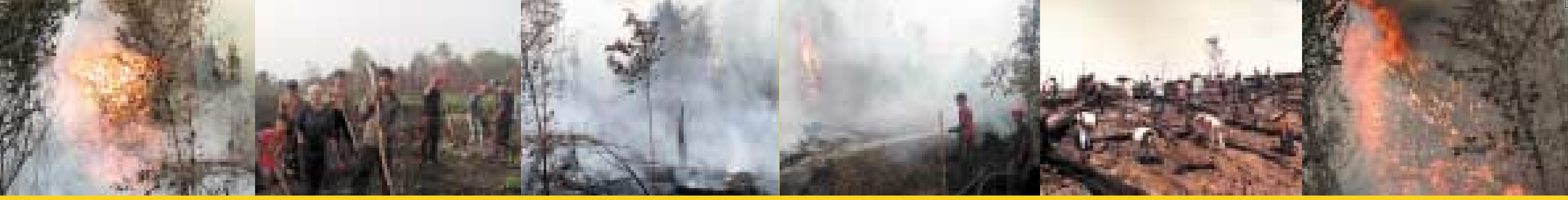

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Fires in Indonesia:

Causes, Costs and Policy Implications

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Acronyms and abbreviations

ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
BAPPENAS	National Development Planning Agency of Indonesia
CIFOR	Center for International Forestry Research
ENSO	El Niño Southern Oscillation
FAO	United Nations Food and Agriculture Organization
GTZ	Deutsche Gesellschaft fűr Technische Zusammenarbeit
IFFM	Integrated Forest Fire Management project
ISAS	Institute of Southeast Asian Studies

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Executive Summary

Fires have risen to global attention in recent years as an environmental and economic issue, especially following the 1997/98 El Niño Southern Oscillation (ENSO) event during which up to 25 million hectares of land worldwide were affected by fire. Fires are considered a potential threat to sustainable development because of their direct effects on ecosystems, their contribution to carbon emissions and their impact on biodiversity. Pollution from smoke haze is a recurrent problem even in non-ENSO years for Indonesia and its neighbours. During the 1997/98 ENSO, Indonesia had the most severe fires in the world, with similar problems from the ENSO in 2002.

Despite several studies on the subject, progress in addressing the fire problems in Indonesia has been hampered, among other reasons, by confusion over the nature of the policy problems, lack of understanding of the economic impacts, lack of clarity over the causes of fires and as a result uncertainty about the appropriate institutional and economic responses. The fire-related policy problems are defined as:

- smoke haze pollution;
- forest degradation and deforestation (with loss of products and services); and
- negative impacts on the rural sector.

Some of the apparent major causes of the policy problems are identified. They are found to vary across the policy problems and, within the policy problems there is variation across the country. Information on the extent and location of fires in 1997/98 is collated and the original estimate of area affected by fires is revised from 9.7 million hectares to 11.7 million hectares.

The economic impacts of the 1997/98 fires are also revised. The fires that resulted in forest degradation and deforestation caused economic costs in the range of $1.62-2.7 billion[1]. The costs of smoke haze pollution were in the range of $674-799 million; smoke haze pollution costs were probably higher because estimates for the economic impacts on Indonesian business activities were not available. The valuation of costs associated with carbon emissions indicates that these may amount to as much as $2.8 billion.

The revised estimates of economic costs from fires and smoke haze are still substantial and point to significant problems to be addressed to avoid similar impacts, especially in ENSO years. However, the measures to be adopted need to be targeted to the specific policy problem, take into account relevant costs to assess the benefits of the proposed policy and address the specific causes of the problems. This implies that policies should be assessed with regard to their appropriateness to address forest degradation and deforestation or the large scale generation of smoke haze.

Conclusions and recommendations

Fires, degradation and deforestation and land use allocation

- In many areas it is the allocation of forest to alternative land uses, such as oil palm plantations and the factors underlying that decision which are responsible for deforestation, rather then the fires;
- given that in many cases it is not the fire itself that causes the policy problem, i.e. deforestation, there is no reason to completely outlaw the use of fire in plantations as currently stated in the legislation;
- the introduction of improved forest management practices may result in a limited reduction in fire risk, given the existing socio-economic and institutional conditions;
- to support improved resource management, research is needed to assess the areas of low access forest (using conservative parameters regarding human access), primary forest, and secondary forest areas that present environmental conditions potentially leading to significant fire risk.

Fires and smoke haze pollution

- Further analysis is needed to clarify the relative contribution of the various activities to smoke haze pollution. However, from the broad existing information presented it is

clear that plantation activities are not the only contributing factor, at least in ENSO years. In non-ENSO years they do appear to be the major contributing factor, but the increasing role of smallholder activities, especially in West and Central Kalimantan, needs to be ascertained;

- in ENSO years, degraded peat lands may be the most significant risk factor for the generation of smoke haze. Their management and eventually their regeneration/restoration may be required to avoid significant events of air pollution;
- a reduction and/or management of land clearing fires in peat lands would probably go a long way towards eliminating the smoke haze problem in non-ENSO years. However, the costs, benefits and distributional aspects of policy initiatives aimed at reducing the impacts of these fires need to be assessed;
- there is still a significant lack of knowledge, at a level appropriate for policy making (district and provincial), about the human activities contributing to these problems in many areas of the country, including those just discussed. This knowledge gap needs to be filled to develop appropriate policy responses.

Fires and legislation

- The legislation should be revised. It should ban fires that have significant smoke haze effects, such as those on peat land, while the use of fire in situations and locations which may have unwanted local effects resulting from smoke, e.g. on health or transport, should be regulated. In relation to fires resulting in unwanted deforestation, the appropriate authorities should be given the power to regulate (including banning) fire use in particular periods, such as during ENSO events;
- an analysis of the appropriateness of the legislation regulating the development of peat lands, including the social, economic and environmental implications is needed;
- clear punitive examples need to be set to effect a change in the use of fires by companies, meaning that companies using fire unlawfully need to be prosecuted. If found guilty the penalties imposed on the companies need to be sufficiently large to act as a deterrent;
- when livelihood activities are involved in a fire or smoke haze problem, only community-based initiatives, backed by legislative means, have any likelihood of succeeding.

Carbon sinks

- Given the contribution of peat fires to carbon emissions, there is a need to consider whether conservation of peat lands should be included in the second commitment period of the Kyoto protocol.

Fires, ENSO and human factors

- The Government of Indonesia, the industry and non-government organizations should move beyond just allocating the blame for the fires and create a serious partnership to address this national and international environmental, economic and social predicament.

Economic costs and assessments

- Policy initiatives aimed at addressing fire-related problems need to take into account both the costs and the benefits related to the use of fire, as well as their distribution;
- economic assessments of policies aimed at addressing the specific policy problem, that is, deforestation and forest degradation or smoke haze pollution, should be mindful of the different causes and impacts of fire;
- the incentives for concession holders to invest in fire prevention and suppression need to be understood;
- it is necessary to address the smoke haze problem, but the problem of deforestation and forest degradation fires needs also to be addressed as it can result in significant losses;
- future research and policy assessments should be aimed at improving the understanding of damage caused by fire to forest functions, to estimate the full range of potential losses from smoke haze pollution;
- economic as well as environmental indicators need to be taken into account in the development of policies aimed at minimizing the impacts of fires and smoke haze pollution.

1. Introduction

Fires have risen to global attention in recent years as an environmental and economic issue, especially following the 1997/98 El Niño Southern Oscillation (ENSO) event, during which up to 25 million hectares of land worldwide were affected by fire (FAO 2001; Rowell and Moore 2001). Fires are considered a potential threat to sustainable development because of their direct effect on ecosystems (United Nations International Strategy for Disaster Reduction 2002), their contribution to carbon emissions and their impact on biodiversity. In Southeast Asia, the concern with the impacts of fires is particularly significant, as exemplified by the signing of the Agreement on Transboundary Haze Pollution by the country members of the Association of Southeast Asian Nations (ASEAN) in June 2002 in Kuala Lumpur. 'Forest fires' is one of the stated priorities of the Ministry of Forestry of Indonesia and action to address this problem has been included in the commitments to donor countries of the Consultative Group on Indonesia.

In 1997/98, Indonesia had the most severe fires worldwide. Images of cities blanketed by haze, burning forests and distressed orangutans were front-page items for newspapers and televisions and attracted global attention. Neighbouring Singapore and Malaysia, as well as aid organizations, sent in help to fight the fires. The event has been described as one of the century's worst environmental disasters (Glover 2001), because of its impact on forests as well as for the considerable amount of carbon emitted.

Despite these concerns and the actions proposed to avoid or mitigate the recurrence of unwanted fires and their impacts, significant smoke haze[2] pollution events have been recurring to different degrees on an annual basis in Southeast Asia, with the one in August-October 2002 being the most significant since 1997.

Despite several studies on the subject, progress in addressing the fire problems in Indonesia has been hampered, among other reasons, by confusion over the nature the policy problems, lack of understanding of the economic and ecological impacts, lack of clarity over the causes of fires and the resultant uncertainty about the appropriate policy responses. For example, the difference between costs attributable to smoke haze pollution and fire, their sources and the need for policies targeting the specific problem is often not recognized. With regard to the causes, it is still disputed whether the fires were more a natural or human-made disaster (Colfer 2002). Also, policy proposals have at times been put forward without any analysis of the costs and benefits of the specific actions to address the problem and its causes. This report reassesses and defines the policy problems and identifies broad policies that may be needed to address the negative impacts of fires.

