



**Timo V. Heikkilä
Roy Grönqvist
Mike Jurvélius**

Wildland Fire Management Handbook for Trainers

Helsinki 2007

MINISTRY FOR FOREIGN AFFAIRS OF FINLAND
Development Policy Information Unit

Wildland Fire Management Handbook for Trainers

TIMO V. HEIKKILÄ, ROY GRÖNQVIST,
MIKE JURVÉLIUS

HELSINKI 2007

Cover picture
Mike Jurvélius

Photographs
Mike Jurvélius
Roy Grönqvist
Timo V. Heikkilä

ISBN-13: 978-951-724-581-4

Helsinki 2007 Kirjapaino Topnova Oy

TABLE OF CONTENTS	Page:	
FOREWORD	6	
THE SAN DIEGO DECLARATION	8	
ACKNOWLEDGEMENTS	14	
1. BACKGROUND AND JUSTIFICATION FOR INTENSIFIED FOREST FIRE CONTROL ACTIVITIES	16	
1.1 General.....	16	
1.2 Environmental Impact of Forest Fires ...	12	
1.2.1 Nutrient stability.....	16	
1.2.2 Flora and fauna.....	16	
1.2.3 Soil texture.....	17	
1.2.4 Ecological stability.....	17	
1.2.5 Global temperature.....	17	
1.3 Social and Traditional Beliefs and Practices.....	17	
1.3.1 Rains	17	
1.3.2 Rangelmanagement	17	
1.3.3 Prestige	18	
1.3.4 Agriculture	18	
1.3.5 Beekeeping	18	
1.4 Fire Prevention Background	18	
2. BASELINE DATA FOR FOREST FIRE CONTROL	22	
2.1 Management Policies for Forest Fire Control.....	22	
2.2 The Objectives for Fire Control in Different Types of Forest.....	23	
2.3 Forest Fire Management Plan	24	
2.4 Losses Caused by Forest Fires and Economic Aspects of Fire Management	26	
2.5 Climate and Fire Seasons	27	
2.6 Climatic Regions and Ground Vegetation	29	
3. RESPONSIBLE ORGANISATION FOR FOREST FIRE CONTROL AND BASIC LAW ENFORCEMENT	34	
3.1 Responsible Organisation for Forest Fire Control.....	34	
3.2 Cooperation and Collaboration	35	
3.3 Law Enforcement and Regulations Affecting Fire Protection	35	
3.4 Plantation or Project Fire Organisations	36	
3.5 Duties of the Responsible Authority in Fire Organisations	37	
3.5.1 Fire protection manager	37	
3.5.2 Fire chief.....	37	
3.5.3 Storekeeper	37	
3.6 Fire Protection Plans	38	
3.6.1 Purpose	38	
3.6.2 Format	39	
3.6.3 Content.....	39	
3.6.4 Protection maps.....	41	
3.6.5 Protection plans - additional notes..	42	
3.6.6 Example of a fire protection plan	44	
4. PREVENTION	62	
4.1 Wildfire Prevention Activities	62	
4.2 Fire Prevention Planning	63	
4.3 Contents of a Wildfire Prevention Plan	64	
4.4 Wildfire Causes and Risk	65	
4.4.1 Land owners, farmers, and the rural population	65	
4.4.2 Cigarette smoking	67	
4.4.3 Campfires	68	
4.4.4 Logging and other forestry operations	69	
4.4.5 Arsonists	69	
4.4.6 Children	70	
4.4.7 Lightning	70	
4.4.8 Railroads.....	70	
4.4.9 Secondary causes of wildfires.....	71	
4.5 Prevention Methods.....	71	
4.5.1 Personal contact.....	71	
4.5.2 Associations and groups.....	72	
4.5.3 Mass media.....	72	
4.5.4 Schools.....	72	
4.5.5 Signs and warning notice boards	73	
4.5.6 Posters.....	73	
4.5.7 Other methods of fire prevention	73	
4.6 Laws and Regulations	76	
4.7 Fire Investigation.....	76	
4.8 Fire Hazard and Hazard Reduction.....	77	
4.9 Controlled Burning of Fire Hazard Areas.....	78	
5. FOREST FIRE BEHAVIOUR	82	
5.1 General- Forest Fire Behaviour.....	82	
5.2 Principles of Combustion.....	83	
5.2.1 Fire triangle	83	
5.2.2 Ignition temperature	84	
5.2.3 Phases of combustion.....	84	
5.2.4 Heat transfer	86	
5.3 Main Factors Influencing Fire Behaviour	87	
5.3.1 Fuel	88	
5.3.2 Basic weather factors	92	
5.3.3 The changing influences of Weather	96	
5.3.4 Topography	97	
5.4 Rate of Spread	98	
5.5 Torching	98	
5.6 Large Fire Behaviour.....	98	
5.7 Parts of a Forest Fire.....	99	
5.8 Form of Forest Fires	100	
5.9 Types of Fire	101	
5.10 Classification of Fires.....	102	
5.11 Fire Behaviour Rules of Thumb.....	103	
6. PRE-SUPPRESSION ACTIVITIES.....	106	
6.1 Introduction	106	
6.2 Planning	106	
6.3 Lists and Records	107	
6.3.1 A list of senior management.....	107	
6.3.2 A list of fire crews.....	108	
6.3.3 Lists of tools, equipment, machines, and transport.....	108	
6.3.4 Cooperation with other authorities	109	

