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The WHO/UNEP/WMO Health Guidelines for Vegetation Fire Events - An Update

Abstract

Forest fires are a recurrent phenomenon around the globe. Most recently, about 20 000 Australian fire fighters tried to control more than 80 extensive fires that raged around Sydney. These fires were extinguished only by sufficient rainfall after weeks of drought. The World Health Organization (WHO), in its Health Guidelines for Vegetation Fire Events, strongly advocates the use of all technical capacities for an early warning system. For this purpose, three documents entitled “Health Guidelines for Vegetation Fire Events – Guideline Document", – "Teachers´ Guide", and – "Background Papers" were published in 1999 as the outcome of the deliberations as the outcome of an expert meeting, convened in the aftermath of the huge forest fires in South East Asia, 1997. This meeting was co-sponsored by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) and funded by the Japanese Ministry of Health. In this meeting experts from different fields of expertise - public health, ground-based monitoring, remote sensing, and administrators - set the stage for an early warning system for the protection of public health from the impacts of smoke from vegetation fires. This paper highlights background and essential results of the guideline document. The guideline document was widely distributed to administrations of countries exposed to smoke from vegetation fires. The early warning system can help to decrease the frequency of fires and to protect the population from the adverse health impacts from smoke of such fires. Recommendations given in the guideline document can also prevent health impacts from smoke of vegetation fires by proper land-use policies.

Introduction

Vegetation fires are caused by slash and burn land clearing, clearing of plantations following logging operations, and by natural events such as lightning or extreme drought. During dry seasons fires usually reach a peak and can present a transboundary problem when prevailing winds disperse the smoke across borders to other countries. It can happen that extensive fire fighting activities do not help to extinguish the fires, especially when peat soil is burning. In recent years after the devastative fires in South East Asia from July to October 1997 (Heil and Goldammer 2001), intensive fires occurred in Mexico in 1999, in the United States in August-September 2000, in Australia in December 2001, and in Russia in 2002 (GFMC 2002). As the statistics from the Global Fire Monitoring Center show, fires are a global phenomenon that occurs in every country around the world (GFMC 2002).

The smoke from vegetation fires contains of several hundreds of compounds including fine particulate matter, carbon monoxides, aldehydes, volatile organic compounds, polycyclic aromatic hydrocarbons, and free radicals. While some of these compounds can affect fire fighters and people living close to the fires, others such as fine particulate matter may disperse over hundreds of kilometres and may seriously sicken exposed populations. An example in case are the concentrations of PM_{10} (particles smaller than 10 micrometers in aerodynamic diameter) as monitored in Malaysia and Singapore during the outbreak of the vegetation fires in Indonesia from July to October 1997 which substantially exceeded the air quality guidelines recommended previously by WHO (WHO 1987) and national air quality standards several hundred kilometres away from the sources. Increased numbers of incidences of respiratory diseases and hospital admissions were reported. Quite recently, in Sydney, whole suburbs had to be evacuated because of the closeness of many wildfires to residential areas and a huge smoke cloud in all parts of the city.

The costs incurred with of vegetation fires may be quire substantial: The South East Asian forest fires, which from July to October 1997 engulfed a large part of the South East Asian region in smoke were estimated to cost US $ 4.5 billion in forest loss alone. A recent study (Awang et al. 2000) estimated the haze-related costs for short-term health effects, production losses, tourism-related losses, and the

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cost of mitigation action in Malaysia to amount to US $ 265 million, and considered this result likely to be an underestimate.

The WHO/UNEP/WMO Health Guidelines for Vegetation Fire Events (WHO/UNEP/WMO 1999a; b; c) advocate a comprehensive strategy and contingency plans harmonised between countries and States within a country to the utmost extent possible, which would help to mitigate the air pollutant burden suffered by the general public. These guidelines are based on broad international consensus and intend to avoid or mitigate the health effects due to exposure of the population to smoke from vegetation fires. The comprehensive strategy includes a rapid detection capability of uncontrolled vegetation fire emergencies on a global scale; the gathering of useful and reliable data on monitoring and a health surveillance system; the dissemination of information to all affected parties for appropriate decision making; and the development of national environmental and health response plans to vegetation fire emergencies. The strategy considers environmental as well as health aspects, cause-effect relationships, long-range pollution transport, land-use planning and fire prevention, and other related issues.