The report starts by consolidating information on the extent and location of fires. Then it focuses on the definition of the policy problems. Some of the major apparent causes of the problems are highlighted by pointing out the land use activities contributing to the fires. The underlying causes of the fires in the various land use activities, such as the institutional arrangements and the incentive structure faced by the stakeholders in using and/or controlling the fires, are not analyzed. That analysis is beyond the scope of this report, but it is esential for the development of appropriate policies; therefore it will be the focus for further research. A review and analysis of the economic impacts of fires is then carried out. The report pays particular attention to the economic assessments of costs caused by the 1997/98 fires. Economic assessments of disasters may be used i) to draw attention to a problem and highlight its significance, ii) to assess the distribution of its impacts on economic sectors and the population and iii) to evaluate remedial policies. The assessment of the economic costs of the fires in Indonesia has been used particularly to draw attention to the problem but limited attention has been devoted to the distribution of the impacts and they have not been used appropriately to evaluate remedial policies. Therefore, the report seeks to provide more reliable estimates and comments on their use in future studies aimed at assessing detailed policies. This study is the first step required to identify further work needed to clarify i) the details of the direct and underlying causes of the problems and ii) the appropriate policy responses. Comments concerning these two issues are provided in the final section.

Before proceeding with the analysis it may be noted that as the severity and impacts of fires increases worldwide, more attention needs to be given to the policy and economic analysis of fires. It is hoped that the methodological issues raised in this report will benefit similar studies in other regions.

2. The extent of fires during the 1997/98 ENSO event

The most comprehensive national assessment of fire-affected areas during the 1997/98 ENSO event estimates a total fire-affected land area of about 9.75 million ha (BAPPENAS-ADB 1999, hereafter, the ADB study [ADB, Asian Development Bank; BAPPENAS, National Development Planning Agency of Indonesia]) (Table 1). This estimate is updated as discussed below and the results are summarized in Table 4. A description of the geographic areas discussed in this report is presented in Map 1. The ADB study built on an initial national assessment prepared in 1997 by Liew *et al.* (1998) that was later revised to include an increase of 316,000 ha of burnt peat swamp area in Sumatra (Liew *et al.* 2001). The ADB estimate is updated accordingly.[3]

The Integrated Forest Fire Management (IFFM) project (a German-funded initiative, hereafter referred to as the GTZ [Deutsche Gesellschaft fűr Technische Zusammenarbeit] study), carried out a detailed assessment of the fires in East Kalimantan in 1997/98 (Hoffmann *et al.* 1999).[4] There are several differences between the estimates of the GTZ study and those produced by the ADB (Table 2). The estimate for burnt swamp forest and wetland mangroves is about 50% higher in the GTZ study. However, given that the ADB study does not provide the same breakdown for this category as GTZ, no integration of the data is proposed. This is due to the fact that burning peat swamp forest would release much more carbon than burning mangroves. Therefore, the ADB estimates can be considered conservative.

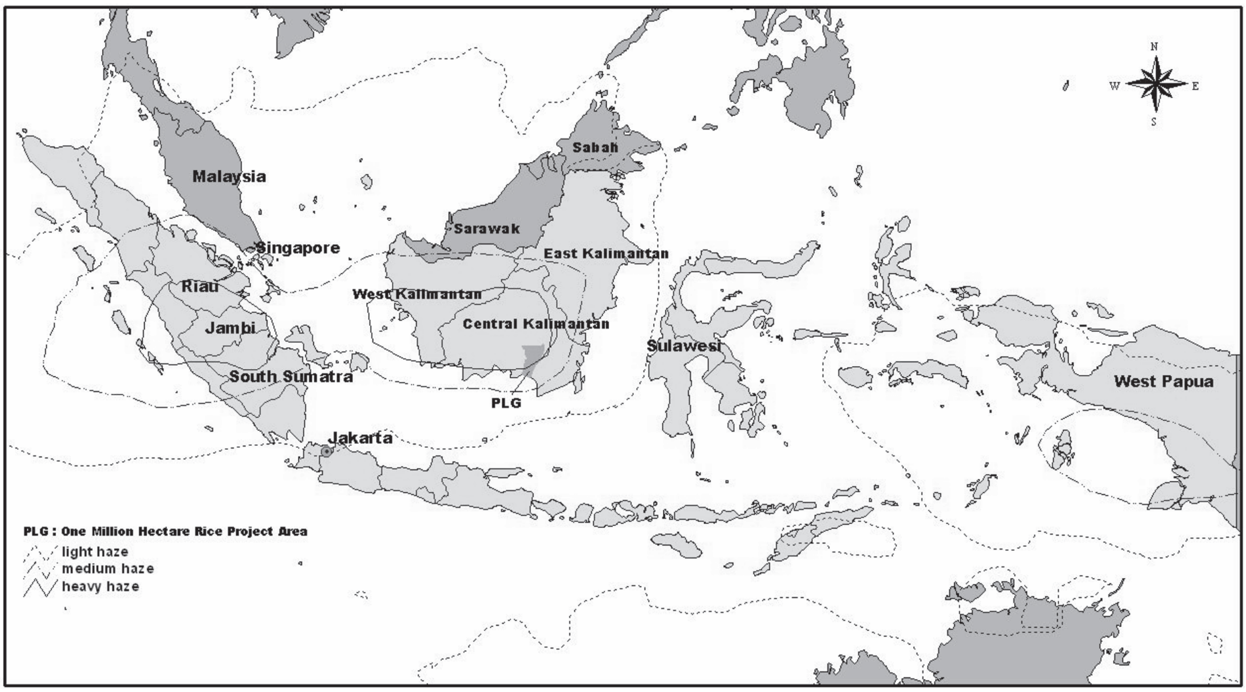
Lowland forest and submontane forest are similar categories in the two studies and can

Table 1. ADB Estimates of fire affected areas in 1997/98 (hectares)

Vegetation type	Sumatra	Java	Kalimantan	Sulawesi	West Papua	Total
Montane forest					100,000	**100,000**
Lowland forest	383,000	25,000	2,375,000	200,000	300,000	**3,283,000**
Peat and swamp forest	308,000		750,000		400,000	**1,458,000**
Dry scrub and grass	263,000	25,000	375,000		100,000	**763,000**
Timber plantation	72,000		116,000			**188,000**
Estate crops	60,000		55,000	1,000	3,000	**119,000**
Agriculture	669,000	50,000	2,829,000	199,000	97,000	**3,843,000**
Total	**1,755,000**	**100,000**	**6,500,000**	**400,000**	**1,000,000**	**9,755,000**

Source: BAPPENAS-ADB (1999).

Map 1. Provinces affected by fires and distribution of smoke haze pollution in 1997/98



Source: Distribution of smoke haze derived from Barber and Schweithelm (2000).

therefore be integrated. 'Unproductive dryland' and 'Open land, alang alang, bushland' are similar categories. However, it may be noted that in Table 1 only 375,000 ha are included in 'dry scrub and grass', which is less than the area classified as burnt in East Kalimantan in the 'unproductive dryland' category (Table 2). It could be assumed, therefore, that part of the unproductive dryland area burnt was included in the ADB 'agriculture' category. The latter is decreased, but not for the full difference because the category 'agriculture' is underestimated in the ADB study.

A substantial difference is found in the 'forest plantation' category. This difference is not surprising because the ADB study relied on data provided by the Department of Forestry of East Kalimantan, which were not based on a comprehensive assessment of remote sensing data. A similar argument applies to 'estate plantations'. The ADB estimate is therefore increased. The total difference between the estimates of the two studies appears substantial. However, once the figures for forest plantation and estate plantations (which were not based on remote sensing analysis in the ADB study) have been adjusted, this difference is only about 10%.

A study assessing peat land fires in Central Kalimantan (Page *et al.* 2002) estimates that about 797,000 ha burnt in the study area of about 2.5 million ha, which included the One Million Hectare Rice project area. Of the total area burnt, peat land accounted for about 729,500 ha, which almost equals the ADB estimate of 750,000 ha for the area of peat and swamp forest burnt in the whole of Kalimantan. Given the GTZ estimate for peat swamp forest burnt in East Kalimantan (311,000 ha) and that areas of peat swamp forest other than that studied by Page *et al.* (2002) did burn in Central Kalimantan as well as in West Kalimantan, it is obvious that the area of peat and swamp forest burnt in the whole of Kalimantan in 1997/98 is well above 1,000,000 ha. Therefore, adding the estimate by Page *et al.* 2002 to that of GTZ for peat swamp forest provides a conservative estimate for Kalimantan of 1,100,000 ha.

Estimates of peat land area burnt in the whole of Indonesia are also provided by Page *et al.* (2002) but are not adopted here for the following reasons. They derive the higher range approximation of about 7 million ha by applying the proportion of burnt area estimated in the study area in Central Kalimantan (33.9%) to the national area of peat land (20.07 million ha). However, there is no evidence that this proportion is valid at the national level. They propose the lower range estimate of 2.44 million ha on the basis of a 'combination of verifiable and uncorroborated sources' but no explanation is provided about the sources.

Detailed estimates of fire-affected areas for the whole of Sumatra are not available, apart from those already considered above (Liew *et al.* 1998; Liew *et al.* 2001). An assessment of fire-affected areas in the provinces of Lampung and South Sumatra estimated the total area burnt at about one million hectares (Legg and Laumonier 1999), but a breakdown of fire-affected vegetation types was not undertaken. A further assessment of fire-affected areas is available for South Sumatra (Forest Fire Prevention and Control Project March 1999). This study estimates the area burnt at about 2.8 million ha. It may be noted that this estimate for the area burnt is larger than the total reported by ADB for Sumatra. This could indicate that the latter estimate is conservative. However, the data presented in Table 3 are almost certainly an overestimate of actual area burnt.[5] Given the

Table 2. Comparison of burned area estimates for East Kalimantan, 1997/98

Vegetation/land use	ADB	GTZ	Difference
Swamp forest, wetland mangroves, of which:	433,000	693,259	260,259
- Peat swamp forest		311,098	
- Wetlands		290,432	
- Mangroves		91,729	
Lowland forest	1,862,000	2,177,880	315, 880
Submontane forest	4,000	213,194	209,194
Unproductive dryland	798,000		
Open land, alang alang, bushland		292,569	-505,431
Forest plantation (HTI)	116,000	883,988	767,988
Estate plantation	15,000	382,509	367,509
Agriculture	301,000	459,239	158,239
Settlements	7,000		-7,000
Shrimp ponds		316	316
Total	**3,536,000**	**5,102,954**	**1,566,954**

Source: ADB: BAPPENAS-ADB (1999); GTZ: Hoffmann *et al.* (1999).

