FOREST FIRE IMPACT TO THE AIR POLLUTION

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Abstract

Normally in a certain province that located in Sumatra and Kalimantan Islands of Indonesia, smoke problems appear during dry season which started at around June or July every years even with no El-Nino year. In the last few years it had been found that haze problems was not appear in the dry seasons only but also in the wet seasons as it occurred again in the year 2006. Further observation and field finding shown that most of the smoke rooted from land preparation using fire was occurred in oil palm and forestry plantation even though it is absolutely prohibited. As a results most of flooding area that occurred in both province was located in burned area.

Key word: Fire, peat, land degradation, flood, policy

INTRODUCTION

Transboundary haze pollution due to the smoke from land preparation using fire done by an oil palm, forestry plantation and local peoples become a big problem in Indonesia every years especially when the dry season come since last 10 years. Smoke pollution reached a record during the 1997/98 fires, which released more carbon dioxide than the cars and power stations of western Europe release in one year (WWF, 1997). In total the fires contributed 22% of the world's carbon released in that year, or more than 700 million tones, which made Indonesia one of the largest contributors of carbon emissions in the world (UNCHS, 1999) and new released research stated about 2.6 Gt. Recent publication shown that Indonesia become ranked third for the greenhouse emissions.

Smoke and "haze" from forest fires produce some of the most visible costs to society. People suffer respiratory problems, which puts pressure on meager medical facilities in many tropical countries. Estimates suggest that between 20 million and 70 million people were adversely affected by smoke from the Indonesian fires and at least 40,000 people were hospitalized both in Indonesia and neighboring countries (Asian Development Bank, 1999 and Glover and Jessup, 1999). Smoke reduces visibility, provoking transportation accidents and airport shutdowns. This often leads to transboundary smoke pollution, which provokes international indignation (ADB, 1999). It had been found also the flooding area emerges in several districts and regions mostly believed have directly due to the fire done before.

NATURAL RESOURCES AND FIRE DISASTROUS

Commercial use of forest resources and forest lands was very limited up to and including the middle decades of this century. This changed dramatically when forestry basic law 1967 used. Millions of hectares of forest land where awarded as timber concessions in the late 1960s and early 1970s, leading to a timber boom in Sumatra and Kalimantan that changed the landscape of these two islands over a period of two decades. The government policies and procedure for allocating and supervising timber concessions were deeply flawed and riddled with corruption, leading to severe impacts on forest ecosystems, biodiversity and forest dwelling peoples. Forest management and land use practices in Sumatra and Kalimantan have evolved very rapidly over the past three decades (Scweithelm, 1998). The forests of Indonesia are being logged at a rate of approximately 40 million cubic meters per year, a rate that is nearly twice that recommended by the Ministry of Forestry for sustainable yield (UNCHS, 1999).

Based on land sat image in the year 2000 about 101.73 million ha of the total forest and land had been degraded where 59.62 million ha of it found in the forest where 10.52 million ha found in the protection forest, 4.69 million ha in the conservation forest and rest totally about 44.42 million ha found in the production forest. The rate of deforestation during 1985-1997 estimated at 1.6 million ha/year, in the period of 1997-2000 very much increased to be around 3.8 million ha/year and during 2000-2003 it was hard to estimate because it was very un controlled (Purnama, 2003) or at an average of 2.8 million ha/year.

Poor logging practices resulted in large amounts of waste would left in the forest, greatly elevating fire hazard. Failure by the government and concessionaires to protect logged forests and close old logging roads led to and invasion of the forest by agricultural settlers whose land clearances practices increased the risk of fire. The fact that Sumatra and Kalimantan remained forested until recent decades indicates that neither naturally-caused fires nor human use of fire caused significant deforestation in the past (Schweithelm, 1998).

FIRES DISASTERS

Forest fires have been reported a number of times over the past 150 years on the island of Borneo and such fires probably also occurred in Sumatra. Records of forest fire were first made

in the late 19th century when Michielsen (in 1882) conducted a survey of the region between the Kalanaman and Cempaka Rivers (now Sampit and Katingan Rivers) in Central Kalimantan. He reported that forest fire had damaged a number of sites in 1877. Soon after Gerlach recorded evidence of forest fires in what is now the Sentarum Lake Wildlife Reserve in the Southwestern region of West Kalimantan. It can no longer be assumed that tropical forest fires are a recent phenomenon. But the frequency and intensity of tropical forest fires have increased in parallel with the frequency and intensity of human activities in the forests (Schindler, 1998).