6.4	Supply Service for Personnel and Equipment.....	109	7.2.3	Centrifugal pump.....	149
6.5	Forest Fire Detection	110	7.2.4	Use of fire pumps and hose lines	151
6.5.1	General.....	110	7.2.5	Main categories of pumps.....	153
6.5.2	Detection planning	110	7.2.6	The main pump hook-ups, booster pumps and tanks	153
6.5.3	Ground patrolling	113	7.2.7	Fire pumps used in forest fires	155
6.5.4	Fixed lookout stations	113	7.3	Fire Armature.....	160
6.5.5	Air patrols	115	7.3.1	Fire hoses.....	160
6.6	Communication	115	7.3.2	Nozzles	164
6.6.1	General.....	115	7.3.3	Couplings.....	166
6.6.2	Communication equipment and methods.....	116	7.3.4	Firing devices	167
6.6.3	General directives for organising communication systems	117	7.4	Fire Apparatus	168
6.7	Fire Reporting and Alarm Systems	118	7.4.1	Patrol or pick-up units	168
6.7.1	Reporting and analysis of smoke and fire	118	7.4.2	Fire trailer units	168
6.7.2	Regional fire alarm centre system	119	7.4.3	Pumper units.....	169
6.7.3	Methods to alert fire crews and other units	120	7.4.4	Slip-on units.....	169
6.8	Location and Maps	120	7.4.5	Tanker units	169
6.8.1	Location	120	7.4.6	Fire buckets and portable water bags.....	171
6.8.2	Maps	122	7.5	Coordination of forest fire equipment..	172
6.9	Fire Weather Service	123	8	SUPPRESSION TACTICS AND TECHNIQUES	174
6.9.1	General	123	8.1	General - Definition of Terms	174
6.9.2	Fire weather index.....	124	8.2	Phases of Wildfire Suppression.....	176
6.9.3	Measuring fire danger	125	8.3	Tactics	177
6.9.4	A practical example.....	125	8.3.1	Rule of thumb tactics.....	177
6.9.5	To compute fire hazard index.....	126	8.3.2	Basic rules of fire suppression tactics	177
6.9.6	Fire danger conditions in different scales.....	128	8.3.3	Sizing-up.....	178
6.9.7	Definition of terms	128	8.3.4	Analysis of the fire.....	179
6.10	Training.....	129	8.3.5	Safety (hazards to life)	180
6.10.1	Background	129	8.3.6	Threatened property and some tactical advice	180
6.10.2	Overall training strategy.....	130	8.3.7	Resources.....	180
6.10.3	Example of a course	131	8.3.8	Situation evaluation (calculation of probability)	180
6.10.4	Training of personnel	132	8.3.9	Rate of spread and height of flame.	181
6.11	Public Awareness of Large Fires.....	133	8.3.10	Size of the fire.....	182
6.12	Field Preparation Prior to the Fire Season	133	8.3.11	Priority of control action	182
6.12.1	Forest roads	133	8.4	Methods of Attack	182
6.12.2	Lookout towers.....	133	8.4.1	Direct attack.....	184
6.12.3	Warning signs and boards	133	8.4.2	Indirect attack	184
6.12.4	Firebreaks and firelines	133	8.4.3	Burning methods	186
6.12.5	Hazard reduction	133	8.5	Factors Affecting Choice of Attack.....	187
7.	FOREST FIRE EQUIPMENT	136	8.6	Suppression Techniques	188
7.1	Forest Fire Handtools	136	8.6.1	Basic methods to extinguish a fire	188
7.1.1	Basic considerations in selecting fire accessories and tools.....	136	8.6.2	Equipment and techniques in use	188
7.1.2	Availability of fire control tools .	137	8.6.3	Principal techniques for line construction	189
7.1.3	Local tool manufacture	137	8.6.4	Backfiring techniques.....	196
7.1.4	Training.....	138	8.6.5	Water suppression techniques	199
7.1.5	Tool maintenance, use, and storage.....	138	8.6.6	Aircraft used in fire suppression.....	202
7.1.6	Description of hand tools	139	8.6.7	Suppression techniques in peat-land fires	203
7.2	Fire Pumps.....	148	8.6.8	Mopping-up.....	203
7.2.1	General	148			
7.2.2	Backpack pump	148			