Table 3. Estimate of burnt areas during the 1997 dry season in South Sumatra

Land status and land use	Burnt areas	
	Ha	% of total
Non-forest areas	**2,097,050**	75
Controlled fires	***1,501,000***	54
- Irrigated rice	390,000	14
- Shifting cultivation	894,000	32
- Rice in swamp area	145,000	5
- Land clearing in old rubber plantations by small holders	14,000	1
- Land clearing in old coffee plantations	8,000	0
- Land clearing by plantation companies	50,000	2
Uncontrolled fires	***596,050***	21
- Oil palm/rubber and other big scale plantations	13,800	0
- Secondary forest	100,000	4
- Bush and shrub vegetation burnt by escaped sonor fires	290,000	10
- Bush and shrub vegetation	30,000	1
- Grassland	30,000	1
- Smallholders plantation area	30,000	1
- Transmigration area	250	0
- Others	102,000	4
Forest land	**700,988**	25
Controlled fires	***70,000***	3
- HPHTI industrial timber plantations, land clearing	70,000	3
Uncontrolled fires	***630,988***	23
- Primary and secondary forest in concession areas (HPH)	10,491	0
- HTI reforestation	14,494	1
- Reforestation in other than HTI	5,000	0
- Bush and shrub land	393,000	14
- Grassland, degraded forest	30,000	1
- Peat and swamp area for sonor	173,000	6
- Other	5,000	0
Total controlled fires	**1,571,000**	**56**
Total wildfires	**1,227,038**	**44**
Total of all controlled and uncontrolled fires	**2,798,038**	**100**

Source: Forest Fire Prevention and Control Project (1999).

uncertainty about the data and the fact that they do not lend themselves to updating the ADB figures, the ADB estimate is not revised.

The conservative estimates presented in Table 4 increase the area affected by fire by about 1.94 million ha, with increases in lowland forest and peat and swamp forest of about 315,000 ha and 666,000 ha respectively.

3. Fire related policy problems

National and international NGOs, aid agencies and the media have all used the figures for the estimated costs of the 1997/98 fires to highlight the severity of the 'fire problem,' the need for government action to prevent further fire outbreaks and to manage them. Policy recommendations are wide-ranging and concern the forestry and agricultural plantation sectors, including oil palm and timber plantations, as well as smallholder agriculture. They include restricting or freezing forest conversion until improved land allocation policies and fire control procedures are in place, the adoption of reduced impact logging, strengthening rules and penalties against fire use for land clearing in plantations and land use rationalization with community participation to promote consensus on land use and establish community responsibility and commitment (BAPPENAS-ADB 1999; Barber and Schweithelm 2000; Applegate *et al.* 2001; Glover 2001; Qadri 2001; Siegert *et al.* 2001).

It is misleading to think about 'fires' as *the* policy problem, or indeed as a *single* problem

Table 4. Revised estimate of fire affected areas in 1997/98 (hectares)

Vegetation type	Sumatra	Java	Kalimantan	Sulawesi	West Papua	Total
Montane forest			*213194*		100000	***313194***
Lowland forest	383000	25000	*2690880*	200000	300000	***3598880***
Peat and swamp forest	*624000*		*1100000*		400000	***2124000***
Dry scrub and grass	263000	25000	375000		100000	**763000**
Timber plantation	72000		*883988*			***955988***
Estate crops	60000		*382509*	1000	3000	***446509***
Agriculture	669000	50000	*2481808*	199000	97000	***3496808***
Total	***2071000***	**100000**	***8127379***	**400000**	**1000000**	***11698379***

Source: Adapted from BAPPENAS-ADB (1999). Italics indicate updated figures.

and to provide generalized recommendations to address it. The impacts of fires are a set of problems. Not recognizing this has two significant implications:

a) there is a risk that all fires are perceived as problematic rather than considering in what circumstances fire may be an appropriate land management tool;
b) we might loose sight of the fact that fires may have differentiated impacts (eg according to the location and affected area) that need to be addressed with different policies.

In relation to the first point, there has been considerable discussion in Indonesia about the extent of the fires, but it has not been clarified which fires are considered problematic, in the sense that they have undesirable impacts. In the case of Indonesian fires, the three main fire-related policy problems identified here are:

- smoke haze pollution, carbon emissions and related impacts;
- forest degradation and deforestation, and loss of products and services, including timber, non-timber forest products, soil erosion and flood control, biodiversity; and
- rural sector losses from escaped fires and fire—induced weather anomalies.

Carbon emissions could also be considered as a separate problem due to the global nature of the issue. However, the lesser importance of carbon emissions from fires to governments is discussed later. Biodiversity losses are also probably more of a concern to international groups than to the national government.

The three main policy problems are considered in turn. The problem of rural sector losses is briefly highlighted. It has not figured high on the international, national and even provincial policy agenda and it has yet to be the focus of detailed research.

3.1 Smoke haze pollution and carbon emissions

Smoke haze pollution is the main fire-related policy problem attracting the attention of neighboring countries and through their pressure, the attention of the Government of Indonesia. There have been several episodes of transboundary smoke haze pollution over the last two decades, the most important being associated with the 1997 fires.

In Indonesia, peat land fires are by far the largest contributor to smoke haze pollution. In 1997/98, peat land fires may have contributed between 60% and 90% of the emissions resulting in smoke haze and they were also the major source of carbon emissions (BAPPENAS-ADB 1999). In 1997, the main contributors to the smoke haze pollution that affected Singapore, mainland Malaysia and Sumatra itself were peat land fires in the provinces of Jambi, Riau[6] and South Sumatra. The fires were mainly due to land clearing for oil palm and timber plantations. In the South Sumatran wetlands fires were also due, to livelihood activities such as rice cultivation, fishing and logging[7] but to an as yet unclear degree (Anderson and Bowen 2000; Barber and Schweithelm 2000, Map 2; Tapper *et al.* 2001). In non-ENSO years, land clearing for plantations on peat lands appears to be the main source of smoke haze (Sargeant 2001).

While the role of large companies has been clearly documented, the extent to which smallholder activities are increasingly contributing to the smoke haze problem is only beginning to be contemplated.

In 1997, peat land fires in the area of the government-initiated One Million Hectare Rice Project in Central Kalimantan appear to have been the main source of smoke haze in Kalimantan

(Barber, 2000; Siegert, 2001) also affecting Sarawak. Again in 2002, fires in the same area contributed significantly to the smoke haze that engulfed Central Kalimantan from August to October. Fires with large quantities smoke haze affected the same area in August 2001 (Anderson 2001).

Extensive burning in West Kalimantan in 1997 probably for land clearing in oil palm and timber plantations (Potter and Lee 1999) in peat areas and from livelihood activities in the Danau Sentarum area (Dennis *et al.* 2000) contributed to smoke haze pollution in West Kalimantan and Sarawak. In January-April 1998, fires in the Central Mahakam Lakes area, which seems to be linked to livelihood activities (Chokkalingam *et al.* 2001), as well as large scale fires in other parts of East Kalimantan, contributed to smoke haze pollution in the province. These fires did not result in significant transboundary pollution.

Fires in southern West Papua contributed to large amounts of smoke haze in 1997. This did not draw public attention because the smoke haze spread westwards to sea (Legg and Laumonier 1999; Tapper *et al.* 2001) and the affected area in West Papua itself has low population density and no major city.

To summarize, smoke haze pollution and carbon emissions are due mainly to intentional and escaped fires in peat land areas. Fires burning in forests and plantations outside peat land, grasslands and other agricultural areas are of more limited relevance in relation to this problem.

3.2 Forest degradation and deforestation and loss of products and services

The loss of forests and their products and services is mainly a national policy problem in the sense that the costs are born by Indonesia. Obviously there are also foreign stakeholders concerned by the loss, especially in relation to biodiversity. In 1997/98, East Kalimantan had the most extensive area of fire-affected lowland forest, about 60% of the total. It was also the area most severely affected by the ENSO-related drought (Fuchs and Schneider 2002). The causes of fire ignition are not yet well understood, but ignition zones were distributed independently of land use allocation (Steenis and Fogarty 2001). This would indicate that all land uses were affected to a similar extent and that escaped fires related to a range of commercial and livelihood activities were predominant. The contribution of the various activities needs to be further explored. Given the significant area of forest burnt in forest concessions and in protected areas — 2,347,717 ha and 440,381 ha respectively (Hoffmann *et al.* 1999, p 21) — it seems that large-scale unplanned forest degradation took place. Whether large-scale deforestation also took place remains to be assessed.

Forest fires in 1997 were much more extensive than in non-ENSO years (Anderson *et al.* 1999), indicating that there may have been escaped fires. However, the fires in Sumatra, Sulawesi, West Papua and West and Central Kalimantan appear to have been in land-clearing areas. In South Sumatra fires affected mainly degraded forest and scrub (Achard *et al.* 1998; Potter and Lee 1999; Anderson and Bowen 2000; FWI/GFW 2002). Noting difference between planned forest clearance with fire or fires escaped but still in areas allocated for land clearing and accidental, unplanned loss of forest through fire is fundamental both to the calculation of the economic losses, as detailed in Section 4, and to the eventual development of remedial policies.