Health impacts of smoke from vegetation fires

Smoke from biomass burning contains a large and diverse number of chemicals, many of which have been associated with adverse health impacts (WHO/UNEP/WMO 1999b). Nearly 200 distinct organic compounds were identified in wood smoke aerosol, including volatile organic compounds and polycyclic aromatic hydrocarbons. Available data indicate high concentrations of inhalable particulate matter in the smoke of vegetation fires. Since particulate matter produced by incomplete combustion of biomass are mainly less than 1 □m in aerodynamic diameter, both PM_{10} and $PM_{2.5}$ (particles smaller than 2.5 micrometers in aerodynamic diameter) concentrations increase during air pollution episodes caused by vegetation fires. Carbon monoxide and free radicals may well play a decisive role in health effects of people who live and/or work close to the fires.

Inhalable and thoracic suspended particles move further down into the lower respiratory airways and can remain there for a longer period and deposit. The potential for health impacts in an exposed population depends on individual factors such as age and the pre-existence of respiratory and cardiovascular diseases and infections, and on particle size. Gaseous compounds ad- or absorbed by particles can play a role in long-term health effects (cancer) but short-term health effects are essentially determined through particle size (WHO/UNEP/WMO1999b). Quantitative assessment of health impacts of air pollution associated with vegetation fires in developing countries is often limited by the availability of baseline morbidity and mortality information. Air pollutant data are of relatively higher availability and quality but sometimes even these data are not available or reliable.

According to recent epidemiological studies, the levels of suspended particulate matter currently monitored in many urban areas in the world are associated with increased daily mortality, increased outpatient emergency room visits and hospital admissions, and exacerbation and increase in number of respiratory diseases (see e.g. Pope 2000). Increases in restricted activity days and in school absenteeism have been observed with increased levels of fine particulate matter as well as increases in the frequency of cough and bronchodilator use. Infants are a particularly sensitive group with respect to acute respiratory infections (ARI) exacerbated in the presence of smoke. ARI is worldwide the main cause of death in infants. These impacts were derived from time-series and cohort studies, which investigated the health impacts of particulate matter in the urban airshed.

The association between increases in daily mortality and particulate matter concentrations exists primarily for the elderly and for individuals with pre-existing respiratory and/or cardiovascular illness (POPE 2000; Pope and Dockery 1999). A threshold for the onset of health effects in to suspended particulate matter in the general population was not established. Therefore, the WHO Guidelines for Air Quality (WHO 2000) did not quote a guideline value for PM_{10} and $PM_{2.5}$ but rather recommended essentially linear exposure-response relationships be used as guidance for deriving air quality standards and a means to estimate the burden of disease due to exposure to particulate matter. The health-related considerations in the Guideline Document concentrate essentially on particulate matter since the potential effects of the many compounds, acting alone or together, in smoke from vegetation fires is not well studied. Concentrating on particulate matter and its health effects observed in urban airsheds and caused by vehicular and industrial emissions bases on the assumption that "urban" particulate matter and particulate matter emitted from vegetation fires may have comparable health impacts. No studies are known that indicated that fine particulate matter fin the smoke from vegetation fire would lead to different health impacts (Brauer 1997).