9. ORGANISATION AND MANAGEMENT OF WILDFIRES	206	12. FIRE: A NECESSARY EVIL.....	238
9.1 General Management	206	12.1 Background why fire is perceived harmful.....	238
9.2 Basic Requirements for a Fire Chief....	207	12.2 Fire is a conservation and livelihood issue.....	239
9.3 Management Procedures	207	12.2.1 The role of fire in ecosystems ...	239
9.4 Incident Command System (ICS)	210	12.2.2 Fire-Independent Ecosystem.....	240
9.4.1.Introduction	210	12.2.3 Fire-Dependent Ecosystem	240
9.4.2 ICS Organization.....	210	12.2.4 Fire-Sensitive Ecosystem.....	241
9.4.3 Example of ICS staff requirements for a large fire	211	12.2.5 Fire-Influenced Ecosystem.....	242
9.4.4 Incident Action Plan.....	212	12.3 The source of fire threats to biodiversity	242
9.4.5 Span of control	212	12.3.1 Case Studies: Fire as tool for Livelihood and ecosystem Improvement	243
9.5 Management Check-list for the Incident Commander (IC) or Fire Chief.....	212	12.3.1.1 Economic and social context.....	243
9.6 A detailed list of "must follow up" activities	213	12.3.1.2 Nutrient cycling.....	244
10. SAFETY, WELFARE AND FIRST AID	215	12.3.1.3 Plant growth initiation and forage improvements	244
10.1 Responsibility for Safety	215	REFERENCES.....	246
10.2 General Safety Measures.....	215	COLOUR PICTURES	49-56
10.3 Accident Prevention	215		
10.4 Ten Fire Fighting Rules.....	217		
10.5 Dangerous Situations.....	217		
10.6 Welfare of the Crew.....	218		
10.6.1 Safety briefing	218		
10.6.2 Hand tool safety.....	219		
10.6.3 Pumper and tanker safety	220		
10.6.4 Tractor safety	221		
10.6.5 Foot travel safety	222		
10.6.6 Safety on the line.....	222		
10.6.7 Advising civilians.....	223		
10.6.8 Personal safety.....	224		
10.7 First Aid	224		
11. COMMUNITY BASED FIRE MANAGEMENT	227		
11.1 Background.....	227		
11.2 CBFiM – What is it	227		
11.2.1 Definition.....	227		
11.2.2 Gender and fire	227		
11.2.3 Forms of CBFiM.....	228		
11.2.4 Policy/legal/regulatory frameworks of CBFiM	230		
11.2.5 Land tenure.....	230		
11.3 Fire and burning	231		
11.3.1 Agricultural burning	231		
11.4 The current state of CBFiM	232		
11.5 External intervention	232		
11.5.1 CBFiM Processes and Activities/ Products by External Actors	232		
11.6 The lengthy process of changing human behaviour	233		
11.7 Development of rural Community Fire Institutions.....	234		
11.8 Training.....	235		
11.8.1 Components of fire training.....	235		
11.8.2 Training in controlled or prescribed burning.	236		
11.9 The way forward	236		