3.3 Rural sector losses

Losses in the rural sector may result from escaped fires caused by agricultural or other activities. National as well as local level data on potential losses are very sparse. It is possible that this issue has received limited attention because most of the organizations involved in the assessment of the impacts of fire were concerned mainly with forests and biodiversity. It may also be that impacts on the rural sector were not significant, thus limiting the interest of national and local stakeholders on this topic and/or that it is also a difficult and expensive assessment to be carried out. The data available (Jhamtani and Badawi 1998; Oosterman and Widayat 2001) show that at least in some areas there might have been relevant impacts on the rural sector from escaped fires. There have also been reports of potential negative impacts of smoke haze on agricultural production, e.g oil palm (Casson 2000), as it may affect photosynthesis processes, but others attribute these losses to the drought (United States Department of Agriculture 1998). However, there is some evidence showing that smoke from the 1998 fires in Kalimantan did suppress precipitation events (Rosenfeld 1999). Further research on the impacts of smoke haze and fires on the rural sector is warranted particularly in areas that are affected by significant escaped fires such as East Kalimantan.

4. Reassessing the Economic Costs of the 1997/98 Fires

Three national level studies were undertaken on the fire event of 1997/98 (Jhamtani and Badawi 1998; BAPPENAS-ADB 1999; Glover and Jessup 1999, hereafter the ISAS [Institute of Southeast Asian Studies] study). The ADB study built on Jhamtani and Badawi (1998). Therefore, only the ADB and ISAS studies are considered in detail and a summary of their main assumptions and parameters is presented in the Appendix. Both major studies are assessed for the following reasons:

- many practitioners think that the two studies support each others' findings, hence the widespread acceptance of their results. This belief is based on the fact that the ADB study, covering the 1997 and 1998 events, estimated the burnt area as well as the total economic losses to be about double those of the ISAS study, which covered only 1997;
- shortcomings in one study could be highlighted by the other study's findings;
- their estimates can be used to complement each other.

The reassessment of the economic losses is carried out in a framework that highlights the difference between tangible and intangible costs (Bureau of Transport Economics 2002). Tangible costs are those that can be measured through market values such as damage to infrastructure (direct cost) and loss of production (indirect cost). Intangible costs are those that do not have market values such as negative impacts on health (direct cost) and disruption of social activities (indirect cost). The intangible costs are difficult to measure, therefore they are subject to broad approximation. The relevance of intangible costs should not be overlooked simply because they are difficult to estimate. However, the reliability of the estimates may be questionable and disregarded by some stakeholders.

The data presented below are organized to highlight the impacts on Indonesia and other countries, as well as the costs attributable directly to fires and those related to smoke haze.

The aggregate estimates are discussed first. Then the relevant individual cost items are considered in detail. Where necessary the estimates are revised, and they are summarized in Tables 8 and 9.

4.1 The aggregate estimates

The ISAS study used the average 1997 exchange rate of Rupiah/$2,500, whereas the ADB study adopted the average 1998 exchange rate of Rupiah/$8,000. The Asian crisis in 1997/98 revealed the weaknesses of the Indonesian economy, which included an overvalued currency. With hindsight, it is therefore appropriate to adopt the 1998 exchange rate.

In the ISAS study, the costs relating to agriculture and health in Indonesia, which were the costs categories calculated in rupiah then converted to dollars, are reduced respectively from $470 million to $147 million and from $924 million to $289 million (Table 5).

Table 5. ISAS estimate, exchange rate adjusted ($million)

Cost item	Indonesia		Other countries		Total
	Tangible	Intangible	Tangible	Intangible	
1. Fire-related damages					
Timber	494				494
Agriculture	147				147
Direct forest benefits		705			705
Indirect forest benefits		1077			1077
Capturable biodiversity		30			30
Fire fighting costs	11		13		25
Carbon emissions				272	272
Sub-total	652	1812	13	272	2750
2. Smoke haze-related damages					
Health		289		17	306
Tourism	70		186		256
Transport	18		7		25
Industrial production losses			157		157
Fishing decline			16		16
Sub-total	88	289	366	17	760
Total costs	**740**	**2101**	**379**	**289**	**3509**

Source: Adapted from Glover and Jessup (1999).

The ADB study estimated the total cost of 'fire and drought' in Indonesia. However, the results of this study are often cited by the media, in the literature (e.g. Barber and Schweithelm 2000), as well as in official documents (e.g. Qadri 2001), as being the losses from 'fire'. The agricultural costs associated with the drought ($2.431 billion) are therefore excluded (Table 6).

There are significant similarities as well as differences between the two studies (Table 7). Both studies attribute the largest share of total costs to Indonesia. In both studies, smoke haze contributes a smaller proportion of the costs than fire. If regional costs of smoke haze pollution were added to the ADB study, their total contribution would rise only by about 5%. While fire contributes the largest proportion to costs in both studies, in the ISAS study the intangible costs of fire are about three times as high as the tangible ones. The ADB finds tangible and intangible costs contributing an even share to the total. These differences indicate that the two studies do not wholly support each other's findings. A detailed assessment of the cost categories is required.

Table 6. ADB estimate ($million)

Cost item	Indonesia		Other countries		Total
	Tangible	Intangible	Tangible	Intangible	
1. Fire-related costs					
Timber	1461				
Lost growth of timber	287				
Timber plantation	91				
Estate crops	319				
NTFPs		631			
Indirect forest benefits					
Flood protection		413			
Erosion and siltation		1354			
Fire fighting costs	12				
Carbon emissions				1446	
Buildings and property	1				
Sub-total	2171	2398		1446	6015
2. Smoke haze-related costs					
Health		148			
Tourism	111				
Transportation	33				
Sub-total	144	148			292
Total costs	**2315**	**2546**		**1446**	**6307**

Source: Adapted from BAPPENAS-ADB (1999).

Table 7. Comparison of the main results of the ADB and ISAS studies

	Cost item	Indonesia		Other countries		Total
		Tangible	Intangible	Tangible	Intangible	
ISAS	Fire costs	652	1812	13	272	2750
	Fire contribution to total	18.6%	51.6%	0.4%	7.8%	78.3%
	Haze costs	88	289	366	17	760
	Haze contribution to total	2.5%	8.2%	10.4%	0.5%	21.7%
	Total costs	**740**	**2101**	**379**	**289**	**3509**
	Contribution to total	**21.1%**	**59.9%**	**10.8%**	**8.2%**	**100%**
ADB	Fire costs	2171	2398		1446	6015
	Fire contribution to total	34.4%	38.0%		22.9%	95.4%
	Haze costs	144	148			292
	Haze contribution to total	2.3%	2.3%			4.6%
	Total costs	**2315**	**2546**		**1446**	**6307**
	Contribution to costs	**36.7%**	**40.4%**		**22.9%**	**100%**

4.2 Reassessing the individual cost items

4.2.1 Agriculture

The ISAS study assumes that all the agricultural land that burnt resulted in economic costs. It does not take into account that fire could have been used to prepare the land or that at the time of the fires there were no crops on the land. In fact, the July to October period when the fires occurred in 1997 is the dry season, when the land is prepared for planting. Hence, only if the burnt area were planted with perennial crops, would fire have resulted in economic loss. In relation to annual crops, it is likely that many areas had not been planted, or crops had not grown because of the drought.

The ADB study adopts estimates of estate crops lost to fire provided by Jhamtani and Badawi (1998). While large areas of plantations in East Kalimantan were reported as affected by fire (Table 4), they had yet to be planted. The ADB estimate is adopted as it is the most accurate available in terms of costs. It appears unlikely that fire damage exceeded that implied by this estimate because national production statistics of the main perennial crops affected (oil palm, rubber, coconut) over the period 1996-2000 show regular upward trends[8] (AgroIndonesia 2002).

4.2.2 Timber

The ISAS estimate is incorrect because it uses an average stocking rate derived from the arithmetic average for Sumatra and Kalimantan but the total forest areas burned in Sumatra and Kalimantan differ. A weighted average would have been appropriate. Both the ISAS and the ADB study may overestimate the amount of burnt timber, because a large part of the burnt forest had been logged over. For East Kalimantan, it has been noted that:

> "in 1997/98 the area of the 1982/83 fire burnt again … but this time most of the affected areas had already been subjected to logging operations or were recently converted. Thus large amounts of the commercial timber above cutting limit had been taken out before the fire events of 1997/98. … This resulted in conditions of very poor timber stock in parts of the 1997/98 fire damaged area." (Hoffmann *et al.* 1999, p 21.)

The data used in the ADB report were substantiated through rather limited fieldwork but are supported in relation to East Kalimantan by Siegert *et al.* (2001). Therefore, the ADB estimate is adopted and is considered an upper level estimate.

The revised estimate for the minimum value of timber loss takes into account that, as discussed in Section 3, forest fires in Sumatra, Sulawesi, West Papua, West and Central Kalimantan were probably in land clearing areas, in which commercial timber harvesting had taken place. In addition, forest areas burnt by accidental fires in South Sumatra appear to have been already degraded (Forest Fire Prevention and Control Project 1999). Therefore, the minimum estimate for timber loss includes only the area burnt in East Kalimantan.

The true cost of burnt timber may also be lower than that assumed here because soon after the fires the Government of Indonesia issued a regulation allowing 'salvage logging', so that burnt trees could be harvested (van Nieuwstadt *et al.* 2001). There are no data available on the value of the burnt timber extracted.

4.2.3 Lost growth of timber

In theory, it is appropriate to include lost growth of timber as a cost. However, this holds only if the forest is not burnt to establish an alternative land use. Many of the areas burnt were being converted to plantations. Therefore, the ADB study overestimates the value of lost growth of timber. As in the case for timber, the revised estimate for the minimum value of lost growth takes into account that forest fires in Sumatra, Sulawesi, West Papua, West and Central Kalimantan were probably in land clearing areas.

4.2.4 Timber plantations

While large areas of timber plantations were reported burnt in East Kalimantan (Table 4), a significant portion of them had not yet been planted (Steenis and Fogarty 2001). The ADB estimate referring to reported fires in established plantations is not adjusted.

