



Policy responses to complex environmental problems: insights from a science–policy activity on transboundary haze from vegetation fires in Southeast Asia

Daniel Murdiyarso^{a,*}, Louis Lebel^b, A.N. Gintings^c, S.M.H. Tampubolon^d,
Angelika Heil^e, Merilyn Wasson^f

^a Department of Geophysics and Meteorology, Bogor Agricultural University, Jl. Raya Pajajaran, Bogor 16143, Indonesia

^b Department of Social Sciences, Chiang Mai University, Chiang Mai, Thailand

^c Forest Research and Development Centre, Jl. Gunung Batu 5, Bogor, Indonesia

^d Development Research Centre, Bogor Agricultural University, Jl. Raya Pajajaran, Bogor, Indonesia

^e Fire Ecology Research Group, Max Planck Institute for Chemistry, Freiburg, Germany

^f Research School for Biological Sciences, Australian University, Canberra, Australia

Abstract

Transboundary pollution from vegetation fires is a recurrent and highly politicised environmental problem in Southeast Asia. This paper is a critical synthesis of the policy response to the severe haze episodes of 1997/1998. It is based on a series of science–policy activities co-ordinated by the Global Change Impacts Centre for Southeast Asia aimed at exploring land-use planning and management options to reduce the impacts of transboundary pollution from vegetation fires. We begin with a brief summary of what is known about the causes of the fires and haze, the composition and distribution of haze, and the main impacts. Policy options and instruments are considered at a range of levels, from local waste-wood management options and national land development strategies, through to regional and international institutions. In these analyses, we seek to understand the interaction of different interest groups and identify potentially complementary policies as well as likely tradeoffs. Ultimately, the aims of these activities are improvement of the public policy process and greater relevance of research activities and research-based knowledge.

© 2004 Elsevier B.V. All rights reserved.

Keywords: Land management practices; Environmental governance; Policy intervention; Science–policy; Dialogue

1. Introduction

The high economic growth and social changes experienced by many countries in the Southeast Asian region over the past few decades has been based in

part upon the exploitation of natural resources and development of agriculture-based industries, both of which involve conversion of forests and intensification of land-uses. The fires that raged in Indonesia in 1997 and early 1998, many of them deliberately lit to clear land for tree crops, produced a blanket of smoke or “haze” that spread and persisted over Indonesia and neighbouring countries for months. The impacts of the atmospheric pollution on health, transport and tourism, largely were borne by Indonesia, Singapore and Malaysia. However, at times parts of southern

* Corresponding author. Present address: Center for International Forestry Research (CIFOR), P.O. Box 6596 JKPWB, Jakarta 10065, Indonesia. Tel.: +62-251-311-681/622-622; fax: 62-251-376-817/622-100.
E-mail address: d.murdiyarso@icsea.org (D. Murdiyarso).
URL: <http://www.cifor.cgiar.org>.

Thailand and the Philippines also were affected, which helped make the fires and associated haze a major international environmental issue and media event.

This was not the first time the region has been affected by haze. In fact fires are used every year to prepare land and burn waste wood and crop residues. The haze episode in 1997/1998 resulted from the combination of dry conditions during the El Niño Southern Oscillation (ENSO) cycle and resulting atmospheric inversion that results in greater amounts persisting for a longer time.

The haze issue is a striking example of a cyclic policy issue—one that literally waxes and wanes with the weather. The highly visible transboundary smoke stimulates a quick and sharply critical response from the public and media in recipient countries. Action groups, academics and political leaders soon follow with calls for corrective actions. Regional and international organisations follow often supported by short-term funding and many meetings and workshops. The research community then comes to the fore with criticisms of past inaction, new formulations of the problem, and more options. Then it rains, and everything is forgotten. There is clearly a need for a more sustained dialogue between science and policy.

This paper is a synthesis of the results of activities described in the next section. It draws largely but not exclusively on the experiences from a series of science–policy activities co-ordinated by the Global Change Impacts Centre for Southeast Asia (IC-SEA) based in Bogor, Indonesia to explore land-use planning and management options to reduce the risks of transboundary pollution from vegetation fires. The ultimate aim of these activities are to: (1) improve the use of existing research-based knowledge in the public policy process and (2) highlight key gaps in understanding for the research community. A common theme that emerges is that reducing the risks of severe haze episodes will require institutional and policy reform at national and regional levels.