FOREWORD

Fire is an important land management tool, but careless or criminal use of fire may have catastrophic impacts. Wildfire can be a major cause of ecosystem degradation and may result in loss of human life, economic devastation, social disruption and environmental deterioration. Each year, fires destroy millions of hectares of valuable timber, other forest products, and environmental services provided by forest ecosystems. However, in fire adapted ecosystems, managed fire plays a positive role in ecosystem health and vitality whilst in fire sensitive ecosystems, damage is incurred. In many ecosystems, good management practices help to reduce the extent and severity of unplanned fire. Countries benefit if they develop the capability to manage fire as an integral part of their approach to ecosystem management.

Globally more than 350 million ha were burned in 2000 of which 95 percent were caused by people. The continued expansion of agriculture and other forms of land conversion activities in developing countries; the increased use of wildlands for recreational purposes and tourism in both developed and developing countries; are among the factors that are contributing to the increasing incidence and impacts of wildland fire. In 2005 an estimated 230 million hectares of forest, savannah and grasslands were burned south of the equator in Africa. Many fires were intentionally set to clear land for agriculture, and many of these fires burnt much larger areas than were originally intended.

It is not possible to state conclusively that there is a long-term upward trend in fire at the global level, since historical data are available for only a small minority of countries, however, an increasing number of national and local governments are elevating fire as a priority, requiring increased policy attention and increased allocation of resources.

The FTP-21 Handbook on Forest Fire Control, A guide for Trainers was first produced by the Finnish National Board of Education in 1993 to train people in the developing countries in fire detection and suppression; as was the global priority at the time. Since then, the Voluntary Guidelines for Fire Management highlights that the risk, frequency, intensity and impacts from wildfire can be reduced through more holistic approaches to fire management that include monitoring, early warning, fire prevention, fire preparedness, fire suppression and restoration following fire events. Sound policy, legal, regulatory and planning frameworks need to be supported by mechanisms to ensure compliance, including law enforcement. However, equally as important is the adoption of community based fire management approaches and public awareness raising programmes that improve knowledge of fire impacts (positive and negative) on food security and rural livelihoods, including linkages and conflicts between uses of fire in the forestry-agriculture and wildland-urban interfaces.

Many countries are adopting fire strategies that address the root causes, prevention and preparedness for fire that are proving more cost effective than investments in fire suppression technologies and resources, which are often only used during a few months each year.

The majority of today's wild fires stems from fire uses outside the forest ecosystems. The sustainable management of forest ecosystems requires the participation of the local population in landscape level management of wildland fire, adjacent to these areas. Where people have a direct interest in protecting their natural resources, haphazard or unplanned wildfire started by people is significantly reduced. Successful fire management produces direct benefits to local communities. Only when local communities understand that they will benefit from protecting their natural resources will they be mobilized to prevent fires.

Fire management requires that trainers and instructors, including at community level, be trained to facilitate the new holistic approaches in fire management, including ecology and local communities. Also land-use authorities and managers around the world, need to be educated in principles of ecological fire management.