4.2.5 NTFPs and other direct forest benefits

The ISAS study adopts a global estimate for non-timber forest products (NTFPs) and recreation values of forests (Costanza *et al.* 1997) and transfers it to Indonesia. The estimate was not validated by making reference to actual values that may apply to Indonesian forest ecosystems. The lack of transferability of that estimate is demonstrated by the discussion that follows.

The ADB study derived the loss of NTFPs by applying the total value of natural resources extracted per hectare, derived from a study carried out in the Danau Sentarum wetlands in West Kalimantan (Aglionby and Whiteman 1996), to the total burnt forest area. The Danau Sentarum study extrapolated, from a sample of households, the total net direct-use benefits from the ecosystem derived by all households living in the protected area. The ADB study divides the total direct-use benefits by the hectares in the protected area to derive the per hectare value. The use of this figure as an approximate value of NTFPs loss per hectare of burnt forest is inappropriate for a range of reasons.

First, let us consider the issue of transferability of the per hectare value to different ecosystems. About 60% of the total net direct-use benefits in the Danau Sentarum protected area are attributable to fishing activities. These activities do not take place to the same degree in the forest ecosystems to which the estimate has been transferred. Also, there is no clear evidence showing that fish catches in the lakes and rivers of East Kalimantan have suffered as a result of fires (Sarwono 1989). It is also possible that, at least in the short term, fish harvesting increases as result of fires, as they are actively set to facilitate fishing (Chokkalingam *et al.* 2001).

Second and related to the above, the value of NTFP loss per hectare of forest burnt is considerably lower than that adopted by ADB ($23). A study carried out in two villages in East Kalimantan (Grossmann 1997) found that:

- NTFPs contribute about 9% ($26) of the total household yearly cash income (about $290) and almost all NTFP income (about 77%) is from game;
- the annual replacement value of all NTFPs consumed by a household is about 20% ($58) of its yearly cash income;
- most NTFPs have a very low density and the vast majority of plants are cultivated species;
- wild species are primarily collected in open spaces, along river banks and in young agricultural fallows.

Third, the direct-use benefit (i.e. total value) is an inappropriate measure of the economic value of NTFPs. "The value of a hectare of forest for nontimber products is equivalent to the rent that would be paid for the right to harvest that hectare." (Chomitz and Kumari 1998, p 26). The economic rent of NTFPs is close to zero given that the cost of extraction, that is labour input, accounts for most of the sale of value of NTFPs (Chomitz and Kumari 1998).

Fourth, losses of cultivated species such as rattan could be significant (and need further attention) but they would be better included under losses relating to agricultural products as they are cultivated, rather than inflating the per hectare value of forests.

On the basis of these arguments, the per hectare economic loss for NTFPs may be assumed to be zero. This is included as the minimum estimate. The maximum estimate allows for losses in East Kalimantan of $1/ha,[9] over a period of 10 years discounted at 10%. The forest fires in the other provinces are assumed to be land-clearing fires.

4.2.6 Indirect forest benefits

The ADB study assessed the value of flood protection and erosion and siltation on the basis of a report considering the total economic value of forests in Indonesia (Whiteman and Fraser 1997). They estimate that in relation to flood protection, conservation and protection forests, a land use category located on the upper slopes, are particularly important for flood protection. Production forests, a land use category mostly located in the lowlands, are much less important in the provision of this function.[10] The cost of additional floods resulting from a reduction in forest cover includes urban and rural infrastructure, such as schools, shops, government buildings, mosques and roads. Housing and road density in urban areas is about 11 times greater than in rural areas. Hence, the costs would also be distributed proportionally.

With regard to damage to crops, they assumed that rice is the main crop damaged by floods. The implications for the assumed costs of extra flooding resulting from the 1997/98 fires are as follows. Production forests, i.e. lowland forest, rather than conservation and protection forest, were the land use category most affected by fire. The areas affected had very limited, if any, downstream urban infrastructure and often very limited downstream rural infrastructure. The forest areas burnt had no significant known downstream rice areas. In relation to actual floods that may have occurred in areas significantly affected by the 1997/98 fires, those that occurred in 1998 in East Kalimantan have been singled out as having a possible link to the fires (Glover and Jessup 1999). In fact, floods in East Kalimantan were recorded well before the 1982/83 fires (Massing 1981) and there is no clear indication that flood patterns have changed. Flooding is an integral part of the Central Mahakam Lakes ecosystem on the Mahakam River (Wetlands International 2002), the largest river in East Kalimantan flowing through the area affected by fire.

With regard to soil erosion and siltation, there are three aspects to the calculation of the costs. First, soil erosion has to take place. Second, relevant siltation needs to result. Third, some economic costs have to arise from these processes.

The economic value of forests related to soil and siltation protection functions was derived by calculating the economic costs to 52 large dams and eight harbours (Whiteman and Fraser 1997). The name and location of the dams were not provided in that report. We could find 68 large dams registered as of 1995,[11] and there are no large dams in the areas affected by fire. The eight national ports are not in areas affected by fires and ensuing potential erosion and sedimentation.

In relation to soil erosion following the fires in East Kalimantan, the limited quantitative evidence available shows that the "rate of soil erosion in logged-over forest lands (heavy, light and no logging densities) followed by severe forest fire was still acceptable/tolerable/permissible, according to the research conducted 1.5 years after the logging and 6-10 months after the fire" (Sudarmadji 2001, p. 43). This research was conducted in a very limited area affected by fire and is by no means representative of the whole area. With regard to the 1982/83 fires, widespread soil erosion was noted but no quantitative data were collected (Leighton and Wirawan 1986). Still in East Kalimantan, it has been found that erosion rates in logged forests are almost as high as in logged and burnt forests. Also some agricultural activities practiced in East Kalimantan, such as traditional pepper growing (Kartawinata and Vayda 1984) result in soil erosion rates higher than those in logged and burnt forests.

In relation to siltation, there is not information available confirming its occurrence. Also, there have been no studies establishing the impact of soil erosion and siltation on economic activities. For example, there was no clearly established relationship between fisheries decline and sedimentation in East Kalimantan following the 1982/83 fires (Schindele *et al.* 1989). A decline in some of the species seems to have been associated with the combined effects of the drought, fires reducing some of the habitat and over-fishing.

On the basis of the above arguments, the revised cost estimates are as follows. The forest affected by fire did not have an economic value for flood protection (minimum value), which seems to be substantiated by the fact that there were no relevant floods in the 2 years following the fires that can be associated with the fires themselves. If it is assumed that a flood protection function exists and could be attributed to those forests (maximum value), given that the areas affected were rural rather than urban ones, the economic value of this function should be no more than 9% of that assumed in the ADB report (on the basis of the 1:11 ratio of rural to urban infrastructure discussed above). The costs resulting from soil erosion and siltation may also be limited in economic terms (maximum: 9% of ADB study), or do not exist at all (minimum).

These estimates attempt to present a picture based on known facts. It should not be excluded that the costs associated with soil erosion and siltation were in fact higher. There are examples showing that significant reduction in forest cover does not result in an increase in sedimentation (Alford 1992). However, there is also evidence that fires, especially severe ones, can normally be expected to result in soil erosion and siltation, although the effects at a watershed level are not well known (DeBano 2000). Therefore, there is a need to further assess these biophysical impacts to understand better the environmental and economic implications of fires.

4.2.7 Biodiversity

To estimate biodiversity loss, the ISAS study adopts a value of \$300 per km^2 in perpetuity, derived from international experience indicating that payments ranging between \$30-\$3000/km^2 have been made to conserve tropical forests. The study points out that this is not an estimate of the 'real' value of biodiversity, but of its 'capturable values', i.e. the value that the limited international market may be interested in paying. The estimate presents several problems.

First, willingness to pay for secondary forest (most of the fire-affected lowland forest had been logged, even in protected areas through illegal logging) can be expected to be much lower than that adopted. Second, the inclusion of the cost of biodiversity loss as well as timber loss results in double counting. If the value of timber were to be realized, i.e. harvested, biodiversity values would be lost to a significant extent, unless reduced impact logging were adopted. However, this would result in a different stream of benefits from harvested timber and it would be reflected in a reduced estimated loss of timber. Third, including biodiversity loss in perpetuity implies that fire causes a complete and permanent loss of forest, which is not the case. Fire normally results in partial damage[12] and the forest would regenerate overtime if other factors, normally human related activities, did not prevent that. Therefore, it is this relationship between human disturbance and fires that makes forests vulnerable to a cycle of repeated fires and disturbances that may result in deforestation.

For these combined reasons, the revised minimum estimate assumes that the value of biodiversity loss is zero. The maximum estimate adopts the minimum value of the range provided in the ISAS study ($30 ha) to account for the fact that most of the area burnt was secondary forest and willingness to pay for this forest type is expected to be lower than that for primary forest.

4.2.8 Carbon emissions

The ADB study reports a higher amount of carbon emissions than that reported in the ISAS study. It is possible, as described below, that actual carbon emissions were even higher than those adopted by the ADB study. Therefore, we focus our analysis on the ADB study.

According to the ADB study, of the estimated 206.6 million tonnes of carbon from the fires, 156.3 million (about 75%) were produced by burning peat, which also produced about 5 million tonnes (60%) of particulate matter out of a total of 8.2 million. These estimates are based on the assumption that about 750,000 ha (50%) of the area identified as peat and swamp forest in the ADB estimate was actually peat land. If all the area identified as 'peat and swamp forest' were actually peat and we adopt the area reported in Table 4, then carbon emissions from peat could have been as high as 442 million tonnes, bringing total carbon emissions to 493 million tonnes.[13] This is about 30% of the annual global average emissions from land-use change over the period 1989-1995 (IPCC 2000), with peat fires contributing up to 27% of global emissions from land-use change. Using the value adopted by the ADB study ($7/tonne), the total loss would be about $2.8 billion.

