supplied by forests (SPO 2001).

Due to rapid increase in population and necessity, forest resources have been destroyed and the forest areas decreased more and more. Therefore, people are more sensitive about the benefits obtained by them from forests and the negative consequences of the destruction of forest resources by fire. Some of these benefits and losses, especially unpriced with the market price, are identified as the externalities of forestry activities (Türker et al., 2003b).

Today, due to increasing importance of forest resources, the determination of externalities in the forestry practices becomes important for the society. For this purpose, various attempts at regional, national and international levels have been realised by individuals and institutions. One of these researches is an international project called as MEDFOREX, whose findings were used for evaluations in this paper, and carried out by European Forest Institution Regional Project Centre. In the coverage of this project, it is aimed that the negative and positive externalities linked to forests and forestry in the Mediterranean Countries were evaluated from the different aspects of issue (EFI, 2000).

In the coverage of watershed management, the benefits such as erosion prevention or soil conservation, preventing floods and avalanche may be expressed among the positive externalities of forests (EFI, 2000). Consequently, most of these benefits are obtained from the losses prevented by forests.

Furthermore, there are many positive externalities provided by forests such as increasing landscape quality, carbon storage, regulating climate, increasing water quality and purification, biodiversity and providing sustainability of local ecosystems (EFI 2000). Similarly, these benefits, which are also called as environmental services of forests, are quite important especially for the sustainability of natural ecosystem balances and for preserving continuously physical and psychological health of individuals in the society.

On the other hand, the negative externalities occurred by the interferences to forests can be summarised as follow: erosion, floods and avalanche events due to poor or no forest management and the losses in the landscape quality due to increasing the intensive use of forest lands may be accepted as negative externalities.

Forest fires arisen from many different reasons, the losses such as biodiversity and landscape value occurred due to plantation forestry, the losses of recreational value arisen from poor management and intensive plantation forestry might also be accepted as negative externalities of forests (EFI 2000). Currently, the economic value of forest fire damage in Turkey has been calculated as follows (GDF 1999; Anonymous 1999): [2]

General Total Loss = the loss of completely burned wood + reforestation cost + extinguishing costs
= $US 2,222,978 + U$ 4,548,601 + $US 1,835,958
= $US 8,607,537

With this figure, the impact of forest fires on the total economic value of forest resources in Turkey is about 5% of total negative externalities. The forest fires are also a negative externality for forest resources and forest management activities. In this case, the compensation value calculated according to current approach will indicate the minimum compensation value, although all cost items are taken into account. Because, that a forest area is destroyed by fires, it means that it will be deprived of many positive externalities such as erosion prevention, regulation of water regime, carbon storage etc. provided by that forest area (Türker et al., 2002a). Consequently, considering the positive externalities deprived as a result of forest fire, it is seen that the calculation of real compensation value is very difficult and the amount calculated shows only minimum value of compensation.

In Turkish forest management, one of the most important reasons of using such a method in calculation is that the production of wood raw material based forest products is considered and applied as a priority goal. Therefore, in the forest resource subject to fire damage, the calculation of wood raw material based compensation by taking into consideration the growing stock instead of multiple uses has been realised and the ecological and environmental values or externalities of forests are not added to the calculation. However, in the burned forest area, it should be considered that not only

[2] The forest area damaged by the fires is 5804 ha. This figure was used as a quantitative indicator in calculation.

growing stock, but also many ecosystem elements such as soil, micro-organisms, game and wildlife, every kinds of plants and recreational services provided by forest resources, macroclimate etc. would be destroyed by the forest fires (Türker et al., 2001; Türker et al., 2002b).

As a result, in the calculation of current fire damage compensation in Turkish forest management, in the short run, a few items might be added to the calculation by using available inventories. In the middle and long run, other cost items can also be added to the calculation when transforming into intensive forest management practices. For this reason, firstly the production of the versatile products and services obtained from the forest resources should be determined as a management objective. Then a comprehensive inventory based on the forest ecosystem and considering the multiple use benefits should be realised. Thanks to these inventories, the occurrences related to forest fire before and after fire should be recorded by the staff of SFE in detail.