2. Methods

Various parts of the research community are well positioned to contribute knowledge about the uses of fire and the impacts of the haze. The Alternatives to Slash-and-Burn (ASB) Programme, for example, has

been studying the processes of land conversion and their implications for global change and human welfare in key fire areas in Sumatra. The international global change programs, especially the World Climate Research Programme (WCRP) and the International Geosphere–Biosphere Programme (IGBP) have been studying the effects of fires on the global atmosphere and the effects of climate change on ENSO. Other key projects on forest and fire management, often with close collaboration with the Indonesian Ministry of Forestry and Estate Crops are also on-going (Dennis, 1999). Finally, a number of specific projects were developed in response to the 1997/1998 haze episodes, often making use of the expertise of individuals or institutions working on some of these other long-term projects. Together this community of researchers and experts form a research community (or network) around the transboundary pollution issue. With claims of knowledge and expertise the network then had some legitimacy in engaging the public policy process. For example, the economic impacts have been thoroughly studied by the Economy and Environment Program for Southeast Asia (EEPSEA) and the underlying causes of fires were studied by Center for International Forestry Research (CIFOR) and International Center for Research in Agroforestry (ICRAF).

A group of researchers affiliated with IC-SEA began discussing plans for an activity that would facilitate science–policy dialogue in late 1997. Fig. 1 shows the step-by-step process of the implementation of the activities. The feeling at the time was that there were many projects and meetings being planned, but little sense of overall co-ordination among them. It was hoped that IC-SEA, with only a relatively small amount of funds, could nevertheless make an impact by facilitating collaboration among key individuals in the research community. Reviews on waste-wood management options, regional and national policy options, and stakeholders interviews were commissioned. The outcomes were brought together and discussed in a synthesis workshop with a wider audience. Satellite workshops were then conducted to capture health and tourism related issues in the neighbouring countries, in this case Malaysia and Thailand, respectively.

The independence of IC-SEA from major Indonesian authorities, and international players such as Association of Southeast Asian Nations (ASEAN), the