An analysis of remote sensing data from the mid-1980s indicated that the Indonesian archipelago contained about 10 million ha of grasslands at the time (RePPProT, 1990). Much of the remaining forest has been logged in recent years, and logged forests are frequently degraded or converted to agriculture. The present landscape is a mosaic of vegetation types and land uses, including some intact forest ecosystem, logged forest in various stages of regeneration, scrubland, grassland, annual crops, and tree plantations (Qadri, 2001).

Periodic fires have been reported in the Lake Sentarum Wildfire Reserve in West Kalimantan since the middle of the 19th century. Brunig (1971) reports that the relatively fire-prone *kerangas* of heath forest of Sabah and Sarawak burned spontaneously or by human action in the 1880_s, the early 1930_s, and the late 1950_s. So while the burning of forest of Sumatra and Kalimantan is clearly not a recent or geographically unique phenomenon, the fact that these islands remained largely forested until recent decades indicates that neither naturally caused fire or human use of fire led to significant deforestation in the past (Qadri, 2001).

During pronounced *El Nino* years, when conditions are usually dry, fire and smoke problems tend to be much more serious. Serious fire occurred in 1982-1983, 1987, 1991-1992, 1994-1995, and 1997-1998, 2000, 2002 and 2005. The economic cost of the fires has extended far beyond the destruction of large tracts of forestland. In addition to the direct damage these fires have caused to human and animal populations living in the affected areas, the resulting smoke has directly imperiled human health and economic well-being in adjacent AMCs (Qadri, 2001).

One of the most serious of the recent fires was in East Kalimantan during 1982-1983, demonstrating the greater vulnerability of disturbed forests to blazes. In the fire season, ENSO caused large-scale wildfires, which ran out of control from several land clearings and slash-and burn sites as well as form logging areas, *alang-alang*, and camping sites. It has been estimated

that the overall land area of Kalimantan affected by fire exceed 5 million ha, where in East Kalimantan alone, about 3,5 million ha were affected by drought and fire.

Table 1. Area burned in 1982/1983 forest fire (Hess, 1994)

Vegetation/land use	area (x 1000 ha)
Undisturbed forest	45.1
Lightly disturbed forest	635.68
Moderately disturbed forest	826.56
Heavily disturbed forest	639.76
Plantations	25.92
Kerangas forest	18.0
Limestone hills and rocks	24.08
Undisturbed swamp forests	30.77
Disturbed swamp forests	373.45
Open swamp forests	90.2
Brackish swamps	5.06
Tidal forests	0.0
Shifting cultivation	328.95
Cultivated areas, settlements	146.97
Lakes and rivers	0.0
Other land use	526.93
Total area	3,717.43

Land and forest fires that occurred during the extended dry periods in 1987 (66,000 ha), 1991 (500,000 ha), and 1994 (5.11 million ha) were distributed over some 25 provinces, including Maluku and Sulawesi. These fires were larger than during years with normal rainfall. The smoke emitted from the Indonesian archipelago during these years was not primarily caused by forest fires alone, but also by the application of fire for converting forest into estate tree crops and forest plantations, as well as by slash-and burn agriculture (Goldammer, 1998).

Table 2. Area burned in 1994 forest fire (Goldammer, 1995)

Vegetation/land use	area (x 1000 ha)
Traditional dry land farming	2,800.0
Shifting cultivation	1,500.0
Transmigrant farming	260.0
Plantations	221.0
Transmigrant settlement	39.5

Reforestation areas	20.5
Timber estates	17.0
Natural forests	8.0
Total area	4,866

Noted by UNEP as one of the biggest environmental shocks since 1950, the 1997-1998 forest fires of Indonesia were among the most damaging in recorded history (UNEP, 1999). The area affected by fire has been estimated as 9.76 million ha. Indonesia (and Malaysia) experienced one of the worst recorded droughts in recent history during that period. It occurred in two spells. The dry conditions that started around April 1997 abated briefly by November 1997. But the *El Nino* persisted and drought resumed in early 1998, in a pattern reminiscent of the *El-Nino* drought and fires of 1982-1983. The second spell lasted from January to May 1998, until the onset of rain. Less serious, sporadic fires occurred in the dry season of 1999.