4. Discussion

The negative externalities such as erosion, forest fires and illicit fuelwood consumption have a negative impact on the TEV of Turkish forest resources. The economic value of negative externalities reduce the TEV from $US 1,071,087,995 to $US 897,480,458. According to the result of this study, the impact of forest fire damage is 5 % of total negative externalities. The forest fires are very important for Turkish forests because of its location in the Mediterranean region. About 58% of Turkish forests have sensitive characteristics with regard to forest fire. Regarding the rate (58%), the portion of forest fire (5%) in the negative externalities is very low. The case is a result of current calculation method. If the compensation value is calculated according to the new approach, the amount of compensation value and consequently the rate of forest fire in the negative externalities will be higher. This main objective of this study is to open the issue to discuss with other researchers and managers.

The cost of damage occurred as a result of forest fires, which bring the continuity of forest resources and the life of all life community living in the system based on forest ecosystem to an end, was calculated as $US 8,607,537 for whole country in 1999 (GDF, 1999). However, this amount indicates only minimum damage because of the reason mentioned above.

Whereas, the non-wood forest products, especially endemic species damaged by fire, the alternative cost of labour forces used for extinguishing fire and briefly the cost items examined above are not taken into consideration in this calculation. Also to deprive of revenues from the land left as unplanted after forest fire and the share of the land under consideration in the general administration costs have not been taken into account (Türker, 2000; Türker et al., 2002). Therefore, there are some opinions and criticisms arisen from some groups, especially Non-Government Organizations which are directly or indirectly interested in the forestry, that the amount of fire damage calculated by the GDF is at very low levels, and that the damage incurred by fires need to be calculated more precisely.

Likewise, cost items not calculated in practice for forest fire damage compensation and those previously discussed are taken into consideration such as:

- The revenue not obtained from the land for the years left unplanted after fires,
- The share of the forest area burned by fire in the general administration cost, and
- The alternative costs of labour force used for extinguishing forest fire

It is seen that the damage compensation value for a forest fire occurred in Surmene State Enterprise Forests reaches to 11.3 billion TL. This is about 11 % of the compensation value (10.6 billion TL) calculated by using current application for the model forest area burned by fire (Türker et al., 2001). The rate is about 23% in other calculation for a forest fire occurred in Torul State Forest Enterprise (Türker et al., 2002b). This is just a result of adding the three items to the compensation calculation. However, as the other items that cannot be added to the calculation because of various reasons are taken into account, the compensation value in question will reach to greater figures. The impact of forest fire damage on the total economic value of Turkish forest resources would be more than 5% of total negative externalities as the real amount of forest fire compensation is calculated by adding some new items mentioned previously according to the forest economics perspective.

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The Vital Role of Geographic Information Systems to Fight Forest Fires

Abstract

Forest fires lead to disastrous consequences such as huge economic and ecological losses in every country. Turkey has accumulated great deal of experience in forest fires. Nevertheless, because of under-utilisation of relevant technological tools, Turkey has not been able to make adequate use of this experience. Unless fire managers be able to use relevant technological tools, however, it is unlikely to be effective and achieve desirable outcomes. The most critical issue of fire fighting is to manage it, since decision-making is extremely crucial when there is a fire. Experience of technicians makes a difference during a fire. But that would be hardly enough to give right and timely decisions. Thus, in addition to know what to do during a forest fire, it is vital for a fire fighting management to have relevant information to make fast and right decisions to reduce costs. Related decision support systems such as Geographic Information Systems (GIS) are invaluable in this respect. GIS help a fire management to give right and timely decisions not only with required paper maps and other related outputs of the area, but also with the simulation of the fire through a simulation program integrated to the system. This paper will introduce GIS with the particular focus of simulation programs they integrate and provide some samples for their applications.

Keywords: forest fire management, geographic information systems, simulation models

1. Introduction

Forest fires might lead to disastrous consequences such as huge economic and ecological losses in Turkey, Eastern Mediterranean, Balkans and adjoining regions of the Near East and Central Asia and many other regions. On the other hand, discussions have arisen on whether fire is a disaster or a natural phenomenon (Landsberg, 1997). Although public opinion and media approach fire as a disaster, forest fire researchers advocate that it is a natural occurrence that shapes function and structure of forest and other ecosystems. Researches on this subject support the idea that fire is a natural and ecosystem-regenerating phenomenon. Therefore, prescribed fire can be used in forest resource management for recycling of nutrients, regulating plant succession and wildlife habitat, maintaining biological diversity, reducing biomass, and controlling insect and disease populations (Rideout et al., 2003).