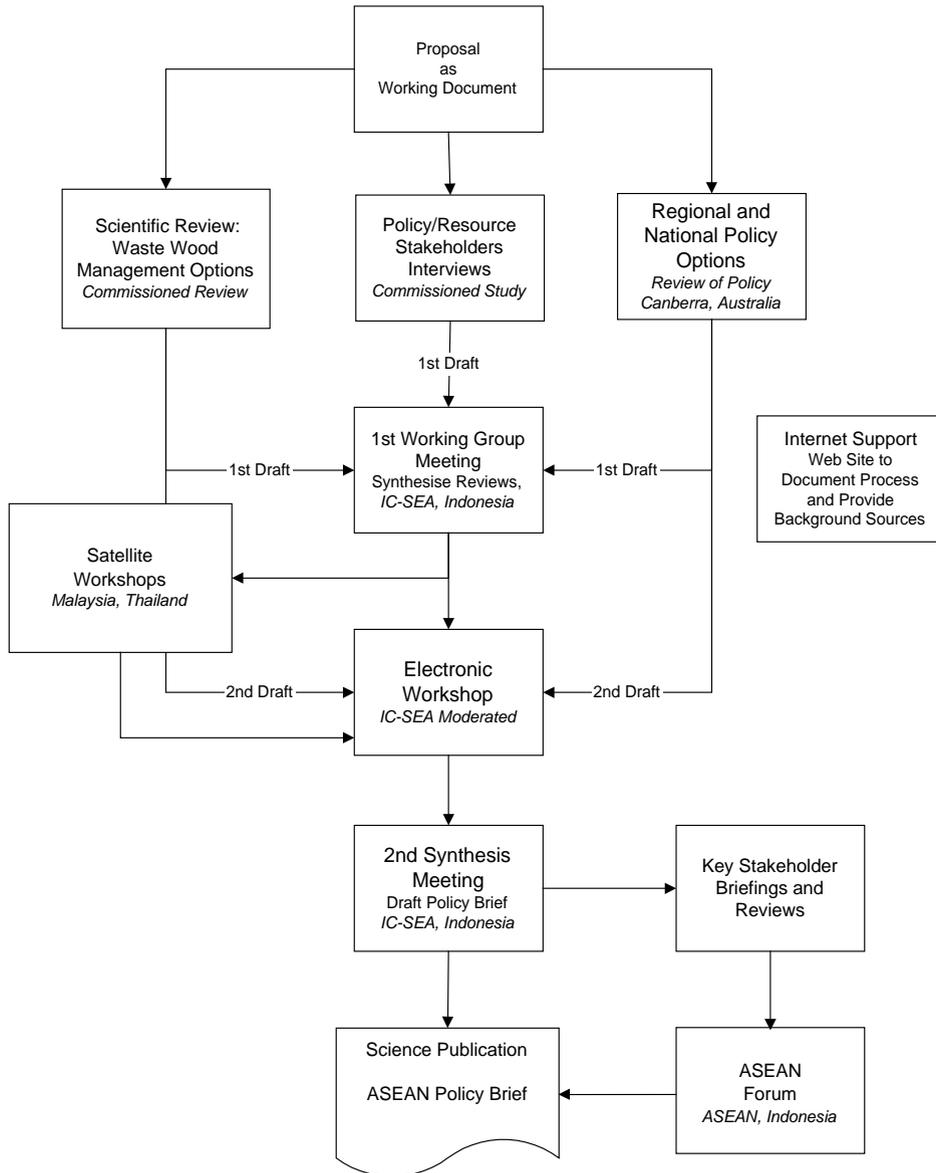


Fig. 1. Overview of the Impacts Centre for Southeast Asia’s science–policy activities on transboundary pollution from vegetation fires.

Asian Development Bank (ADB) and the World Bank was also an important advantage. A forum that involved these institutions and government officials was organised following an electronic discussion on the synthesis results.

Overall, the science–policy process was designed to effectively motivate interests and facilitate open discussions and collaboration among members of the

research community across the Southeast Asia region. When the level of political interest is high this interaction became more difficult, but at the same time more important, as researchers needed access to peers. It should be noted that many individuals in this network as members of the technical elite in their countries often have roles as informal advisors to their governments.

On the other hand, the direct influence of IC-SEA's activities on the use of research-based knowledge in the public policy process was limited. Although some dialogue between policy advisors and leaders with the research community was achieved, this was fairly limited, and we did not make much use of news media to raise awareness among the wider public. In most ways it is not realistic (or sensible) to expect to be able to document direct impacts from a single project when there were so many related concurrent projects. Considering the overall efforts and influence of the research community, especially those projects based in international organisations like CIFOR, ICRAF, and EEPSEA were substantial. Newspaper and newsletter articles and communications over the internet undoubtedly helped people outside the region to better understand some of the issues involving the use of fire, in particular, the political economy of forest conversion in Indonesia.

3. Use of research-based knowledge

3.1. The causes of fire

There was a widespread misconception about the source of haze and smoke. The general public perceived that haze was primarily from wildfires or from slash-and-burn agricultural activities of smallholders. In fact, there were a variety of sources including a substantial contribution from large-scale land clearing activities. The availability of satellite images of fires and haze from remote sensing groups outside Indonesia was particularly important as evidence to back up requests for the Indonesian government to take action against large-scale plantation developers.

It was also accepted by lay people and repeatedly quoted by bureaucrats that fires were caused by ENSO, and therefore, a natural disaster, which could not be prevented. In fact, fires were caused by people and most were lit deliberately to take advantage of the dry conditions to prepare land (or as a weapon in land disputes). ENSO in many locations provided the climatic conditions suitable for haze episodes but it is hardly the underlying driver or cause.

An underlying cause neglected in the early discourse on the haze was that the forest land development strategies in Indonesia are not sustainable and

often wasteful. The process is underlined by an official plan to convert forests on a massive scale, known as Ministerial Decree No. 682/Kpts/Um/8/1981. The 1982–1987 Five-Year Development Plan, as a result, designated 20–30 million hectares of forestland as Conversion Forests. The cumulative impacts are compounded by poor site selection of large-scale agriculture and human settlement projects. The net result being vast areas of abandoned and degraded land.

Thus, a more comprehensive analysis suggests that there is a suite of underlying and interacting causes which form a cascade of policy problems in land-use planning and management of forest resources (see e.g. Tomich et al., 1998; Potter and Lee, 1998; Siscawati, 1998; Goldammer, 1998; Goldammer et al., 1998; Schweithelm, 1999). These are: (1) inappropriate use of fire as a tool to clear land; (2) destructive and inefficient logging practices; (3) an unfair system for planning and allocating use rights to forests; (4) questionable land development strategies emphasising monoculture crops, few commodities and promoting rapid deforestation; and (5) lack of an effective international (regional) environmental regime.