The Finnish Ministry of Foreign Affairs (MFA) have supported implementation of the Voluntary Guidelines for Fire Management by financing review of the Handbook on Forest Fire Control, A Guide for Trainers, to incorporate the more holistic approaches. This new *Handbook on Wildland Fire Management, for Trainers*, will target field trainers/instructors, and thus complement the other recent Wildland Fire Management Handbooks; for Sub-Sahara Africa (2004), for North-East Asia (2006) in Russian, produced by the UNISDR and the Global Fire Monitoring Center (GFMC).

Since 2002 the UNISDR Regional Wildland Fire Networks facilitates regional and global dialogue and facilitates transfer of knowledge and technology. It is proposed that each country will analyze its fire situation, develop a strategy for preventing and managing wildland fire and assess the risks and impact on forest ecosystems. As many countries lack the capacity and capability to implement an effective programme, the Voluntary Guidelines for Fire Management, supported by this Wildland Fire Management Handbook for Trainers, will form the bases for a programme of institution strengthening and capacity building in fire management, particularly in developing countries. It is hoped that Governments and other stakeholders will embrace the approaches outlined in this handbook and the fire management code and commit the resources to implementation of the principles and practices necessary for effective fire management.

Helsinki, January 2007

Mike Jurvélius

THE SAN DIEGO DECLARATION ON CLIMATE CHANGE AND FIRE MANAGEMENT

WAS PRESENTED AT THE THIRD INTERNATIONAL FIRE ECOLOGY AND MANAGEMENT CONGRESS 1.
BY THE ASSOCIATION FOR FIRE ECOLOGY, NOVEMBER, 2006¹.

PREAMBLE

As scientists and land managers who focus on fire and its effects on natural ecosystems, we recognize that climate plays a central role in shaping fire regimes over long time scales and in generating short-term weather that drives fire events. The science surrounding human-caused climate change continues to strengthen and the weather patterns that shape the ecosystems where we live and work may be altered dramatically over the coming decades. In anticipation of such changes it is important to consider how fire management strategies may enable us to respond to a changing global climate and thereby reduce potential disruptions to plant communities, fire regimes and, ultimately, ecosystem processes and services.

Currently, we are observing serious wildland fire conditions, such as increasing numbers of large and severe wildfires, lengthened wildfire seasons, increased area burned, and increasing numbers of large wildfires in fire-sensitive ecosystems (*e.g.* tropical rain forests and arid deserts). Recent research suggests that these trends are, in part, related to shifts in climate.

As temperatures increase, fire will become the primary agent of vegetation change and habitat conversion in many natural ecosystems. For example, temperate dry forests could be converted to grasslands or moist tropical forests could be converted to dry woodlands. Following uncharacteristic high-severity fires, seedling reestablishment could be hindered by new and unsuitable climates. Plant and animal species already vulnerable due to human activities may be put at greater risk of extinction as their traditional habitats become irreversibly modified by severe fire. Streams and fisheries could be impacted by changing climates and fire regimes with earlier peak flows, lower summer flows, and warmer water even if ecosystems don't burn. Finally, extreme wildfire events and a lengthened fire season may greatly increase the risk to human lives and infrastructures, particularly within the wildland urban interface.

We acknowledge that there are uncertainties in projecting local impacts of climate change, however, without taking action to manage fire-dependent ecosystems today and in the absence of thoughtful preparation and planning for the future, wildland fires are likely to become increasingly difficult to manage.

We, the members of the Association for Fire Ecology that endorsed this document at the Third International Fire Ecology and Management Congress, support the following considerations for planning and management to enhance ecosystem resiliency to wildland fire in a changing global climate.

¹ This declaration represents the position of the Association for Fire Ecology and other signatories and may not represent the position of other organisations or agencies sponsoring the Congress.