Specific studies of exposure to biomass smoke or “haze” of children and adults indicate a consistent relationship between exposure and increased respiratory symptoms, increased risk of respiratory illness and decreased lung function (see WHO/UNEP/WMO 1999b). A limited number of studies also indicate an association between biomass smoke exposure and visits to hospital emergency rooms. Asthmatics are a particularly sensitive group. During the smoke episode caused by the vegetation fires in Indonesia, the Malaysia Ministry of Health reported a two- to three-fold increase in the number of outpatient visits for respiratory diseases during high PM_{10} concentration events. A study by the Universiti Kebangsaan Malaysia has demonstrated a 14% lung function decrease in a group of Kuala Lumpur schoolchildren during the smoke episode. A crude analysis of surveillance monitoring of ARI, asthma and conjunctivitis incidence in August-September 1997 at three hospitals in the Klang Valley in comparison to the Malaysian air pollution index indicates a clear relationship between incidence and PM_{10} concentration. The Indonesian Ministry of Health indicated a total of 210000 clinically affected individuals as of 22 October 1997, one month after the peak of the episode. Pneumonia cases in South Sumatra, in 1997, increased 1.5-5 fold as compared to 1996. In September 1997, in the province of Jambi, Indonesia, an increase of 50% of upper respiratory tract infections as compared to the previous month was observed. Pneumonia cases in South-East Kalimantan, Malaysia, in 1997 increased 5- to 25-fold as compared to 1995/1996. Surveillance data by the Ministry of Health, Malaysia indicated a 2-3-fold increase in number of outpatient visits for respiratory diseases during the 1997 episode. An increase of PM_{10} from 50 to 150 $\mu g/m^3$ in Singapore was associated with increases of 12% of cases of upper respiratory tract illnesses, 19% of asthma, and 26% of rhinitis; however, an increase in mortality and admissions was not observed in Singapore during the 1997 episode (Emmanuel 2000). While most of these reports are more anecdotal statements and lack scientific consideration of confounding variables, a recent study of the RAND institution in Santa Monica, CA, USA, showed that the smoke from the South East Asian fires had a deleterious effect on public health in Malaysia (Sastry 2002). Sastry observed the following.

In Kuala Lumpur, for the entire population, total deaths due to non-traumatic causes were 21% higher after a high-pollution day; deaths due to non-traumatic causes increased by 75% in the people aged 65-74, and those for cardiovascular and respiratory deaths by 100% in the same age group, respectively. In Kuching, Sarawak, Malaysia, deaths due to non-traumatic causes increased by 260% in the people aged 75+, those for cardiovascular deaths by 310% in the same age group, and those for respiratory deaths by 240%; in the group 65-74, respiratory deaths increased by 260%. These results were not substantially changed by an autoregressive analysis. For the week of highest contamination in Kuching this would correspond to 17.5 excess deaths. This result, extrapolated ceteris paribus to Sarawak with 5 times the population of Kuching would amount to 88 excess deaths.

In 1998, the WHO estimated the increase in premature deaths due to exposure to smoke from forest fires in various regions of the world, using a simple model, published by Schwela (1996). The results for various States in Brazil, Malaysia and Indonesia are presented in Figure 1. As can be inferred from this figure, the excess death rate in the week of highest particulate matter pollution in Sarawak, as evaluated in the paper of Sastry (2002) lies well in the range of the rough estimate of WHO for Sawarak of between 47 and 203 deaths.

Sastry points out that in Indonesia, the effects from the smoke of vegetation fires must have been very large as the presence of significant mortality effects in Malaysian cities that are several hundreds miles away from the main fires suggests. For Sumatera and Kalimantan, the estimates of WHO in Figure 1 underline this expectation. Unfortunately, no appropriate health or mortality data have as yet been analysed for Indonesia to study this issue directly. Preliminary evaluations show, however, that there was a significant increase in respiratory conditions, lung function complaints and other related impacts due to the haze (Aditama 2000).

In other parts of the world health impacts from smoke of forest fires were also noted: The number of respiratory disease outpatients in Alta Floresta, Brazil, 1997, was before the burning season 2-3 outpatients per week, while this number increased during burning to 40 outpatients per week (Mims 1997). During California forest fires in 1987, a 40% increase in emergency visits for asthma and 30% increase in emergency visits for chronic obstructive pulmonary diseases were observed (Duclos et al. 1990).