3.2. The impacts

The haze produced by vegetation fires consists mainly of fine particulate matter (PM), which can be transported to a great distance. To a lesser extent, the haze also contains carbon monoxide and polycyclic aromatic hydrocarbons (PAH), which are transported a relatively short distance. During the 1997 haze episode stations in the Klang Valley recorded particulate matter larger than 10 μm (PM_{10}) up to 450 $\mu\text{g}/\text{m}^3$ (Noor et al., 1998), stations in Singapore recorded 100–150 $\mu\text{g}/\text{m}^3$ (Anonymous, 1998), and in southern Thailand the maximum value was 218 $\mu\text{g}/\text{m}^3$ (Phoonboon, 1998). These figures were much higher than the normal concentration, which should be below 50 $\mu\text{g}/\text{m}^3$.

Transboundary pollution had impacts on ecological and human systems. The primary short-term ecological impacts were reduction the amount of light for photosynthesis for plant growth (including crops and plantations, e.g. Hassan, 1998) and the disturbance of wildlife (e.g. Schweithelm, 1999). In the long-term, the most important impact of the fires on

native vegetation was habitat loss and degradation and the threats these pose to biodiversity conservation. After the fires, some short-term impacts on erosion and hence water-quality may be expected, which in turn may have had some impacts on inland waters and coastal zones.

The 1997/1998 fires in Sumatra and Kalimantan, especially the smouldering fires in peat swamps, added millions of tons of emissions and smoke to the atmosphere. Levine (1998) estimated that these episodes produced 85–316 Mt of CO₂, 7–52 Mt of CO, 0.2–1.5 Mt of NO_x and 4–16 Mt of particulate matter, the range depending largely on assumptions about the amount of peat burnt. The emissions were transported horizontally by south-westerly monsoon winds after the plumes reached a critical height (Garstang, 1998).

The emissions released from fires, while still small on a global scale compared to those emissions from industrial activities in developed nations, are nevertheless significant. There was no exact figure on the area of vegetation burned during the fires in 1997/1998 but an estimate of 10 Mha was often quoted. If the median of carbon density of 50 tC/ha and burning efficiency of 50% were assumed, the maximum CO₂ release during that episode was about 0.90 Gt. Since 1 Gt CO₂ is equal to 0.5 ppmv, the 1997/1998 fires have added 0.45 ppmv CO₂ into the atmosphere. This figure is almost one third of the global annual CO₂ growth rate of 1.5 ppmv per year (IPCC, 1995).

In terms of global carbon cycles the carbon loss due to fire is considered as one of the disturbances to the medium-term net ecosystem production (NEP) causing long-term terrestrial carbon storage—called net biome production (NBP)—to be much less than expected. Globally NEP is 10 Gt per year and due to disturbance it has been reduced to NBP which is less than 2 Gt per year (IGBP Terrestrial Carbon Working Group, 1998).

Apart from their effects on the global earth system, the fires and haze had regional, national and local economic impacts through multiple and widespread effects on health, transportation and tourism industries in Indonesia and neighbouring countries, especially Malaysia, Singapore and Thailand. The net economic impacts were significant. Glover and Jessup (1998) estimated that the fires and haze in 1997 cost the region over US\$ 4 billion. A later more comprehensive

estimate by World Wildlife Fund (WWF) and the Environmental Emergency Project (EEP) of the Indonesian Ministry of Environment arrived at figures of over US\$ 6 billion (BAPPENAS, 1999a,b).

The potential human health impacts of transboundary pollution were a contentious issue. Nevertheless, it was abundantly clear from a number of studies in the region, that the haze episodes did have a substantial impact on short-term health problems, in particular, respiratory-related cases (e.g. Dawud, 1998; Noor et al., 1998). Indeed in some cases, for example, in southern Thailand the health impact (Phoonboon, 1998) may have been even larger than expected based on environmental measurements suggesting the importance of human perceptions and collective psychology. This is not, however, to dismiss or downplay, the real immediate and long-term effects, especially in locations close to the fires.

The response of international tourists to the haze episodes illustrates the growing inter-dependence of Southeast Asian countries. National tourism authorities in countries not directly affected by haze or only marginally so had a difficult time in convincing potential tourist markets that their destinations were not affected. For example, tourist arrivals to Phuket, a key tourist destinations in southern Thailand were much lower than expected for several months (Lebel, 1998) although the number of days with haze were few. Within countries affected directly by the haze such as Indonesia, Singapore and Malaysia the challenge of convincing markets that the haze did not affect particular key tourist destinations was even more daunting (Hons, 1998; Lebel, 1998).