From an institutional perspective, carbon emissions from land clearing or other types of fires do not represent costs for the country itself or the global community. Developing countries (in Kyoto protocol terms, non Annex 1 countries) do not have to meet carbon emissions-reduction targets and carbon emissions from avoided deforestation projects are not allowed in the Clean Development Mechanism for the first commitment period. Therefore, while contributing significantly to global emissions, carbon emissions from Indonesian fires cannot currently be considered as a cost to other countries and do not represent a foregone benefit from potential Clean Development Mechanism projects. Hence, the costs associated with carbon emissions are not included in the revised estimate of losses. There are, however, policy implications that will be noted later.

4.2.9 Health

Estimating the health-related economic impacts of air pollution from forest and land fires is particularly difficult because of the lack of a significant body of knowledge studying the links between different levels of air pollution and health effects (Osterman and Brauer 2001). They note that during the 1997/98 smoke haze event, there was a 30% increase in hospital visits for haze-related problems in Singapore, but significant increases in hospitalization and mortality were not recorded. However, after reviewing other epidemiological studies they state that:

> "the studies of seasonal exposure to wood smoke involved exposure durations that were of comparable length to those experienced in Southeast Asia. Based on these studies, it is reasonable to expect that the Southeast Asian haze episode resulted in the entire spectrum of acute impacts, including increased mortality, as well as sub-chronic (seasonal) effects on lung function, respiratory illness and symptoms. It is not possible at this time to determine the long-term effects, if any, from a single air pollution episode, although yearly repeated occurrences of high biomass smoke exposure should be cause for serious concern." (Osterman and Brauer 2001, p. 211.)

Given the uncertainty about the health effects and the number of people affected, the ADB and ISAS estimates are used respectively as lower and upper bounds of the impacts. The ISAS estimate for Indonesia is adjusted (-6%) as it assumes that pollution levels associated with a *moderate* Air Pollution Index 51-100 result in increased health problems, which is not the case (Osterman and Brauer 2001).

5. Policy Implications and Recommendations

Smoke haze pollution and forest degradation and deforestation are the two major fire-related policy problems considered in detailed in the report. The losses relating to them during the 1997/98 ENSO event, as well as in more recent years, can a significant degree be attributed to different causes. This simple but essential finding needs to be recognized to develop appropriate policies. It implies that *policies should be assessed* *with regard to their appropriateness to address the forest degradation and deforestation problem or the smoke haze one.*

5.1 Economic costs and assessments

The total costs of fires and smoke haze pollution in 1997/98 may have been lower than previously thought. A total figure is not provided in the tables because it is somewhat misleading to add the costs of forest fires to those of the fires generating much of the smoke haze. For those inclined to seek one single figure, the estimated total costs range between about $2.3 billion and $3.2 billion. It is possible that the losses from smoke haze were in fact higher than those reported. Assessments of the impacts of smoke haze on business in Indonesia were not undertaken, as shown in Table 9. If it were considered appropriate to include carbon emissions in the costs, the total costs would range between $5.1 billion and $6 billion. The revised estimates of costs are still substantial and point to significant problems to be addressed to avoid similar impacts, especially in ENSO years.[14]

It needs to be noted, however, that the *net economic loss* from the fires, that is the difference between the costs and the benefits, is bound to be lower than the estimated costs. In most cases fires are lit because they provide benefits. For example, these may be reduced establishment costs of plantations – between $68 and $117 per ha respectively for timber and oil palm plantations (Guyon and Simorangkir 2002) — or reduced extraction costs for livelihood activities such as fishing.

The policy initiatives aimed at addressing fire-related problems need to take into account both the costs and the benefits related to the use of fire, as well as their distribution. For instance, the assessment of a policy directed at reducing smoke haze pollution may need to

Table 8. Economic costs of fires ($million)

Cost item	**Indonesia**					**Other countries**
	Minimum		**Maximum**			**Min/Max**
	Tangible	**Intangible**	**Tangible**	**Intangible**	**Total Max**	**Tangible**
Timber	1056		1614			
Lost growth of timber	197		316			
Timber plantation	91		91			
NTFPs		0		8		
Plantation crops	319		319			
Indirect forest benefits						
Flood protection		0		37		
Erosion and siltation		0		122		
Biodiversity		0		181		
Firefighting	12		12			13
Transmigration, property	1		1			
Total	**1675**	**0**	**2352**	**348**	**2700**	**13**
Share of East	1457		1766	283	2049	
Kalimantan	87%		75%	82%	76%	

Table 9. Economic costs of smoke haze pollution ($million)

Cost item	**Indonesia**			**Singapore**	**Malaysia**	**Total**
	Tangible	**Intangible**	**Total**			
Health		147-272		9	8	164
Tourism	111			58	127	297
Transport	33			7	0	40
Industrial production	na			0	157	157
Fishing decline	na			0	16	16
Total	**144**	**147-272**	**291-416**	**74**	**309**	**674-799**
Share in total			43-52%	9-11%	39-46%	

na: not available
Source: Adapted for Indonesia from BAPPENAS-ADB (1999); for Singapore and Malaysia from Glover and Jessup (1999).

consider the costs of implementing the policy as well as the benefits, which could be assessed as the avoided costs arising from smoke haze pollution. This implies a cost-benefit analysis approach to policy analysis. Alternatively, a cost-effectiveness approach could be used. This seeks to minimize the costs of implementing a policy aimed at achieving specific targets, such as the reduction of health impacts. Essentially, the adoption of either approach is a political decision. It is important, however, to consider both costs and benefits of policies, rather than simply focusing on costs of fires as it has been the case in the debate over fires in Indonesia.

Economic assessments of policies aimed at addressing deforestation and forest degradation or smoke haze pollution, should be mindful of the different causes and impacts. For instance, the avoided costs of a smoke haze reduction initiative should not include costs relating to forest degradation and deforestation, unless it was obvious that the fires responsible for smoke haze pollution were also the direct cause of deforestation. While this may seem obvious, policy proposals have been put forward to address 'the fire problem' on the basis that they would result in costs that are a fraction of the total costs from smoke haze and fire without distinguishing which policy problem they were addressing and without recognizing the different sources of the impacts.

The incentives faced by concession holders to invest in fire prevention and suppression need to be understood. These incentives include the capacity to control the timber resources existing in the concession area and the quantity of the resources. The concessionaires' capacity to protect the timber resources from illegal exploitation by others may be a factor influencing their decision to invest in fire prevention and suppression. An improved assessment of standing timber in forest concessions is also needed. Burnt timber was the most significant loss in 1997/98. This estimate relies on parameters that are questionable at the national level. If it resulted that standing timber left in forest concession areas was considerably lower than that assumed in the studies reviewed, the loss of timber would be significantly lower. Lower potential losses are a disincentive towards investment in fire prevention and suppression.

Smoke haze pollution accounts for a larger share of the total losses from the 1997/98 fires (20%-30%) than previously estimated. If data on impacts on business in Indonesia were available, the significance of the costs of smoke haze would increase even further. The significant attention accorded to this problem by the Government of Indonesia and neighboring countries compared to fires resulting in deforestation and forest degradation is explained by two factors. First, the size of the estimated costs. Second, the fact that smoke haze events are almost an annual occurrence affecting Indonesia and neighboring countries directly, with further economic costs as well as negative public relations and diplomatic impacts. *It is necessary to address the smoke haze problem, but the problem of deforestation and forest degradation fires needs also to be addressed as it can result in significant losses.*

In relation to the methodology adopted to assess losses, it is clear that intangible costs are difficult to assess and subject to very broad approximation. The revised estimates show that these losses appear to have been overestimated. However, it is also true that there is limited knowledge of some functions of forests and potential related losses. In addition, other potential losses, such as impacts on industrial production in Indonesia, were not estimated. *Future research and policy assessments should be aimed at improving the understanding of the damage caused by fire to forest functions in order to estimate the full range of potential losses from smoke haze pollution.*

Finally, economic assessments of long-term environmental change, such as potential impacts of multiple fires on soils and biodiversity, fail to capture the costs associated with these events as they are distributed over long periods of time and may be reduced to insignificance by discounting. *Economic as well as environmental indicators need to be taken into account in the development of policies aimed at minimizing the impacts of fires and smoke haze pollution.*

5.2 Fires, degradation and deforestation and land use allocation

The 1997/98 fires were met with great clamour not only because of the smoke haze generated but also because they were perceived to be responsible for economic and ecological losses associated with degradation or deforestation of the areas affected. Little attention was paid to the fact the fires were mainly affecting areas of degraded forest rather than 'primary' forest. Land clearing fires in plantation areas were also criticized as they were contributing to forest loss. As already noted, this resulted in a number of broad policy recommendations ranging from restricting or freezing forest conversion until improved land allocation policies and fire control procedures are in place, to strengthening rules and penalties against fire use for land clearing in plantations and the adoption of reduced impact logging (BAPPENAS-ADB 1999; Barber and Schweithelm 2000; Applegate *et al.* 2001; Glover 2001; Qadri 2001; Siegert *et al.* 2001).

There are shortcomings in this generalization of the problem and proposed policies to solve it. Firstly, *in many areas it is the allocation of forest to alternative land uses, such as oil palm plantations and the factors underlying that decision that are responsible for deforestation, rather then the fires*. In this case, proposing policies to address the 'fire problem' is simply a matter of misplaced focus. If the intent is to avoid deforestation, policy proposals should be directed at revising the land use allocation processes. In this respect, citing economic losses, e.g. timber losses, from deforestation 'caused' by fires as a reason to avoid conversion is also incorrect. It is the costs, including smoke haze pollution and benefits of the alternative land uses that should be considered, e.g. plantation vs natural forest.

