

HEALTH GUIDELINES FOR VEGETATION FIRE EVENTS

Guideline document

Edited by

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This WHO document on the *Health Guidelines for Vegetation Fire Events* is the outcome of the WHO-UNEP-WMO expert task force meeting held in Lima, Perú, in October 1998. This Guideline document is accompanied by a document with the background papers presented and discussed at the meeting and used for the preparation of these guidelines. A Teachers' Guide has also been prepared that allows the presentation of the essential contents of the Health Guidelines in a four day training course

Note to the user:

The electronic form of this document is available on the CD ROM of the Healthy Cities Air Management Information System AMIS and, in part, from the Web site of the World Health Organization (<http://www.who.int/>) and the Global Fire Monitoring Center (<http://www.uni-freiburg.de/fireglobe>).

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Foreword

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

Vegetation fires, particularly uncontrolled ones, are a substantial source of air pollution in urban and rural areas. As such, they affect health delivery systems and access to health care, and add to rapid environmental change and degradation. Vegetation fires also add to urban and indoor air pollution (from domestic wood and coal burning for cooking and heating), and thus enhance the risk of acute respiratory infections in childhood, a major killer of young children in developing countries. The health of women is particularly affected from forest-fire pollution, as they are already exposed to high levels of air pollution in the home. As health is so dependent on a healthy physical environment, there is a need to address the global dimensions of the problem of forest fires. The challenge is to ensure sustainable development and healthy living conditions. And poverty, which leads to land clearing by burning, is at the center of that challenge.

These Health Guidelines are a result of the work of two departments of the WHO: the Department of Emergency and Humanitarian Action (EHA) and the Department of Protection of the Human Environment (PHE), both in the Cluster of Sustainable Development and Healthy Environment (SDE) of the WHO. The guidelines are intended:

- To develop the necessary capacity, not only at regional and national levels but also at the local level, and to give WHO's support to local planning efforts in health, environment and sustainable development;
- To strengthen the basis for inter-sector action in sustainable development policy and planning, by providing the necessary evidence and guidance;
- To determine best practices and disseminate such knowledge worldwide, so that all may benefit and learn from them;
- To strengthen the linkages between health, environment and development;
- To provide ongoing support in the development and implementation of the Regional and National Haze Action Plans, as parts of Environmental Action Plans to be integrated into national sustainable development planning efforts;
- To ensure that the health components of Agenda 21 of the United Nations Programme of Action, following the Earth Summit in Rio de Janeiro, are adequately addressed so that health gains trigger economies to grow and, subsequently, poverty to decrease.

Agenda 21 states:

In many locations around the world the general environment (air, water and land), workplaces and even individual dwellings are so badly polluted that the health of hundreds of millions of people is adversely affected. This is, inter alia, due to past and present developments in consumption and production patterns and lifestyles, in energy production and use, in industry, in transportation etc., with little or no regard for environmental protection. There have been notable improvements in some countries, but deterioration of the environment continues. The ability of countries to tackle pollution and health problems is greatly restrained because of lack of resources. Pollution control and health protection measures have often not kept pace with economic development.

Forests worldwide have been and are being threatened by uncontrolled degradation and conversion to other types of land uses, influenced by increasing human needs; agricultural expansion; and environmentally harmful mismanagement, including, for example, lack of adequate forest-fire control and anti-poaching measures, unsustainable commercial logging, overgrazing and unregulated browsing, harmful effects of airborne pollutants, economic incentives and other measures taken by other sectors of the economy.

Concern about climate change and climate variability, air pollution and ozone depletion has created new demands for scientific, economic and social information to reduce the remaining uncertainties in these fields. Better understanding and prediction of the various properties of the atmosphere and of the affected ecosystems, as well as health impacts and their interactions with socio-economic factors, are needed.