3.3. *Problem framing*

Research-based knowledge can potentially contribute to most phases of the policy process (Tomich et al., this volume), from problem framing through to policy framing, implementation and monitoring. One would have thought that the use of research-based knowledge about the impacts of the haze was relatively straight forward. The visible effects of the haze were clear to see for all and the economic and the short-term health effects, at least, were obvious. Less certain was information about the magnitude of the impacts, and hence possibly the significance of the haze issue compared to other pressing problems.

Decision-makers always face competing issues and tradeoffs. One large “other” problem on the minds of the states at the time was the financial crisis.

Some governments tended to downplay the issue by controlling the domestic news media and academics/researchers in government facilities, for fear of exacerbating the economic impacts, in particular, to the tourism sector. The government efforts were largely ineffective, in part, because of the easy availability of alternative sources of information, the internet, and international media. Governments in the region had to acknowledge that: “we have a problem”. The immediate question is why? What is the cause? Who is to blame? This is part of the crucial problem framing discourse that takes part in early phase in the life-cycle of a policy issue. The transboundary haze issue illustrates well that “environmental problems” are in part socio-political constructs. The problem was constructed in at least three ways—(1) smoke: too much smoke in the wrong place at the wrong time; (2) fire: inadequate fire prevention and management capabilities; (3) land: side-effect (or symptom) of unsustainable rates and patterns of land development. This is reflected in the various perceptions about causes which arose both from research-based knowledge and speculation.

4. Gaps between science and policy

4.1. ASEAN’s program addressed symptoms

The response of the Indonesian government and the region as co-ordinated by ASEAN through the regional and national haze action plans and related technical assistance programs is unlikely to significantly reduce the risks of serious haze episodes in the future.

The reason for this is that the official policy response has addressed the symptoms rather than the underlying causes of the haze problem (Tomich et al., 1998) and that the economic recession and political instability has made many of these factors more rather than less powerful. The evolving haze policy programme has focused on fire suppression, prevention and monitoring (Table 1).

4.2. Zero-burning is not an option, fire will be used

Fire is and will remain the cheapest and easiest way to clear land and remove unwanted vegetation in most settings. Research on the use of fires by smallholders and large developers strongly implies that a blanket zero-burn policy cannot be implemented in all situations and economic conditions. However, some consideration should be given to a prescribed burning system targeted at large-scale operators. Such a system should take into account information about the prevailing environmental conditions affecting the risks of fire spread (drought and wind), levels of synchrony of clearing activities and atmospheric conditions (e.g. inversion).

Shredding waste wood has been brought in many discussions as a possible solution to reduce haze. It is not clear whether the approach is economically feasible and technically viable—a detailed study is needed. One thing which is clear is that burning creates particles about 10 g PM_{2.5}/kg wood burned but shredding also creates particles about 5 g PM_{1.0}/kg diesel fuel burned, which has a worse effect for respiratory problem than larger particulate matter (Yokelson, Personal communication, 1998). Moreover, the net cost of a shredder is US\$ 64,000. Smallholders cannot afford this investment and even large companies may reluctant to spend so much money. Should others help

Table 1
Choices of policy objectives and the issues addressed

Type of goal	Addressing symptoms	Addressing underlying causes
Early mobilisation of regional response	Early warning and hot-spot detection systems	
Better and stronger national response	Shared fire-fighting systems	
Reduce conflict over land-use rights		Land reform/tenure security. ‘Adat’ right integration. Clear demarcation
Sustainable land development		Controls on land development. Incentives and disincentives. Smallholders’ wood pricing

pay? At present there is no mechanism for such environmental services to be financially rewarded.

4.3. Incentives to use waste wood are lacking

An important issue for smallholders and large-scale operators (land developers and loggers) alike is that appropriate incentives to utilise wood on land designated for clearing do not exist. The rubber wood produced by smallholder farmers faces disincentives in the form of taxes and levies. With a logging efficiency of less than 50%, forest conversion produces massive amounts of waste. The reason is that non-commercial timber is considered as waste and has no economic value. Gintings et al. (1998) estimated that with annual log production of around 24 million m³ the waste produced amounted to as much as 30 million m³. The result is that much useful wood material is burnt adding to haze problems.