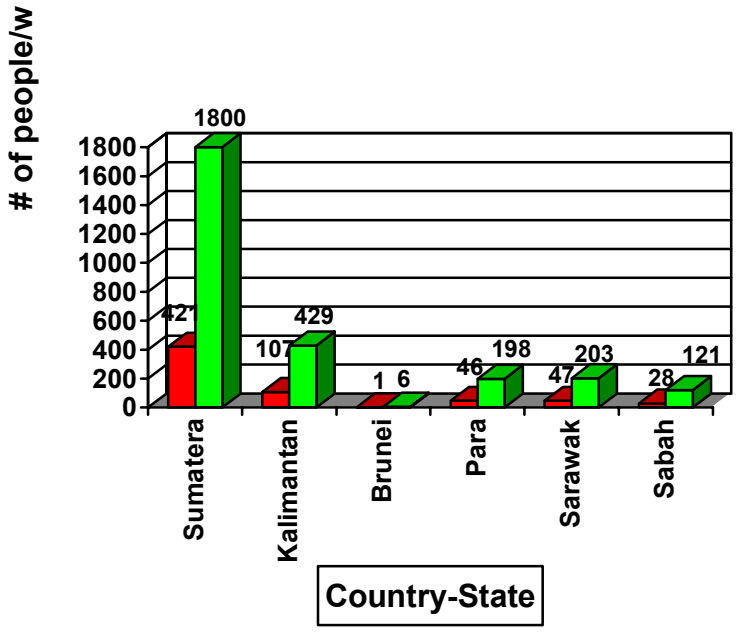


Figure 1. Number of people estimated to have died prematurely due to smoke from forest fires in South East Asia and Brazil in the week of most pollution in Southeast Asia, September 1997

Health Guidelines For Vegetation Fire Events

Based on background papers, the WHO, in collaboration with UNEP and WMO, and with funds froim the Ministry of Health of Japan, convened in October 1998 in Lima, Perú, a group of high-level experts with personal experience covering collectively all pertinent aspects of the problem, including:

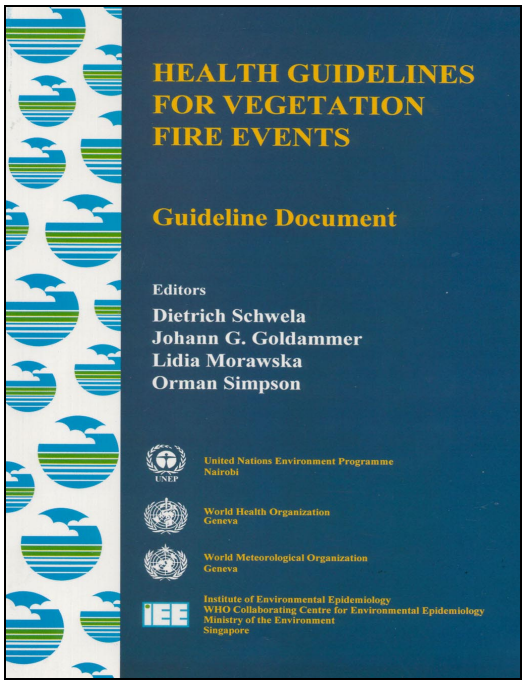
- Methods of health surveillance
- Air pollution (particulate matter) epidemiology
- Bio-mass fuel health effects
- Medical case studies of induced health effects resulting from large area vegetation fires
- Air pollution exposure assessment
- Chemical properties/speciation of smoke compounds
- Ground based environmental monitoring technologies
- Global and regional meteorological mass transport modelling, forecasting, prediction of concentrations
- Advanced regional and global satellite, aircraft mounted environmental monitoring technologies
- Regulatory environmental and health government policies, including early warning procedures

This expert meeting developed the WHO/UNEP/WMO Health Guidelines on Vegetation Fire Events. These guidelines refer to