BACKGROUND

1. Both fire and climate regimes interact with other natural processes to direct the formation of vegetation in ecosystems. Given that climate and fire regimes are linked through vegetation, changes in climate can lead to large or small changes in fire regimes. Climate and fire regimes are also directly connected through the climate drivers of ignitions and fire weather. Climate influences both where and how vegetation grows and thereby creates the fuel conditions that drive fire frequency, intensity, severity, and seasonality. Precipitation and temperature patterns regulate the accumulation of fuels. In some ecosystems, wet years may promote "boom" vegetative (fuels) conditions, while drought years promote "bust" and the burning of the "boom" vegetation. Further, we know that the inevitable dry years, particularly when warm, are associated with larger fires, both in size and number, especially where fuel is abundant. Fire can also contribute to the problem of increasing green house gas emissions because it is a source of CO₂ and particulate emissions, which may affect local and regional air quality and worldwide climate.

2. Historical fire regimes have been disrupted in many ecosystems. Factors such as human activities and land development, loss of indigenous burning practices, and fire suppression have all led to changes in some plant communities historically shaped by particular fire regimes. Human activities have significantly increased the number of ignitions in many temperate, boreal, and tropical regions. Fuel loads have increased in some temperate forests where low intensity fires were historically the norm. In some rangelands, shrubs have been replaced by annual grasses or colonizing trees. Human caused burning has increased fire frequency in some tropical regions where fire-sensitive ecosystems dominate.

It should be noted that not all vegetation types in have been significantly altered by fire suppression. Many shrubland ecosystems, such as California chaparral, burn with high severity under extreme weather conditions and fire management in the 20th and 21st centuries has not appreciably changed their burning patterns. Coastal, mesic coniferous forests in the Northwestern US have not been modified to a great extent by fire suppression policies because fire rotations in this area are much longer than the period of fire suppression. In other forests such as Rocky Mountain lodgepole pine, high severity fires every 100-300 years are ecologically appropriate and fire suppression has probably not affected these ecosystems to a great extent. The ecosystems most impacted by fire suppression are forests that once experienced regimes of frequent, low-moderate intensity fires; these ecosystems are probably the most vulnerable to altered fire regimes from changing climates.

Approaches to restore fire-adapted ecosystems often require treatment or removal of excess fuels (*e.g.* through mechanical thinning, prescribed fire, or mechanical - fire combinations), reducing tree densities in uncharacteristically crowded forests, and application of fire to promote the growth of native plants and reestablish desired vegetation and fuel conditions. Excess fuels are those that support higher intensity and severity fires than those under which the particular ecosystem evolved or are desired to meet management objectives. For example, in dry western US forests that once burned frequently, a high density of trees and a large surface fuel load often promotes crown fires that burn over very large areas. Some of these same forests once flourished under a fire regime where frequent, non-lethal low-intensity surface fires were the norm, and large-scale crown fires were rare. Managers should determine if forests can be restored to what they once were or if another desired

condition is more appropriate. If it is not appropriate to restore ecosystems to a previous condition because of expected novel climate conditions, then managers should develop new conservation and management strategies and tactics aimed at mitigating and minimizing uncharacteristic fire behavior and effects.

3. Climate change may interact with other human activities to further change fire regimes. For example, in much of the western US, since the 1980s, large fires have become more common than they were earlier in the century. This has often been attributed to increased fuel loads as a result of fire exclusion. However, a number of research studies suggest that climate change is also playing a significant role in some regions, elevations, and ecosystem types. In the western US, researchers recently identified an increase in fire season duration in mid-elevational forests. These changes were correlated with earlier spring snowmelt dates. With global temperatures projected to rise throughout this century, increases in fire season length and fire size can be expected to continue.