To some extent, many countries have already established policies, legislation and emergency response measures to control and combat vegetation fires and air pollution, and to minimize their impacts. For this reason, the development of a common set of Health Guidelines for the interest of all the countries involved is most timely. To ensure that the objectives of these Guidelines can be achieved, it is important to help the respective countries include the Guidelines in their existing policy, legislation and emergency response. This will allow areas of inadequacy to be identified and strengthened.

These guidelines help to greatly reduce the burden of excess mortality and preventable disability suffered by the poor. They also counter potential threats to health resulting from economic crises, unhealthy environments and risky behaviour. In this sense, the guidelines contribute to meeting two of the key challenges that were highlighted in the 1999 World Health Report and, thus, they contribute to making health a fundamental human right.

Dietrich Schwela

Preface

Smoke pollution due to vegetation fire events is an important public health issue and involves major risks for the health of the people and the environment. Vegetation fires in Asia, Latin America, Africa, and other parts of the world are recurring phenomena. They often lead to health impacts such as increased mortality, increased hospital admissions due to respiratory and cardiovascular diseases, and increased emergency room and outpatient visits. Smoke from vegetation fires sometimes even overlies urban air pollution, and exposure levels are intermediate between ambient air pollution and indoor air pollution from domestic cooking and heating. Because the effects of fire events are nation- and region-wide, a “natural” disaster can evolve into a more complex emergency, both through population movement and through its effects on the economy and security of the affected countries. In such an emergency the development of an early warning system would involve the multidisciplinary collaboration of scientists, technicians and administrators.

The following guidelines were developed in a collaboration of the Department of Emergency and Humanitarian Action (EHA) and the Department of Protection of Human Environment (PHE), both in the Cluster of Sustainable Development and Healthy Environment (SDE) of WHO. As an outcome of this fruitful collaboration, WHO is issuing this set of materials to provide operational tools for health care and environmental professionals, public health authorities, manufacturers of health care products and policy makers.

This WHO document *Health Guidelines for Vegetation Fire Events – Guideline document* is a comprehensive handbook with the objective of providing guidance to Governments and authorities from municipalities on the action to be taken in vegetation fire events, when large parts of the population are exposed to smoke from fires. It has to be seen as the main document that summarises the experience and knowledge laid down in the background papers presented at the WHO-UNEP-WMO expert meeting in Lima, Perú, 6-9 October 1998. These background papers are published separately in the document *Health Guidelines for Vegetation Fire Events – Background Papers*. A third document entitled *Health Guidelines for Vegetation Fire Events – Teachers’ Guide* compiles educational materials that can be used in training courses on the Health Guidelines for Vegetation Fire Events.

All three publications form a “set”, which can be useful for handling this important public health issue in a practical manner. These are the first WHO publications providing global advice and guidance on the management of vegetation fire events.

The set of documents on the Health Guidelines for Vegetation Fire Events (Guidelines, Background Papers and Teachers’ Guide) aims to achieve the following objectives:

- To raise awareness on public health and environment issues;
- To provide information, including an early warning system, on how to prevent the health impacts of vegetation fire events,
- To identify efficient, sustainable, economic and culturally acceptable prevention practices.

This *Guideline document* has been prepared as a practical response to the need for action both with respect to the recurrent vegetation fires at the local level, and improved legislation, management and guidance at the national and regional levels. WHO will be pleased to see that these guidelines are widely used. Continuing efforts will be made to improve its content and structure. It would be appreciated if the users of this guideline would provide feedback from its use and their own experiences. Please send your comments and suggestions on the WHO *Health Guidelines for Vegetation Fire Events -- Guideline document* directly to the Department of the Protection of the Human Environment, Occupational and Environmental Health, World Health Organization, Geneva, Switzerland (Fax: +41 22-791 4127, e-mail: schwelad@who.int).

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The contributions of the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in co-sponsoring the expert task force meeting on the Health Guidelines are gratefully acknowledged.