Incentives may be created through the development of markets for production of charcoal or biomass energy from waste wood. The Kyoto mechanism and climate change related mitigation procedures might help here.

4.4. Land development strategies are not sustainable

To be comprehensive the policy response must take into account the appropriateness of land development strategies from social, economic and ecological perspectives. Specifically, this is concerned with the sustainability of logging of native forests (World Bank, 1990) and the frequent conversion of logged-over concessions into plantation forests (known as HTI) and oil palm estates (Lohmann, 1996; Potter and Lee, 1998). The devaluation of currency, financial crisis, and the structural adjustment program prescribed by the International Monetary Fund for Indonesia, all likely provided further stimulation for plantation development, and hence, forest conversion in the medium-term future. Clearly, to be effective and sustainable a land development policy programme must be properly integrated with other medium and long-term social and environmental goals. A long-term perspective is stressed because the time-scales for regeneration of forests and growth of tree-crop plantations is long relative to some political lives, the losses of biodiver-

sity are irreversible, and the needs for food, fibre and energy of growing populations will have to be met.

The current rates, patterns and extent of conversion of forested lands (primary and secondary regrowth) to oil palm and tree-crop plantations should be re-evaluated to take into better account: (1) the implications for long-term conservation of biodiversity, (2) sequestration of carbon, (3) loss of watershed functions, and (4) land-use rights and benefits flowing to local communities. One way to do this is to explore the tradeoffs for different land-use systems when public and private concerns are compared (see Tomich et al., 2001).

4.5. Causes of gaps

Gaps between what research-based knowledge has to offer and the information upon which policy appears to be based are partly caused by failures of communication. However, the role of deliberate misrepresentation, the weakness of policy-supporting research and fundamental conflicts in policy goals should not be underestimated. There also are gaps in understanding, ranging from ignorance of processes through to fundamental uncertainties in system behaviour, which could not be eliminated even with much more research effort.

Environmental governance is the way society deals with environmental problems and involves the interaction of formal and informal institutions and actors within society (Harashima, 1999). Political change has had, and continues to have, a profound influence on environmental governance in Southeast Asia. Indonesia is beset with fundamental problems of governance. There is already a plethora of legislation regarding the proper use and management of lands in Indonesia, although this has been imposed on areas without reference to pre-existing systems practised by indigenous people. Special patronage relationships between the state and favoured businesses, and a general lack of transparency and accountability, and 'rule of law' however, result in a very poor capacity of agencies to enforce environmental law as and regulations. An emphasis on top-down, centralised planning further alienates local government and non-government organisations. Political changes may over time bring a more democratic system of public policy making, and a stronger civil society that can restrain some of the excesses of the past.

5. Concluding remarks

The science–policy activity reported on here found that current responses still are not comprehensive enough or sufficiently well integrated to reduce the risks of serious haze episodes in the future. The emphasis has been (and continues to be) on fire-fighting, fire prevention and monitoring. To be effective the response must address the underlying causes of fires, in particular, land development strategies, through improvements in land-use planning and management. This requires institutional reform. The challenges are huge given the economic goals of key administrative and business stakeholders. For these groups maintaining high local or regional environmental quality is not a high priority. Policy intervention is essential and as summarised in Table 2 the intervention may be made at various levels ranging from regional down to household level involving formal as well as grassroots institutions.

This study of the transboundary haze issue illustrates a number of general characteristics of the interaction between science, the wider public and the policy community in Southeast Asia.

First, policy-makers often have taken action only at times of crisis. They act when they are forced to by public opinion or their constituents. The threats of action and pursuit of plantation companies using fire to clear land is a good example. Statements of intent, however, are often not followed-through with conclusive action or a full policy programme, because once

the crisis has waned other issues capture the political agenda.

Second, the international media has a crucial role in publicising environmental issues and hence bringing them onto the political agenda in the region. At times it played an important role in translating research-based findings about the sources of fires, the distribution of smoke, and summaries of health effects into popular newsprint and television formats. At other times, sensationalism exaggerated the transboundary haze issue. The large (but short-term) impacts on tourism in Thailand, for example, were mostly a product of the media. The image often portrayed was that all of Southeast Asia was collapsing from fires, political instability and economic chaos.