Second, *given that in many cases it is not the fire itself that causes the policy problem, i.e. deforestation, there is no reason to completely outlaw the use of fire in plantations as currently stated in the legislation* (Government Regulation 4/2001). This approach could be appropriate if plantations were responsible for wildfires, or all plantation fires resulted in significant smoke haze. Evidence that in some cases plantation fires escaped is mainly anecdotal, and it has already been noted that activities on peat lands tend to create most of the smoke haze pollution. The issue of regulation is further discussed below in relation to smoke haze pollution.

Third, *the introduction of improved forest management practices may result in a limited reduction in fire risk, given the existing socio-economic and institutional conditions*. Ecological studies show a positive feedback between logging, forest fires, fuel loading and future fire susceptibility (Cochrane *et al.* 1999; Siegert *et al.* 2001). Therefore, forest management practices such as reduced impact logging are thought to minimize fire susceptibility, but they might reduce fire risk only in areas completely controlled by the concessionaires, e.g. sparsely populated. The extent of uninhabited forest areas left in Indonesia is uncertain. An initial approximation is provided by an estimate of low access forest[15] area of about 52 million ha, with a further 33 million ha located within logging concessions (FWI/GFW 2002). However, this assessment overestimates the area that may be subject to limited human influence. Preliminary analysis in East Kalimantan shows that livelihood activities resulting in fires are found as far as 7 km from a village (compared to the 0.5-1 km distance adopted in the definition of low access forest) and often even further (Tacconi *et al.* 2002). The large area affected by fires in East Kalimantan in 1998 is peppered with villages and about 46% of the land area affected by fire is within 7 km of a village.

A recommendation to keep the people out of the forest to minimize fire risk after it has been logged (Glover and Jessup 1999; Glover 2001) to be approved or adopted in the current political and economic environment, dominated by discourse about increased control over resources by the people. In low population areas, the widespread presence of illegal logging may also reduce the benefits of introducing improved forest management practices. And even without illegal logging, the adoption of improved forest management practices faces several obstacles (Putz *et al.* 2000). Therefore, low access areas, once logged, are likely to see an inflow of people ultimately leading to a greater risk of fire.

In this context it is essential to note that East Kalimantan, the hardest hit by the ENSO droughts of 1997/98 and 1982/83, accounts for at least three quarters of the total costs related to fire. The risk of large-scale fires is particularly significant in areas that tend to be affected by ENSO droughts and it can be expected that recurrent ENSO droughts will affect again this area. Other provinces, such as Central Kalimantan and West Papua, that still have significant forest areas and are experiencing high exploitation rates, could be facing ecological changes that combined with human and institutional factors could result in significantly increased fire risk. Therefore, *to support improved resource management, research is needed to assess the areas of low access forest (using conservative parameters regarding human access), primary forest, and secondary forest areas that present environmental conditions potentially leading to significant fire risk.*

5.3 Fires and smoke haze pollution

The economic losses from smoke haze pollution are due to a range of factors. In Kalimantan and Sumatra, burning of peat lands is the major source of smoke haze. This is only a proximate factor. In 1997, in Kalimantan (and as a result in Insular Malaysia), the major source of smoke haze pollution was the government-initiated One Million Hectare Rice Project; land clearing on peat land by large companies (and possibly to a lesser degree by smallholders) in West Kalimantan seems also to have contributed. In Sumatra (and as a result in Singapore and Peninsular Malaysia), the bulk of smoke haze pollution was contributed by burning peat lands in Riau, Jambi and South Sumatra provinces due to land clearing by companies and possibly smallholders (although to a lesser degree) and, in the degraded South Sumatran swamps, escaped fires from livelihood activities such as agriculture, fishing and logging.

Further analysis is needed to clarify the relative contribution of the various activities to smoke haze pollution. However, from the broad existing information presented it is clear that plantation activities are not the only contributing factor, at least in ENSO years. In non-ENSO years they do appear to be the major contributing factor, but the increasing role of smallholder activities, especially in West and Central Kalimantan, needs to be ascertained. This has implications for priorities for action and for the policy instruments that could be used to address the smoke haze problem.

In ENSO years degraded peat lands may be the most significant risk factor for the generation of smoke haze. Their management and eventually their regeneration/restoration may be required to avoid significant events of air pollution. The costs and the viability of this policy need to be ascertained and compared with the expected benefits (i.e. improved economic production, positive environmental benefits and avoided environmental costs). Focusing only on large and small plantation activities probably would not solve the smoke haze problem in ENSO years.

Land clearing fires in Sumatra can be expected to continue as new plantations are established (Anderson and Bowen 2000). This trend may also apply to Kalimantan. *A reduction and/or management of land clearing fires in peat lands would probably go a long way towards eliminating the smoke haze problem in non-ENSO years. However, the costs, benefits and distributional aspects of policy initiatives aimed at reducing the impacts of these fires need to be assessed.* The losses from smoke haze pollution in 1997/98 can be expected to be far greater than the costs of smoke haze pollution in non-ENSO years. If market-based instruments such as pollution charges were to be considered to reduce air pollution by plantation companies (Qadri 2001), it should not be assumed that the benefits (i.e. avoided costs) of this initiative would equal the losses suffered in 1997/98.

There is knowledge about the major human activities resulting in smoke haze pollution and undesired fires in some areas, such as parts of Sumatra. The report has summarized broad information about probable causes of undesired fires and smoke haze pollution in Sumatra, West, Central and East Kalimantan and West Papua. However, *there is still a significant lack of knowledge, at a level appropriate for policy making (district and provincial), about the human activities contributing to these problems in many areas of the country, including those just discussed. This knowledge gap needs to be filled to develop appropriate policy responses.*

5.4 Fires and legislation

Recognizing that the impacts of fires rather than the fires themselves constitute the policy problems and that in some circumstances fire may be an appropriate land management tool has implications for legislation. The Indonesian legislation (Government Regulation 4/2001) forbids all forest and land fires. It focuses on fire as the problem, to be avoided in any situation. To be effective in addressing the policy problems, the legislation needs to recognize that there are different types of fires and that not all fires are problematic. There are fires that generate significant amounts of smoke haze and those that generate much less. There are land clearing fires lit on purpose for the establishment of plantations, which may not create significant haze if they are not on peat land. There are also fires burning out of control in areas that are supposed to be maintained as forests, such as those that occurred in East Kalimantan in 1997/98.

The legislation should be revised. It should ban fires that have significant smoke haze effects, such as those on peat land, while the use of fire in situations and locations which may have unwanted local effects resulting from smoke, e.g. on health or transport, should be regulated. In relation to fires resulting in unwanted deforestation, the appropriate authorities should be given the power to regulate (including banning) fire use in particular periods, such as during ENSO events. These revisions would focus attention on the really problematic fires. In this way, the limited resources available to prevent and suppress fires could be used to address the problematic fires.

In relation to peat lands, there is legislation that regulates their development. It stipulates that peat areas deeper than 3 meters should not be developed (Presidential Decree No. 32/1990).

It is not clear whether this regulation is implemented at all. *An analysis of its appropriateness, including the social, economic and environmental implications is needed.*

It is obvious that just revising the legislation will not solve fire related problems. The laws need to be enforced and this is not occurring. This is not just because fires may be difficult to monitor and police. The recurring Indonesian fires are often described as 'forest fires,' giving the impression they are burning in remote and inaccessible areas. This is not always true. For example, the fact that during the haze event in July-October 2002 in West Kalimantan over 75 percent of the hot spots identified on peat land were on oil palm plantations and timber plantations[16] means that there are roads to access the areas. Inspections by government officials and the collection of evidence to prosecute those using fire illegally are viable. Therefore, once the law is revised, the Government needs to take firm action against companies that use fire illegally. If some companies were found guilty and the penalties were applied, a significant message would be sent to other companies, possibly influencing their use of fire. Therefore, *to effect a change in the use of fires by companies, clear punitive examples need to be set, meaning that companies using fire unlawfully need to be prosecuted, if found guilty the penalties imposed need to be sufficiently large to act as a deterrent.*

There are, however, clear limits to the effectiveness of legislative means (and their enforcement) in addressing the fire and smoke haze problems. In some cases small-scale livelihood activities by villagers are the main ignition sources and it is unlikely that legislative means will be successful in dealing with these sources of ignition. Small-scale livelihood activities are more dispersed than those of companies, more difficult to monitor and legislated changes to burning practices are virtually impossible to enforce. Therefore, *when livelihood activities are involved in a fire or smoke haze problem, only community-based initiatives,*[17] *backed by legislative means, have any likelihood of succeeding.*

5.5 Carbon sinks

There is a considerable degree of uncertainty about the amount of carbon emissions generated during the 1997/98 fire events. The estimates presented range from 206.6 million tonnes of carbon, with 156.3 million (about 75%) produced by burning peat, to 493 million tonnes, with peat contributing 442 million tonnes (about 90%). The higher estimate is equal to about 30% (and 27% from peat fires) of the annual global average emissions from land-use change over the period 1989-1995 (IPCC 2000).

It was noted above that currently, from an institutional perspective, carbon emissions from land clearing and other types of fires do not represent costs for the country itself or the global community, because developing countries do not have to meet carbon emissions reduction targets and carbon emissions from avoided deforestation projects are not allowed in the Clean Development Mechanism for the first commitment period. *Given the contribution of peat fires to carbon emissions, there is a need to consider whether conservation of peat lands should be included in the second commitment period of the Kyoto protocol.*

5.6 Fires, ENSO and human factors

The debate over whether fires in Indonesia are due to human factors or the result of natural events is a moot point. It is clear that both the environmental conditions brought about by ENSO events and human activities contribute to fires, given that naturally ignited fires in Indonesia are a rarity and large-scale fire events such as those of 1997/98 do not occur in non-ENSO years. On the other hand, it is obvious that the smoke haze problem occurs almost yearly as a result of land clearing activities, albeit to a much smaller extent than in ENSO years. Human factors, involving plantations, villagers and government agencies, as well as the ENSO, contribute to fires and smoke haze.