No matter what we think of either fire, whether as a natural phenomenon or a disaster, it is an emergency we must not leave unconfined. Thus it is critical to have the right data, at the right time, displayed logically in order to respond and take appropriate action in this emergency. If right data are not provided, decision will be made with inadequate information. This costs time, money, and in some cases lives (Johnson, 2000).

When fire statistics are reviewed it stands out that larger fires have little percentage in the number of fires but they constitute greater than the half of total burned areas. Actually these large fires have caused huge economic and ecological losses and aroused public interest. Either in large fires or in prescribed fires it is hard to manage fire suppression activities. This is because adequate information is needed therefore on like fuel type, fuel condition, terrain data (slope, aspect, elevation), weather data (wind, temperature, etc), other vegetation data (canopy cover, stand height, crown base height, etc), condition and position of fire fighting personnel and equipment, natural barriers, water resources of near environment, threatened settlement, establishment storing or producing dangerous material, and other information in relation to fire and see it on the map as a war commander. Otherwise, whatever experiences you have, it will be miraculous to subscribe fires by memorizing all this information in mind and making necessary management plans.

Most of the data requirements for fire fighting management are of a spatial nature and can be located on a map. Using GIS in an emergency as a decision support system bears great advantages. In other words, during the forest fire it will be easier and faster to make decision by looking at the maps and other GIS outputs of concerning fire areas or simulation model of fires in computer compared to expressing verbally. GIS provides a mechanism to centralize and visually display critical information during an emergency (Johnson, 2000).

Without ability or possibility of using GIS, forest fire management will be affected negatively in Turkey, Eastern Mediterranean, Balkans and adjoining regions of the Near East and Central Asia. In fact, use

of GIS would greatly contribute to the better application of previous experience in fire management. The critical point where experiences show it is the management of a fire suppression operation. At this point if you don't have enough experiences or information making a decision you get shilly-shally and nothing to do without waiting for burn out itself. Thus whenever make a decision faster and right GIS is necessary as an emergency management system. Today GIS help to manage various emergencies such as wildfires, tsunami, floods, earthquakes, hurricanes, epidemics, chemical cloud dispersion, and oil spills, etc. (ESRI, 2000).

GIS provides fire manager with right and timely information not only with required paper maps and other related outputs of the area, but also with the simulation of the fire through a simulation program integrated to the system. This paper will introduce GIS with the particular focus on simulation programs they integrate, and will show some examples for their applications.

2. Geographical Information Systems in Forest Fire Management

A Geographic Information System (GIS) may be defined as "...a computer-based information system which attempts to capture, store, manipulate, analyze and display spatially referenced and associated tabular attribute data, for solving complex research, planning and management problems". GIS belongs to the class of computer systems that require the building of large databases before they become useful. Unlike many microcomputer applications where a user can begin use after the purchase of the hardware and software, the use of a GIS requires that large spatial databases be created, appropriate hardware and software be purchased, applications be developed, and all components be installed, integrated and tested before users can begin to use the GIS. These tasks are large and complex, so large in fact, as to require substantial planning before any data, hardware or software is acquired (Becker et.al., 1996).

Over the past decade the geoinformatic field has evolved from a highly specialized niche to a technology with broad impact on society and its interaction with nature. Geographic Information Systems (GIS) applications now range from simple navigation to critical and extremely complex tasks, such as prediction and management of natural disasters. Due to the increased use of GPS, faster access to geo-referenced data, expanding field of remote sensing and real-time monitoring, GIS technology is entering many new disciplines and industries and GIS is becoming a part of general computational infrastructure. It is therefore natural that geospatial tools are being developed also within the Open Source and Free Software community (Mitosava and Neteler, 2002).

Thanks to developments of telecommunication and computer area it is possible to store large amount of data in mobile computer and transfer data from main database by wireless communication. Thus mobile or non-mobile fire management headquarter can be established during the forest fire.

The software components of geoinformation technology have a profound impact on the capabilities to effectively use the spatial data for solving a particular problem. To ensure continuous innovation and improvement, existence of diverse approaches to GIS software development is crucial. Besides the widely used proprietary systems, an Open Source and Free Software GIS plays an important role in adaptation of GIS technology by stimulating new experimental approaches and by providing access to GIS for the users who cannot or do not want to use proprietary products (Mitchell et al., 2002). GRASS (Geographic Resources Analysis Support System) is one of the most widely used GIS software especially in natural resources, and it has developed under GNU General Public License. Some modelling modules (erosion modelling, rainfall-runoff modelling, storm water runoff, hydrologic modelling, watershed calculation, floodplain analysis, landscape analysis, wildfire spread simulation) of GRASS offers great challenges. Data transfer from known GIS software has been solved. It has got both raster and vector GIS capabilities, image processing and other graphics functionality.