Third, although the scientific community can quickly rise to prominence at times of crisis, it has a difficult task in maintain interest of the policy community in cyclic policy issues like transboundary pollution from vegetation fires. Research has great potential to contribute in terms of sorting out underlying causes, assessing the magnitude of impacts, and developing the key understandings of the issues needed to properly frame long-term policy responses. In addition, research should contribute more than it has to exploring implementation options, from policy instruments, through to integration with other policy goals, and systems for monitoring and evaluating policy programs. Solutions will only come about if there is commitment to a long-term policy programme, that is at the same time self-critical and flexible enough,

Table 2
Policy intervention at various levels on land-use planning and management

Policy area	Suggested changes
Regional environmental regime	Need a more binding agreement/protocol with a realistic mechanisms for compliance. Could be based on industry-level actions rather than nation-state to avoid problems of “interference”. For example, cross-boundary litigation
Land development policy	Incorporate negative ecological and social affects of increased plantation areas in overall land development targets/policies. Reduce or completely remove incentive systems for plantation land development: free land, credit schemes/subsidised capital, rights to timber on plantation concessions
Land-use plans/classifications/ allocation system	Improve land information systems as basis for decision-making (spatial planning). Improve accountability of land classifications and allocations: improve decision criteria—make transparent; include local communities in planning/decisions
Land tenure/resource rights	Compatibility of government-granted land-uses with rights/needs of forest-dependent people
Reduced impacts logging	Improve forest management (certification, environmental performance bonds)
Clearing method—use of fire to remove waste vegetation	Regulate conversion of forests to plantations. Control access to logged-over forests. Prescribed burning

that it can take into account new policy research findings and changes in the environmental and social context. The scientific community still has not been able to bring about enough impacts in the patterns of reasoning among key decision-makers in the policy community to make this likely in the foreseeable future.

Fourth, information-technology is a critical tool for researchers, and becoming more important for bridging the gaps between researchers and the public, especially the media. At times of crises there is a huge demand for information about environmental issues, implying that a little effort beforehand on public relations could pay handsome dividends in terms of providing fuel for these policy debates.

Acknowledgements

This paper draws heavily on the ideas and work of researchers participating in the ICSEA science–policy activity on transboundary pollution. We would therefore, like to give special thanks to the authors of the commissioned and contributing studies, namely, H. Roliadi, B. Ginoga, M. Mansur, O. Rachman, R. Maryani, S. Astana, Suyanto, Lorraine Elliott, and the many others who have in some way contributed in workshops or to working group meetings, satellite workshops, and electronic conference. The activities were supported by a block grant from the Australian Agency for International Development (AusAID) through Global Change and Terrestrial Ecosystems (GCTE) a Core Project of IGBP.