1. Review and summary of globally available information and case studies on the health impacts of vegetation fires;
2. Review and summary of globally available monitoring information and data from measurement campaigns on vegetation fires;
3. Characterisation of air pollutant components in vegetation fires and their associated health effects;
4. Recommendations on the interpretation and use of monitoring data, global and regional meteorological data, and atmospheric mass transport modelling to determine source apportionment of smoke episodes (i.e., large area source emissions characterisation) and determine or predict down wind air quality impact on human population;
5. Review and summary of existing national policies and guidelines on vegetation fires emergencies;

6. Guidance on scientific methodologies for studying vegetation-fire-induced health effects;
7. Guidance for contingency plans, including a series of recommended steps to be used in decision making during a vegetation fire episode and actions to taken;

Three documents of the Health Guidelines for Vegetation Fire events were published: Guideline Document (WHO-UNEP-WMO 1999a), Background Papers (WHO/UNEP/WMO 1999b) and a Teachers' Guide (WHO/UNEP/WMO 1999c). The cover page of the Guideline Document is depicted in figure 2.



The Guideline Document, in a chapter on air pollution from vegetation fires and health, discusses the topics

- Global fire occurrence
- Hazard Assessment at the basis of fire risk
- Source characterisation: Emission and post-emission processes
- Ground-based monitoring
- Space monitoring, climate monitoring and modelling of fire emissions distribution; and
- Existing emergency response procedures

Figure 2. Cover page of the Guideline Document

In its chapter on the guidelines the Guideline Document describes the acute and chronic health effects of particulate matter from the smoke of biomass and gives public advisories on how to inform the public with respect to

- Ambient air quality
- National action
- Health effects

Mitigation measures are discussed in detail such as

- Remaining indoors
- Use of air cleaners
- Use of respirators
- Outdoor precautionary measures, and
- Evacuation to emergency shelters

Methodologies are also given for the assessment of forest-fire-induced health effects treating the issues of

- Important potential components
- Study designs/acute exposures
- Study designs/chronic exposures
- Evaluation of data, and
- Priority setting

A final chapter of the Guideline Document elaborates on the prevention of future health-affecting events by discussion of the source of the problem – land-use and fire policies – and addressing gaps in knowledge, technologies, and programmes.

The document of Background Papers contains background papers, prepared by experts of the different scientific communities, which cover the issues

- Ground based and remote monitoring of vegetation fire events
- Assessment of health impacts of vegetation fires
- Case studies of health effects of vegetation fires, and
- Management of vegetation fire emergencies

The goal of the Teachers' Guide is to enable national trainees of the guidelines become trainers, and disseminate the information in the guidelines to the staff of national agencies, fire fighters and other stakeholders involved in the fighting, suppression and prevention of vegetation fires. The Teachers' Guide contains the complete set of slides used in three training courses and may serve for further training courses in all regions around the world, after appropriate updating and revision with respect to scientific and technological development.

The Guideline Document was translated into French and Spanish. In 2001, the AMIS CD-ROM was prepared, which among other topics contains all three documents in English and the French and Spanish editions of the Guideline Document. The CD-ROM contains the slides in English and Spanish used in the above-mentioned training courses in Kuala Lumpur and the one held in Brasilia, Brazil. The AMIS CD ROM is depicted in Figure 3, and can be obtained from WHO free of charge (WHO 2001).