Unfortunately, the game of allocating the blame for the fires and smoke haze to the companies, the villagers, or simply the ENSO, repeats itself as regularly as the smoke haze that disrupts social and economic activities in Indonesia and its neighbours at least twice a year. While the figures for the 1997/98 economic losses have been revised downwards and the biannual haze events may have lower economic impacts than the 1997/98 events, they are still significant. In terms of surface area, this report shows that fires affected an area larger than previously thought, despite claims that fires did not seem to be as extensive as reported by organizations such as the WWF (Lomborg 2001). Therefore, there is a need for the Government of Indonesia, the industry and non-government organizations to go beyond just allocating the blame and to create a serious partnership to address this national and international environmental, economic and social predicament.

Endnotes

[1] All $ values are US$.

[2] Smoke haze refers to the presence of visible aerosol from combustion and reduced visibility due to dry particles.

[3] The figures presented are indicative only. They are affected by the poor quality of the remote sensing data, the lack of accurate land use data and the limited fieldwork that was done to assess the true area affected by fire. I thank I. Anderson, formerly with Forest Fire Prevention and Control Project, for pointing this out. Pers. comm. Nov 2002.

[4] Fires affected East Kalimantan especially in 1998, whereas other areas in Indonesia were affected in 1997.

[5] I. Anderson, pers. comm. Nov 2002.

[6] In normal years, Riau probably has more land clearing fires (as detected by satellite) than any other province in Indonesia. From historical rainfall records, it does not suffer severely from ENSO droughts. In Riau, there were many fires and smoke haze pollution from plantation fires on peat lands in early 1997 and early 1998 but no wildfires such as in Jambi and South Sumatra during the peak haze months of September to mid-November 1997 (I. Anderson, pers. comm. Nov 2002).

[7] It is unknown yet which activities were actually responsible for the fires in the peat areas.

[8] The only exception is a decline of about 20% over the period in rubber production by large estates, which contribute about 15% to total production. This decline appears to be due to structural change in the sector.

[9] This rough figure is probably an overestimate. It is based on the following assumptions: i) NTFPs valued at $58 are collected over a 100 ha area, i.e. $5.8/ha; ii) game is not affected significantly by fires; iii) given that most plant species used are cultivated ones, only about 20% is actually derived from forest areas.

[10] The simulation assumes that 25% of total forest loss in the watershed areas occurs in production forests. This contributes 7% of additional flooded area.

[11] URL: http://www.pu.go.id/publik/pegairan/html/ind/infbair/bendungan/bendungan.htm

[12] In East Kalimantan, on the basis of data provided by the IFFM project, it was calculated that biomass loss was in the 25%-50% range in about 75% of the fire affected lowland forest. Cochrane and Laurance (2002) also report that second fires typically kill about 40% of standing trees and biomass.

[13] Total carbon emissions have been estimated by Page *et al.* (2002) to be at least 810 million tonnes. This minimum estimate is based on the lower range estimate for the area burnt discussed in Section 3 and on an average of 51cm of peat burnt (lower bound 25 cm, upper bound 85 cm). The ADB estimate is based on an average of 30 cm of peat burnt. The average used in the ADB study is adopted here to avoid over-estimation. The area studied by Page *et al.* (2002) was the most severely affected by fires; thus, the national level average of peat burnt may be lower than that used by them.

[14] The July-October 2002 fires and the significant smoke haze pollution in Kalimantan were linked to a medium strength ENSO event.

[15] Low access forest is defined as 'primary or mature secondary forests that are relatively undisturbed by human activity ..[and] ..according to their area and distance from roads, navigable rivers (in the case of Kalimantan), human settlements, agriculture, mines and other development. The minimum distance from these features is 0.5-1 km' (FWI/GFW 2002, p. 73).

[16] CIFOR analysis of hot spot data.

[17] 'Community-based initiatives' refers to activities that seek to involve the local stakeholders in the process. In does not imply that a whole 'community', e.g. village, needs to be involved and it does not imply homogeneous social units.

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Appendix

Table A1. Summary of assumptions and parameters used in the ISAS and ADB study

Cost item	ISAS Assumptions	ADB Assumptions
1. Drought related damage		
Agriculture		Economic losses due to impact of drought on rice are included. Linear trend in increase of rice production adopted. Increased costs related to rice imports included.
2. Fire-related damages		
Agriculture	Area burnt: agricultural and plantation land 2.5 million ha; unproductive land 1.5 million ha Productive land use values for large-scale oil palm plantations $2000 to 4000 per ha. Smallholder land values about $400 per ha. Hence average agricultural land use values $1000 per ha At a 10% discount rate, the annual net value per hectare is $100 After burning, full agricultural productivity re-established in three years, with partial productivity being re-established in years 1 from the burns	Total area burnt of plantation crops about 91,000 ha Estimate derived from the UNDP 1998 report.
Timber	Forest area burnt 1 million ha Average stocking rate 40.5 m^3/ha class >50 cm; 63.5 m^3/ha class >20 cm. Based on inventory data: Kalimantan- 49 m^3/ha in class > 50 cm, 74 m^3/ha in class >20 cm Sumatra – 32 m^3/ha in class > 50 cm, 53 m^3/ha in class >20 cm Stock in class >20 take 10 year to reach maturity. Thus, overall present average stocking rate 49.37 The timber is harvested over a 25 year period. Net timber price: $50	Commercial forest (lowland) burnt 3.283 million ha Stocking rates based apparently on National Inventory data, eg: Lowland Kalimantan- 54.5 m^3/ha in class > 50 cm, 81.4 m^3/ha in class >20 cm Sumatra – 36.1 m^3/ha in class > 50 cm, 56.6 m^3/ha in class >20 cm 30% of standing volume burnt. Net timber price based on calculated ec. rent: Kalimantan: $28-43 Sumatra: $32-39
Lost growth of timber	Included in the section on lost timber above.	65% of the volume destroyed. Forest harvested on 25 year cycle. Tree growth reducers timber loss to 0 over 35 years future harvests discounted by a factor 10%

Table A1. *Continued*

Cost item	ISAS Assumptions	ADB Assumptions
Timber plantation		Total area burnt 135,000 ha. Plantations of less than three years completely burnt. Older plantations only 30% of the area burnt. Cost of plantation establishment, maintenance and tending $504 per ha. Compound rate of 10%. Profit margin 15%.
NTFPs and other direct forest benefits	Applied to one million hectare of burned forest This includes: food, raw materials, NTFPs, ($/ha/year 401) and recreation ($/ha/year 129). Values calculated at a worldwide level are transferable to Indonesia. Derived from Costanza *et al*. 1997	Area affected 4.84 million hectares of forest 75% of NTFP production destroyed in the first year, it will resume over 20 year period Value per ha/year $23, derived from study in Danau Sentarum
Indirect forest benefits	Applied to one million of burned forest This includes disturbance regulation, water supply regulation, pollution control, soil formation, nutrient cycling, waste treatment Derived from Costanza *et al*. 1997	
- Flood protection		Annual value $91.6/ha/yr (based on Whiteman and Fraser 1997) 35% of forest land burnt would be devoid of tree and groundcover. Protective function re-established over five years. Future losses discounted at 10%.
- Erosion and siltation		Value $550 per ha/year 1, $500 per ha/year 2. Function lost over 35% of the forest burnt.
Capturable biodiversity	Value per sq km is equal to $300 (based on international review of amounts that have been paid for biodiversity conservation falling into a range of $30 to 3000 per sq km per year). Applied in perpetuity to one million hectare of forest. It does not attempt to reflect the intrinsic value of species, the potential of ecotourism, or internationally marketed pharmaceuticals.	Insufficient data to make a reasonable estimate of the local value. 'Including a less than rigorous value for this component, may lead to the validity of the whole valuation being questioned'
Carbon release	Value of carbon $10 per tonne 27.2 million tonnes of carbon emitted	206.6 million tonnes of carbon were released. Value $7 per tonne

Table A1. *Continued*

Cost item	ISAS Assumptions	ADB Assumptions
3. Haze related damages		
Health	Population affected by haze was estimated by extrapolating from model derived from data in Malaysia Includes estimated total medical costs: treatment cost in hospital and unreported cases and self treatment. Does not include long-term health impacts. All adult cases would involve employed people (i.e. housewives, elderly and unemployed are excluded). Willingness to pay to prevent adverse effects exceeds the direct costs by a factor of 2:1; included as an additional estimate of lost consumer surplus. 35.4 million subjected to above normal levels of haze 91 days of exposure period 267,000 hospitalizations 623,000 non-hospitalized treatments 9.78 million of self treatment cases 27.9 million workdays lost	Population affected by haze was estimated by extrapolating data from Indonesia. Estimate builds on the UNDP 1998 report. Includes deaths, included in lost productivity over 20 yr. Willingness to pay to prevent adverse effects exceeds the direct costs by a factor of 2:1; included as an additional estimate of lost consumer surplus. In 1997, 12,360,000 affected; total for 1998 not specified, but assumes similar effects as in 1997; 19,108 hospitalizations 44,034 outpatients 695,000 self treatment cases 2.95 million workdays lost
Tourism	Reduced visitors between 15% and 22.5% 50% Reduction in visitors from ASEAN due to economic crisis between 187,000 and 281,000 visitor losses average visitor expenditure $1250	Builds on the ISAS study. Total reduction in tourists in 1997: 326768; 1998: 1,908,070; of which: all arrival from Europe and America between 9/97 and 4/98 reduced by fire; 50% of reduced arrivals from 5/98 to 9/98 from Europe and America due to haze; 50% of reduced arrivals from 9/97 to 12/97 from Asia Pacific due to haze. Average visitor expenditure $1129
Airport closures	1108 flights were cancelled	

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