Executive Summary

Introduction

The Health Guidelines for Vegetation Fire Events are intended:

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

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

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

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

Emission, transport of air pollutants and exposure

Wildfires (uncontrolled fires) are common in all vegetation zones. They are mostly caused by negligence and are often associated with escaped land-use fires. Biomass burning is a major contributor of toxic gaseous and particle air pollutants, as well as greenhouse and reactive gases and occurs throughout the world. But unlike some anthropogenic sources, it is poorly quantified. The nature of biomass burning is such that the combustion is not complete, and as a result a large number of pollutants are emitted. Among the air pollutants emitted from biomass fires are widespread pollutants such as particulate matter, oxides of nitrogen, sulphur dioxide, and carbon monoxide. After the emission, during transport, the air pollutants undergo transformation processes, which result in physico-chemical changes of the pollutants.

In general, comprehensive approaches to be standardized for use in dealing with potential risks to public health of emissions from biomass fires should include:

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

When considering exposure to smoke plumes from biomass burning, particles receive the most attention of all air pollutants that have potentially detrimental health effects. Very small airborne particles (aerodynamic diameters below 2.5 μm) are considered the most significant pollutants from the point of view of health effects. These particles have a very high probability of deposition in deeper parts of the human respiratory tract, where they may lead to a range of health impacts by virtue of their physical, chemical, toxicological or carcinogenic nature

Ground-based monitoring

Ground-based air quality monitoring and remote sensing through satellite imagery can assess air pollutant concentrations of smoke caused by vegetation fires. Ground-based air quality monitoring should aim to provide information for public health warning and decision making on protective measures, for dispersion model inputs, verification and development, and for human health studies that evaluate effects of smoke. Air quality

monitoring should be conducted on a regular basis in major urban and other populated areas likely to be impacted by biomass burning. In addition, stations should be located in rural areas, for background concentration information. Existing networks should be reviewed and the best sites for monitoring smoke and haze episodes identified. Establishment of additional monitoring stations in areas not covered by the existing networks should be considered. The location of the sites should be determined in accordance with existing guidelines. A ground-based network of air samplers is necessary to measure the concentration of aerosols for sizes under 2.5 μm in diameter.

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

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

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

Satellite data

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

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

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

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

Atmospheric transport models

The distribution and concentrations of fire emissions must be calculated from atmospheric transport models. A description of the spatial and temporal distribution of fire emissions should consider the situation before, during, and after the episode. Defined goals are to be achieved in each of those three stages of the event. It is recommended that the agency capable of carrying out the complete suite of tasks associated with climate monitoring and modelling be identified in each area.

Mitigation measures

Mitigation measures recommended for acute events include remaining indoors, personal lifestyle modifications, use of air cleaners, use of masks and respirators, outdoor precautionary measures, evacuation to emergency shelters, and school and business activities. To enhance the protection offered by remaining indoors, individuals/building managers should take action to reduce the infiltration of outdoor air. Schools, childcare centres, retirement centres, nursing homes, hospitals and hospices should be especially urged to provide air conditioned rooms to susceptible individuals, and effective filters should be

installed and maintained in these rooms. During severe smoke episodes, members of the public should be advised on lifestyle modifications, such as the reduction of physical activities and the restriction of cigarette smoking. Evaluation of the use of portable air cleaners should be conducted and appropriate advice given to the public, to assist them in purchasing models suitable for homes or offices. Advice should be given to the public on specific dust/mask respirator types and their relative utility for filtration of smoke particles, including the proper use and selection of available dust masks/respirators. Precautionary measures should be taken to safeguard the health and safety of workers who must continue to perform outdoor work. For example, employers should provide respirators to workers who must work outdoors during acute emergencies. In severe episodes, susceptible individuals should be allowed free access to air-conditioned emergency shelters (with adequate particle filtration). These could be located inside large commercial buildings, educational facilities or shopping malls.