4. Climate change can lead to rapid and continuous changes that disrupt natural processes and plant communities. Are managers safe in assuming that tomorrow's climate will mimic that of the last several decades? Increased temperatures are projected to lead to broad-scale alteration of storm tracks, thereby changing precipitation patterns. Historical data show that such changes in past millennia were often accompanied by disruption of fire regimes with major migration and reorganization of vegetation at regional and continental scales. Exercises in modeling of possible ecological responses have illustrated the potential complex responses of fire regimes and vegetative communities. These exercises indicate that dramatic changes in fire regimes and other natural disturbance processes are likely. Indeed, some believe that the impacts of climate change may already be emerging as documented in widespread insect infestations and tree die-offs across some areas in the western US and British Columbia, and more rapid and earlier melting of snow packs. Developing both short- and long-term fire and fuels management responses that improve the resilience of appropriate ecosystems while reducing undesired impacts to society will be critical.

5. Changes in climate may limit the ability to manage wildland fire and apply prescribed fire across the landscape. Under future drought and high temperature scenarios, fires may become larger more quickly and could be more difficult to manage. Fire suppression costs may continue to increase, with decreasing effectiveness under extreme fire weather and fuel conditions. In some temperate and boreal regions, it is expected that more acres will burn and at higher severities than historically observed. In humid tropical regions exposed to severe droughts, vast forests could burn making it difficult for forest managers to prevent farmers from entering destroyed forests and establishing new farms. Globally, new fire regimes would be associated with shifts in ecosystem structure and function and likely, changes in biodiversity.

6. Approaches to fire management that recognize the potential for greater variability and directional change in future climates may help to reduce ecological and societal vulnerability to changing fire regimes. Such approaches are likely to improve fire management and ecosystem health. A goal could be to reduce the vulnerability, both ecologically and socially, to the uncertainties that accompany a changing climate. For example, if managers restore some forests as a means to increase ecosystem resiliency to climate change, they will also be improving biodiversity and protecting important forest resources. In the humid tropics, if managers make a concerted effort to prevent fire from entering rain forests during drought years, then they would be reducing the risk of future fires and illegal logging, even if droughts did not become more frequent and severe with a changing climate.

CONSIDERATIONS FOR MANAGEMENT, RESEARCH, AND EDUCATION

Recent changes in climate and fire patterns have been observed in many areas of the world, and current projections are that ongoing and long-term changes are likely. We believe that the actions outlined below could help managers to be better prepared to anticipate and mitigate potential negative effects of variable and changing future environments.

Fire and Ecosystem Management

- Incorporate the likelihood of more severe fire weather, lengthened wildfire seasons, and larger-sized fires in some ecosystems when planning and allocating budgets, which traditionally are based on historical fire occurrence.
- Make use of both short-term fire weather products AND season-to-season and year-to-year climate and fire outlooks that are increasingly available from "predictive services" groups in federal agencies, and particularly the sub-regional variations in anticipated fire hazards that enable strategic allocation of fire fighting and fire use resources nationally.
- Continually assess current land management assumptions against the changing reality of future climates and local weather events.
- Develop site-specific scenarios for potential weather events linked to climate change and redesign fire management strategies to make room for rapid response to these events.
- Consider climate change and variability when developing long-range wildland fire and land management plans and strategies across all ownerships.
- Consider probable alternate climate scenarios when planning post-fire vegetation management, particularly when reseeding and planting.

Fuels Management

- Prepare for extreme fire events by restoring some ecosystems and reducing uncharacteristic fuel levels through expanded programs of prescribed burning, mechanical treatments, and wildland fire use to meet resource objectives. Burning under the relatively mild weather conditions of a prescribed fire produces lower intensity burns and, generally, less carbon emissions than would a fire burning under wildfire conditions. Burning and thinning treatments should be strategically placed on the landscape in locations where they are more likely to influence fire spread. Some ecosystems will continue to burn in high severity stand replacement fires and this is appropriate for their sustainability.
- Incorporate emerging scientific information on the impact of changing temperature and precipitation on plant communities into fuels management project design and implementation at the local level.
- Expand wildland fire use at the landscape scale in fire-adapted ecosystems to restore fire regimes and reduce fuel loads. Be more aggressive in promoting fire use during lower hazard fire seasons, and fire use in landscapes that offer particular opportunities for relatively low-risk, large-scale burning. This will allow more acres to be burned under less extreme fire weather conditions than fires that might occur in the future under extreme heat or drought conditions.
- Control highly flammable non-native plant species and develop management options to address their increased spread and persistence. In some ecosystems appropriately timed prescribed fires can be used to reduce non-native species, while in others, continued fire exclusion may be the best management strategy. In some areas, reseeding and active restoration may be the best option.
- In some cases the removal and use of small diameter forest products (engineered lumber, pulp and paper, biofuels) and chipped fuels (for electrical energy generation) could be used to reduce fire hazards in appropriate vegetation types. Burning excess fuels in a co-generation plant has the additional advantage of producing lower emissions when compared to prescribed fires.