The applications of the GIS are increased and detailed parallel to software and hardware developments. GIS has become an important tool in various branches of forestry. One of the applications of GIS in forestry is forest fire. Forest fire applications of GIS, can be classified in three main categories:

- Establishment of real-time fire risk and hazards database,
- Analysis of database for making decision during the forest fire,

- For better prediction of forest fire behaviour, making simulations by simulation software integrated to GIS software or self executed.

Second and third categories of above will be focused on in this paper. A good example study of first category has been completed by Southwest Anatolia Forest Research Institute of Turkey.

Existing main database must contain fire data useful for GIS in fire management headquarter established during the fire. If this data is available, desired information (for example: elevation, slope, aspect, fuel model, canopy cover, canopy height, canopy base height, fuel moisture, roads, water resources, etc.) will be acquired rapidly by queries and analysis of main database (Figure 1). Beside two-dimensional spatial outputs, this information can be seen on the digital elevation model of the same area.

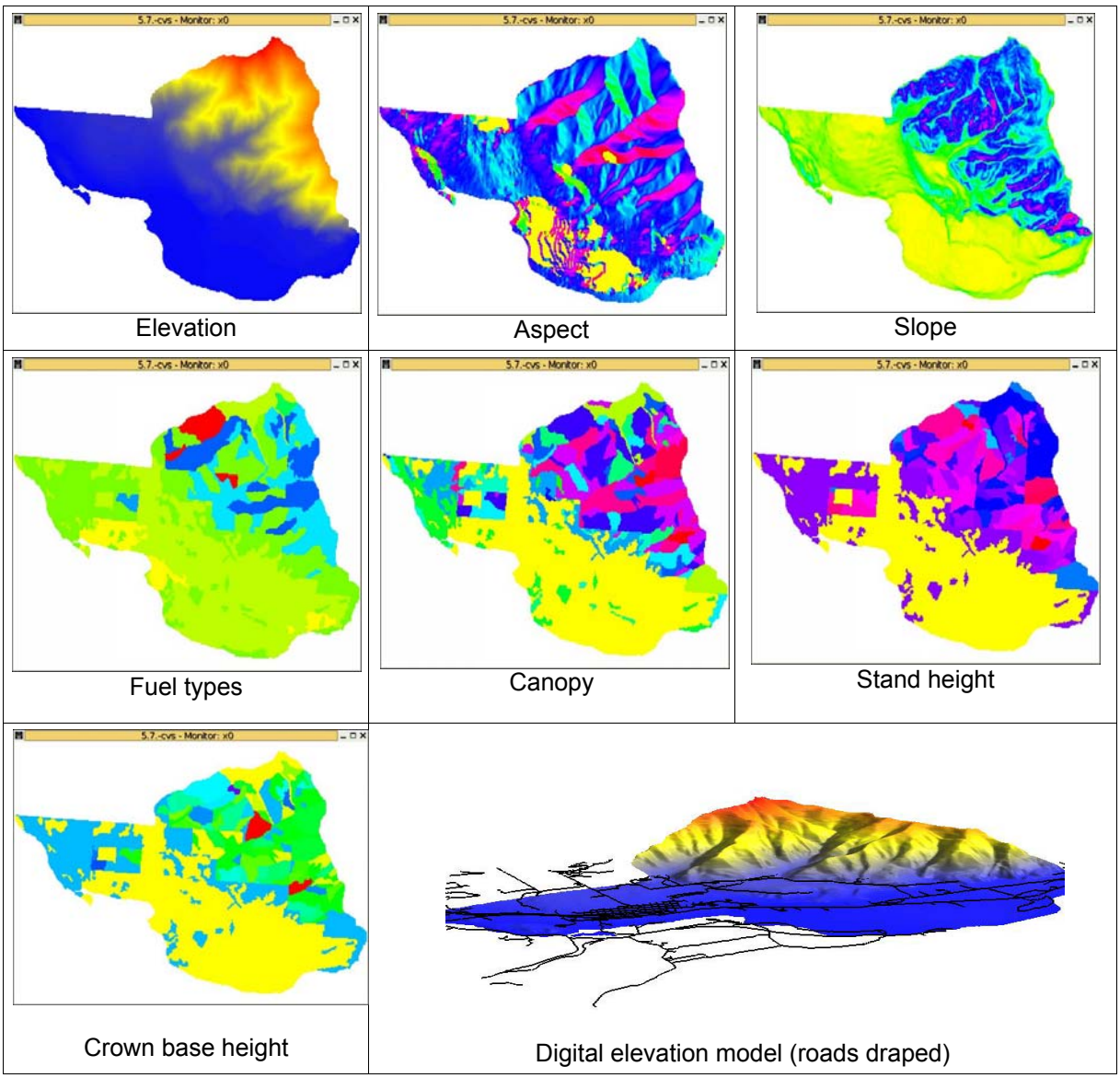

Figure 1. Some fire related GIS layers

3. Forest Fire Simulation Models

Resource management requires increasingly more effective fire management. Fire managers require ways of evaluating the various elements affecting ignition potential and probable fire behaviour for proper fire control and use. Fuel, weather and topography are the main factors that affect fire behaviour (Hawkes et.al., 1995).

FIRE ENVIRONMENT
Pre-fire conditions
- Fuel type, description
- Fuel condition, moisture content
- Weather --wind, temperature, etc.
- Terrain--slope, elevation, aspect

FIRE CHARACTERISTICS
Processes that take place during the fire
- Ignition
- Extinction
- Fire state -- flaming or smouldering
- Flame dimensions -- length, height, depth
- Intensity
- Rate of fire spread
- Fuel consumption
- Emissions -- gaseous and particulate
- Heat transfer above the surface
- Heat transfer below the surface

FIRST ORDER FIRE EFFECTS
Prompt and local--measurable within a few days after the fire and restricted almost totally to the burned area
- Reduction in fuel loading
- Exposure of mineral soil
- Mortality or thermal injury to vegetation
- Chemical and physical response of fire-heated soil
- Local air quality

SECONDARY FIRE EFFECTS
Removed from the fire area and/or resulting after a longer time delay
- Erosion
- Smoke transport and dispersion
- Health effects due to air quality
- Wildlife habitat change