References

- Anonymous, 1998. Singapore Country Report on the 1997 smoke haze for the WHO Bioregional Workshop On Health Impacts of haze-related Air Pollution, Kuala Lumpur, 1–4 June, 1998.
- BAPPENAS, 1999a. Planning for Fire Prevention and Drought Management Project (1). Planning for Fire Prevention and Drought Management in Indonesia, Jakarta.
- BAPPENAS, 1999b. Planning for Fire Prevention and Drought Management Project (2). Cause, Extent, Impact, and Cost of 1997/1998 Fires and Drought, Jakarta.
- Dennis, R., 1999. A Review of Fire Projects in Indonesia (1982–1998). CIFOR/ICRAF/UNESCO/EC-JRC.
- Dawud, Y., 1998. Respiratory health impacts from the vegetation fires. Paper presented in the Satellite Workshop on Transboundary Pollution from Fires: Chemistry, Transport and its Impacts. UPM/IC-SEA, Kuala Lumpur.
- Garstang, M., 1998. The role of the atmosphere in fire occurrence and the dispersion of the fire products. Background paper submitted to WHO Meeting on Health Guideline for Forest Fires Episodic Events, Lima.
- Gintings, A.N., Roliadi, H., Ginoga, B., Mansur, M., Rachman, O., Maryani, R., Astana, S., Suyanto, 1998. The relationship between waste wood management and the risk of transboundary haze from forest fire. <http://www.icsea.or.id/sea-span/scipol2/SUDY4.htm>.
- Glover, D., Jessup, T., 1998. The Indonesian fires and haze of 1997: the economic toll. <http://www.idrc.org.sg/eeepsea/>.
- Goldammer, J.G., 1998. The ASEAN Fire Forum: initial thoughts towards cooperation in fire and smoke research and management in the ASEAN region. In: Proceedings of the AIFM Conference on Transboundary Pollution and the Sustainability of Tropical Forests: Towards Wise Forest Fire Management, Kuala Lumpur. ASEAN Institute for Forest Management, Kuala Lumpur.
- Goldammer, J.G., Rufelds, H.C., Malingreau, J.P., Yokelson, R., Abberger, H., Manila, A., 1998. The ASEAN FireForum: results of the working group discussions. In: Proceedings of the AIFM Conference on Transboundary Pollution and the Sustainability of Tropical Forests: Towards Wise Forest Fire Management, Kuala Lumpur. ASEAN Institute for Forest Management, Kuala Lumpur.
- Harashima, Y., 1999. Environmental Governance in Four Asian Countries. Institute for Global Environmental Studies. Kanagawa.
- Hassan, M.N., 1998. The damage costs of haze episode in Malaysia. Paper presented in the Satellite Workshop on Transboundary Pollution from Fires: Chemistry, Transport and its Impacts. UPM/IC-SEA, Kuala Lumpur.
- Hons, P., 1998. Economic values of the 1997 haze damages to Singapore. Economy and Environment Programme for Southeast Asia (EEPSEA) and World Wildlife Fund for Nature, Indonesia.
- IGBP Terrestrial Carbon Working Group, 1998. The terrestrial carbon cycle: implications for the Kyoto Protocol. *Science* 280, 1393–1394.
- IPCC, 1995. Climate Change 1995. IPCC Second Assessment Report. Working Group I—The Science of Climate Change. Cambridge University Press, Cambridge.
- Lebel, L., 1998. Impacts of transboundary haze from vegetation fires on tourism in Southeast Asia. Discussion Paper for the Satellite Workshop on the Impacts of 1997/1998 Transboundary Haze Episode on Tourism in SE Asia. Walailak University/IC-SEA. Tha sala, Nakhon-sri-Tammarat.
- Levine, J., 1998. Gaseous and particulate emissions released to the atmosphere during forest fires: a case study in Kalimantan and Sumatra, Indonesia in 1997. Background paper submitted to WHO Meeting on Health Guideline for Forest Fire Episodic Events.
- Lohmann, L., 1996. Freedom to plant: Indonesia and Thailand in globalizing pulp and paper industry. In: Parnwell, M.J.G., Bryant, R.L. (Eds.), *Environmental Change in Southeast Asia. People, Politics and Sustainable Development*. Routledge, London, pp. 23–48.

- Noor, H.M.F., Awang, M., Jaafar, A.B., 1998. Haze and health: Malaysian experience. Paper presented in the Satellite Workshop on Transboundary Pollution from Fires: Chemistry, Transport and its Impacts. UPM/IC-SEA, Kuala Lumpur.
- Phoonboon, K., 1998. Health and Environmental Impacts from the 1997 ASEAN Haze in Southern Thailand. Health Systems Research Institute, Bangkok, Thailand.
- Potter, L., Lee, J., 1998. Tree planting in Indonesia: trend, impacts and direction. Occasional Paper No. 18. Center for International Forestry Research, Bogor, Indonesia.
- Schweithelm, J., 1999. The Fire This Time: An overview of Indonesia's forest fires in 1997/98. WWF-Indonesia Programme, Jakarta.
- Siscawati, M., 1998. Underlying causes of deforestation and forest degradation in Indonesia: a case study on forest fire. In: Proceedings of the IGES International Workshop on Forest Conservation Strategies for the Asia and Pacific Region. Institute for Global Environmental Strategies, Kanagawa, pp. 44–57.
- Tomich, T.P., Fagi, A.M., de Foresta, H., Michon, G., Murdiyarso, D., Stolle, F., van Noordwijk, M., 1998. Indonesia's fires: smoke as problem, smoke as a symptom. *Agroforestry Today*, January–March, 1998, pp. 4–7.
- Tomich, T.P., van Noordwijk, M., Budidarsono, H.S., Gillison, A., Kusumanto, T., Murdiyarso, D., Stolle, F., Fagi, A.M., 2001. Agricultural intensification, deforestation, and the environment: assessing tradeoffs in Sumatra, Indonesia. In: Lee, D.R., Barrett, C.B. (Eds.), *Tradeoffs or Synergies? Agricultural Intensification, Economic Development and the Environment*. CAB International, Wallingford, UK.
- World Bank, 1990. *Indonesia: Sustainable Development of Forests, Land and Water*. IBRD, Washington, DC.