Research, Education, and Outreach

- Implement long-term biodiversity and fuels monitoring programs in the fire-adapted ecosystems that are expected to undergo the widest range of change and variability linked to climate change, such as those that once experienced frequent, low-moderate intensity fire regimes.
- Expand inter-disciplinary research to forecast potential fire season severity and improve seasonal weather forecasts under future climate change scenarios.
- Integrate the subject of climate change and its influence on ecosystem disturbance into curricula within natural resource management programs at the university and continuing education levels, and in science programs within primary schools.
- Disseminate information to the general public and government agencies regarding the potential impacts of changing climate on local natural resources and disturbance regimes, particularly those that interact with fire.

- Hold conferences or symposia to enhance communication among researchers and managers and to engage the general public in discussion on how best to adapt public land management to cope with fire in a changing environment.
- Form inter-disciplinary teams of researchers that include fire ecologists and climate scientists to identify and pursue emerging areas of climate and fire research.

ACKNOWLEDGEMENTS

FIRMIT CONSULTING, the Editing Team, and the Food and Agriculture Organization (FAO) of the United Nations, are grateful to the Ministry for Foreign Affairs (MFA) of Finland, which financed this important up-dating work.

Sincere thanks go to the writers of the new and revised chapters of the book, notably Mark Appiah, who wrote Chapter 12 and to Timo V. Heikkilä who revised Chapter 9 and to Ronald Myers of The Nature Conservancy (TNC), whose text on Fire Ecology, forms a portion of Chapter 12 in this Handbook.

FAO and its Forestry Department in Rome, Italy, has been closely involved with the up-dating work; particularly Jim Carle, who greatly contributed to sections of the Handbook. The Editor also wants to thank the FAO Assistant Director General Jan Heino, for allocating staff time, for this important work as well as for supporting the global distribution of this publication.

Special thanks go to The Nature Conservancy (TNC) and its Global Fire Initiative, who granted the permission to copy into this book a part of their latest development work on Fire Ecology; personal input was gratefully received from Ayn Schlinsky and Wendy Fulks.

Thanks also go to the Global Fire Monitoring Center (GFMC) and its director Johann Goldammer, for his advices to the Editing Team, likewise to Peter F. Moore who drafted the framework for the CBFiM write-up.

The staff of the MFA, notably Jussi Viitanen, Markku Aho, Matti Nummelin, Sanna Leminen and Outi Einola-Head all assisted in developing approaches for the up-dating process, which greatly forwarded the work.

Final thanks go to Paul Sammer, who advised on the technical printing work in the up-dating process.



International Strategy
I S D R
for Disaster Reduction



*The Nature
Conservancy.* 
SAVING THE LAST GREAT PLACES ON EARTH

Development Policy Information Unit

Street address: Kanavakatu 4 a, 00160 Helsinki

Postal address: Box 176, 00161 Helsinki

Telephone: + 358 9 1605 6370

Telefax: + 358 9 1605 6375

Exchange: + 358 9 16005

E-mail: keoinfo@formin.fi

Internet: <http://global.finland.fi>



MINISTRY FOR FOREIGN
AFFAIRS OF FINLAND