- Water quality change
- Economic impact
- Visual change of the landscape
- Global climate change

Figure 2. Fire modelling is categorized as fire environment, fire characteristics, first-order fire effects, and secondary fire effects. Examples are given for each category (Andrews and Queen, 2001).

Although these factors can be seen directly on the output of GIS as a GIS levels, it is better to see their modelling in the simulation software environment for predicting fire behaviour perfectly. Some of this simulation software is working in integration with GIS software, and the others work as a self-executables. This software helps managers to make fast and reliable decision during wildland fire or prescribed fire. Simulation software has different functions and models. These models can be categorized by various points of view but classification suggested from Andrews and Queen is rather meaningful (Andrews and Queen, 2001) (Figure 2).

Fire environment models describe the conditions that can be defined before a fire event. The results are used in fire characteristics models, which are in turn used by first order effects models. Those immediate and local effects plus many other influencing factors are then used to calculate secondary effects.

Simulation software is used widely in the USA and Canada, and developed continuously. To highlighting the subject a simple example of wildfire simulation was realized through wildfire simulation modules (r.ros, r.spread, r.spreadpath) of GRASS Open Source GIS Software. In these modules, developed by Jianping Xu and Lathrop (1995), Rothermel's wildfire mathematical model has been used. Because of open source code of modules, making any desired changes are possible.

Since it was not possible to obtain relevant data, a sample data of FARSITE simulation program has been processed by GRASS, after it was transformed into an appropriate format. To render this transfer ".shp" files imported by "v.in.ogr" command and ".asc" files imported by "r.in.ascii" command. Because fuel moisture (live fuel moisture, 1 hour moisture, 10 hour moisture, 100 hour moisture) and weather data (wind speed, wind direction) read from raster map in GRASS, FARSITE text data were converted into separate raster maps by "r.reclass" command. After data transferring has been completed first they were entered "r.ros" wildfire module and produced four maps (base rate of spread, the maximum rate of spread, the direction of the maximum rate of spread, the maximum potential of spotting distance) to use in "r.spread" module.

Then these raster maps and other data were processed in “r.spread” to simulate forest fire desired location and duration (Figures 3, 4).