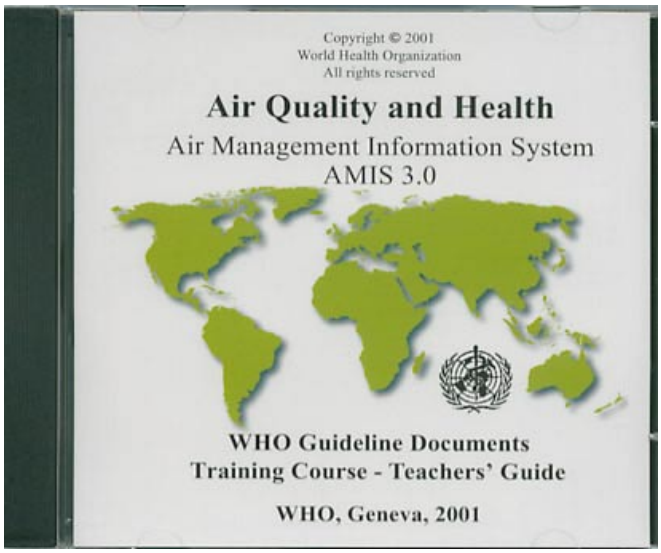


Figure 3.
The CD ROM of the Air Management Information System AMIS

In summary, the WHO/UNEP/WMO Guidelines for Vegetation Fire Events are useful documents, which serve to advise Governments and the general public to prevent health impacts of smoke/haze caused by vegetation fires by use of an early warning system against such events, mitigation measures, and appropriate land use planning. Although the Guidelines for Vegetation Fire Events were widely distributed to Governments of countries at hazard to impacts from forest fires, efficient action to prevent vegetation fires and mitigate their health impacts in future episodic events is only slowly emerging.

In the aftermath of the South East Asian fires in 1997, the Association of South East Asian Nations (ASEAN) adopted a plan to deal with forest fires, with Malaysia overseeing preventive measures, Indonesia fire-fighting resources and deployment and Singapore, a regional-monitoring mechanism. A workshop on transboundary atmospheric pollution, in November 1998, produced a framework for dealing with large fires. In April 1999, ASEAN adopted a "zero-burning" policy and urged all countries to quickly implement the necessary laws and regulations to enforce this major decision aimed at controlling the transnational environment pollution caused by forest and land fires. In March 2000, ASEAN has put into operation its Fire Suppression Mobilisation measures in the districts of Riau Province, Indonesia to contain the spread of forest fires and smoke haze. These mobilisation measures are part of the broader Action Plan for the Prevention and Control of Land and Forest Fire and Haze in Sumatra and Kalimantan.

As part of ASEAN's efforts to develop a long-term capability to undertake fire suppression, field-training exercises for the prevention and control of land and forest fires and haze have been held in

Sumatra and West Kalimantan. ASEAN's Regional Haze Action Plan Co-ordination and Support Unit continuously monitors the haze situation on a day-to-day and region-wide bases and shares it findings through its website called the ASEAN Haze Action Online (ASEAN HAO 2002). This website provides the following information:

- Hyperlinks to institutions involved in regional monitoring and prediction of fire and smoke haze
- ASEAN Transboundary Haze daily update
- Intranet: Information and possible participation in the ASEAN Haze Action Online Intranet Information Services
- Model Fire Suppression Mobilization Plan
- Inventory and analysis of forest and land fire suppression capabilities
- Communication platform on fire and smoke-haze issues in the ASEAN region
- Calendar of fire and haze-related events.

These activities certainly are a step in the right direction. It has to be seen, however, whether scientific measures are sufficient; whether national and regional arrangements are adequate, appropriate, or in place at all, and whether they are supported by policies, procedural guidelines and information availability, and if not, which policies and legislative measures are required to back up the regional haze action plan. It is, moreover, important to address the causes of vegetation fires, to develop rational options for land-use planning, and to develop a community and social-based approach, in which local populations' methods and habits are influenced. Such approaches were advocated in the WHO/UNEP/WMO guidelines.

IFFN Contribution by

Dieter Schwela [1]
European Commission Joint Research Centre
Institute for Health and Consumer Protection
Physical and Chemical Exposure Unit, TP 460
21027 Ispra, Varese
Italy

Tel: +39-0332-78-9484
Fax: +39-0332-78-9453
e-mail: dieter.schwela@jrc.it

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[1] Formerly at Department of Protection of the Human Environment, Occupational and Environmental Health Programme, World Health Organization

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