Health effects

The epidemiological studies of indoor and community exposure to biomass smoke indicate a consistent relationship between exposure and increased respiratory symptoms, increased risk of respiratory illness and decreased lung function. A limited number of studies also indicate an association between biomass smoke exposure and visits to emergency departments. Recent assessments of impacts from the 1997-98 Southeast Asian haze episode support an association with increased hospital visits. Studies of the relationship between biomass air pollution and acute mortality have not been conducted to date. However, as biomass air pollution mostly consists of fine and ultra-fine particulate matter the new air quality guidelines of the WHO for particulate matter suggest a definite impact on daily mortality, hospital admissions, emergency department visits and outpatient visits.

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

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

need to conduct a rapid epidemiological assessment, focusing on the demographics and health concerns of people in the affected community.

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

Public policies

Policy objectives

In terms of policies, most countries have in place some form of laws and regulations for the control of forest fire and air pollution, and for protecting public health and the environment from the impact of haze episodes. Presently, areas of weakness need to be identified and means of strengthening enforcement need to be established.

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

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

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

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

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

- To monitor and report on air quality;

- To develop an effective mechanism for monitoring land and forest fires;
- To develop the capability for detecting and predicting forest fires and haze;
- To monitor the health and environmental impacts of haze.

The *Management Policies* focus on the following aspects:

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

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

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

National Haze Action Plans

To ensure full preparedness of the population for the health impacts of vegetation fire pollution, a comprehensive National Haze Action Plan should be developed and widely publicized through the media, before the occurrence of any air pollution episode. Based on this action plan, government departments should develop operating procedures and ensure that the population will be aware of any changes made to public services and facilities in an emergency situation. Data on air pollution related illnesses from primary health care

providers, hospitals, and mortality registries should be reported periodically. Special educational efforts should be developed for susceptible populations, such as asthmatics, the elderly, and children to ensure that they are adequately prepared for air pollution episodes. Health authorities, via the media, should proactively address frequently asked questions, such as the safety of food and potable water supplies exposed to smoke for prolonged periods.

Lessons learned from the 1997-98 fires

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

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

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

- Policies that tend to increase forest fires must consider public health effects. Policies concerned with maintaining the health of fire-adapted ecosystems may have to balance public health and forest health issues.

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

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

Research needs

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

- The development of dedicated space-borne remote sensing technologies for improving decision support in fire management, including technologies for fire detection and early warning;
- Post-fire recovery techniques, fire effects and ecosystem recovery processes;
- The impact of climate change on fire regimes and fire severity,
- The implementation of a global vegetation fire inventory, and the implementation of a center to monitor, archive, and disseminate global fire information, as well as forecast fire and related hazards;
- Special attention to fire-generated radioactive emissions;
- The development of source information for fires in different ecosystems,

- Physical/chemical factors contributing to the changes that occur over time and space during transport;
- Compilation of information pertaining to levels of exposure and fire activity, in conjunction with past fire and smoke episodes;
- Mitigation approaches;
- Health impacts of air pollution due to biomass burning within the general population.

Conclusions

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

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

These Health Guidelines are a result of the work of two departments of the WHO: the Department of Emergency and Humanitarian Action (EHA) and the Department of Protection of the Human Environment (PHE), both in the Cluster of Sustainable Development and Healthy Environment (SDE). The recommendations and chapters were drafted at the WHO-UNEP-WMO expert meeting held in Lima, Perú, in October 1998.

The Health Guidelines are intended to develop the necessary capacity not only at regional and national levels, but also at local levels, and to give WHO's support to the local health, environmental and sustainable development planning efforts being undertaken; to provide the necessary evidence and guidance for strengthening inter-sector action in sustainable

development policy and planning; to determine best practices, and disseminate such knowledge worldwide; to strengthen the linkages between health, environment and development; and to provide ongoing support in the development and implementation of the Regional and National Haze Action Plans, as part of Environmental Action Plans to be integrated into national sustainable development efforts.

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