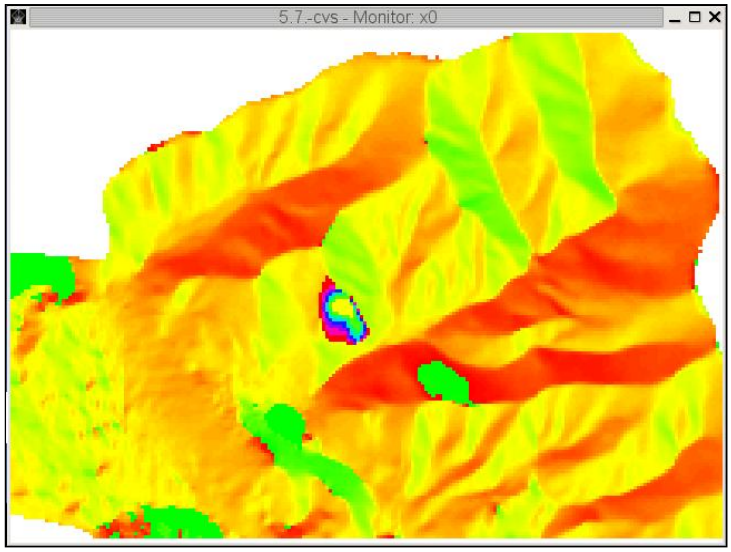

Figure 3. Simulation results overlayed aspect map

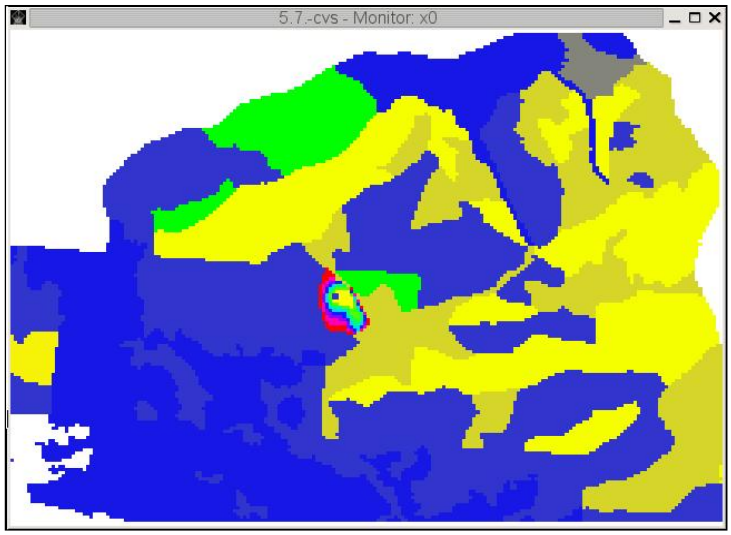

Figure 4. Simulation results overlayed fuel map

4. Conclusions

A new era has been started with the advent of GIS in management of natural resources and urban environment. Developments not only in GIS and related disciplines but also in computer and telecommunication areas have improved the acquirement, storage, and communication of data. These developments have led to rapid increase in GIS applications and development of GIS software in various areas of applications. One of such areas is forestry. Of course, GIS has branched into many areas in forestry (for example: watershed applications, silvicultural applications, forest inventory and management applications, forest fire applications, etc.). Either natural phenomenon in regeneration of ecosystems or a disaster causing economic and ecological losses, forest fire is an emergency to be dealt with carefully and systematically. In such a situation forest fire managers need information about elements affecting fire. Some of this information is spatial and obtainable through GIS. In addition to this information, fire behaviour is predicted by simulation software to help fire managers make better decisions.

In order to utilise GIS economically and productively for fire emergency management in Turkey, Eastern Mediterranean, Balkans and adjoining Regions of the Near East and Central Asia, the following criteria are taken into consideration:

- Existing geographic database must be used (development of database only for fire management would be insufficient and redundant)
- If there is not any existing geographic database, the need of forest fire information must be considered in database planning and design
- Fuel related data (fuel loading, fuel moisture, etc) that is crucial element of fire behaviour should be updated frequently
- Database has to incorporate the criteria (attributes) for fuel type classification
- Telecommunication infrastructure that enables data transfer from main geographic database must be constructed
- Existing or new simulation software should be tested in forest fires.

As a result, although GIS has vital role in fire management activities as a state-of-the-art decision support system, the most important component is the staff with the experience and expertise in forest fires and GIS.

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IN MEMORY

Frank Albini
1936 – 2005

Frank Albini, fire behaviour research scientist from 1973 to 1985, died of cancer at the age of 69 on 3 December 2005. He was born in Madera, California where he graduated from high school. He attended the California Institute of Technology and earned a B.S. in Aeronautical Engineering in 1958, and a year later an M.S. in Mechanical Engineering. He was awarded a Ph.D. Mechanical Engineering and Philosophy from Cal Tech in 1962.

The wildland fire community is fortunate that Frank felt the call to do fire behaviour research. He was drawn to Missoula Fire Sciences Laboratory not only by the interesting subject matter and the opportunity to make a contribution, but also by outdoor opportunities offered by the State of Montana. Many friends, family, and colleagues have fond memories of hunting and fishing adventures shared with Frank.

In an invited paper for American Scientist titled Wildland Fires (1984) Dr. Albini focused on the current state of knowledge about the behaviour of wildland fires. Following is the concluding statement in that paper: “The list of poorly understood phenomena can be expected to lengthen for some time to come because research in this field is still in its infancy. As the base of knowledge grows, new puzzles will emerge, and explanations that were once accepted will be challenged as their implications are explored. But useful results have been produced from the present level of understanding, and continued research should yield substantial rewards in terms of safer, more economical control and use of wildland fire.”

He not only made advances in understanding and describing basic fire phenomena, but also formulated models such that they could be applied. Many of his models form the core of widely used decision support systems.

Among Frank’s early influential accomplishments at the Fire Lab (USDA Forest Service, Rocky Mountain Research Station) was development of nomograms for calculating fire spread rate and intensity. Nomograms continue to be used as a training aid and as a field tool for estimating fire behaviour. He also developed and documented FIREMOD, an early computer program for fire behaviour and fire effects prediction. Frank played an important role in the implementation of mathematical models as tools for fire managers.

Frank conducted analytical and experimental research studies on basic processes governing behaviour of free-burning fires in forest and rangeland fuels. His research addressed flame structure, radiation driven mechanisms of fire spread, soil heating, and crown fire spread. He developed models

for fire spotting distance, fire containment, and the consumption and intensity of the burning of large woody fuels. He modelled wind flow into a forest, upslope convective winds, midflame wind speed, and the response of free-burning fires to nonsteady wind.

He was an internationally recognized authority on modelling the behaviour of wildland fire, making presentations and doing cooperative research in Australia, Germany, Russia, Canada, Japan, China, and Portugal. He assisted with the planning and execution of the International Crown Fire Experiment with US and Canadian Forest Services, burning full scale crown fires for data to test a radiation-driven crown fire spread model, which was published in 2004.

Frank had a wide range of talents and interests. He had both a deep and a broad knowledge of many subjects. He was an editor and referee for several technical journals and the author of over 100 refereed papers (many classified). Many who knew Frank through his wildland fire research are not aware of his extensive contributions to other fields. He had 20 years experience in defence-related research and development activities on topics including weapons systems analysis, system component performance assessment and prediction, and ballistic missile defence. He worked for Hughes Aircraft, the Institute for Defence Analysis, General Research Corporation, and Science Applications International Corporation.

In his book, Young Men and Fire (1992), Norman Maclean wrote of Frank Albini “In addition to being a brilliant scientist, he turned out to have a quiet, persuasive literary style that helped to make him an effective half-concealed salesman for the extended uses of mathematical models in the woods.”

He applied his exceptional knack for explaining complicated concepts in understandable terms to teaching and writing about wildland fire behaviour. As a Research Professor of Mechanical Engineering at Montana State University from 1992-2001, in addition to teaching introductory thermodynamics and advising senior design teams, he taught first year calculus in provost’s experiment to discover why students are so weak in math.

Frank has been described as an unassuming, down to earth, uncommonly brilliant, and interesting person. Ever the thinker, teacher, and communicator, the following is from a letter he wrote six weeks before his death: “I have known frustration and fulfilment, success and failure, deprivation and reward, rebuke and acclaim. Though each negative experience was painful to endure, it made the positive the more poignant. How much more gratifying is acknowledgement after having endured scorn for the effort to achieve. How much more enjoyable is good health after enduring the pains of injury and disease. How much more rewarding is the thrill of discovery after enduring the agony of the quest and the repeated disappointments that seem to accompany all exploration.”

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