Table 3. Area burned in 1997/1998 (BAPPENAS, 1999)

Vegetation/land use	area (x 1000 ha)
Agriculture	3,843
Estate Crops	119
Timber Plantations	188
Lowland Forest	3,100
Peat and Swamp forest	1,450
Dry Scrub and Grass	700
Montane forest	100
Total area	9,500

ENVIRONMENTAL IMPACT

Biomass burning

Our planet and global environment are witnessing the most profound changes in the brief history of the human species. Human activity is the major agent of these changes: depletion of stratospheric ozone, the threat of global warming, deforestation, acid precipitation, the extinction of species, and others that have not become apparent (Levine, 1996). They are caused and significantly enhanced by biomass burning. Biomass burning is the burning of the worlds living

and dead vegetation, including grasslands, forests and agricultural lands following the harvest for land clearing and land-use change (Levine, 1996). Biomass burning is a significant global source of gaseous and particulate emissions to the atmosphere. The impact of biomass burning on the atmospheric chemistry and biogeochemical cycles has been widely exposed in recent years (Crutzen and Andreae, 1990), it is through interactions with the atmosphere that biomass burning acquires its truly global character. Changes or trends in emissions, transport, chemical transportation and deposition of biomass burning gaseous are thus important to asses (Malingreau and Gregorie, 1996). Based on existing data, it has been predicted that biomass burning is responsible for 20-40% of the total anthropogenic CO_2 emitted into the atmosphere (Levine, 1990). Burning release large amounts of CO_2 into the atmosphere, some of which is reincorporated into the terrestrial biosphere over the course of months to years. Reincorporating occurs during the period of re-growth following the annual burning of certain ecosystem, primarily grassland (Kambis and Levine, 1996).

Biomass burning is a significant global source of gaseous and particulate emissions to the atmosphere. Gases produced by biomass burning include (1): GHG gases, CO_2, CH_4 and N_2O that lead to global warming, (2) chemically active gases, NO, CO, CH_4 and NMHCs, which lead to the photochemical production of ozone (O_3) in the troposphere, and (3) CH_3Cl, and CH_3Br which lead to the chemical destruction of ozone in the stratosphere (Levine, 1985).

The largest single atmospheric emissions from fire are CO_2. Along with water vapor, CO_2 makes up about 90 percent of the atmospheric emissions from fire and 80 to almost 90 percent of the C emissions. CO_2 can account for 99 percent of the C emissions in efficient burns, that is burns consuming most, if not all, of the available fuels, but account for only 50 percent in low-intensity smoldering fire (Debano et al, 1998). Based on existing data, it has been predicted that biomass burning is responsible for 20-40% of the total anthropogenic CO_2 emitted into the atmosphere (Levine, 1990). Burning release large amounts of CO_2 into the atmosphere, some of which is reincorporated into the terrestrial biosphere over the course of months to years. Reincorporating occurs during the period of re-growth following the annual burning of certain ecosystem, primarily grassland (Kambis and Levine, 1996).

Impacts

Impacts of fire on the atmosphere occur at all scale. Visibility effects and the changes in chemical constituents in the atmosphere (such as CO_2, water vapor, CO, and particulate matter)

are a concern at the scale of a small fire of less than a hectare. At a landscape and regional scale, changes in atmosphere processes and chemical deposition emerge as issues, although visibility and the chemical content of air are still important. The major environmental concern on a global scale is the response of atmospheric processes to the chemical constituents added to the atmosphere from the burning of fuels in forests, shrub lands and grasslands (Debano *et al*, 1998).

Atmospheric CO2 content is presently rising at 0.4-0.48 % annually, faster than at any time in the past 500 million years (Sorensen, 1994). If no immediate counter-actions are taken, a doubling of atmospheric CO2 is expected to occur between the year 2025-2050. The present sharp rise in CO2 levels is expected to have profound effects on the global climate as well as on natural ecosystems and their biodiversity, and on current patterns of agricultural production. Other greenhouse gases exist and are also on the rise.

GHG effect

The greenhouse effect is a natural phenomenon: without it the average temperature of the earth would be below freezing (Sorensen, 1994). The concern with the rapid increase of greenhouse gases in the atmosphere caused by human activity is that there will be an enhanced greenhouse effect, leading to rapid climate change. A doubling of CO2 levels in the atmosphere is expected to induce a rise in average global temperature of between 3-4°C. This does not sound like much, but during the last glacial period, when large parts of northern Europe and America were under 2-3 kilometers of ice, the global temperature was only 4-5°C°C lower than today. Fossil fuel is the largest source of atmospheric CO2 which has had the sharpest rate of increase of all greenhouse gases. Other human sources of CO2 include forest clearing and other vegetation changes associated with land use (Sorensen, 1994).

Not only does climate influence fire, but fire activity also can influence climate. Regionally, large fires with their change in albedo and removal of vegetation with the accompanying drop in evapotranspiration can influence the energy budget and climate. Recent evidence suggests that local to regional changes in the land surface characteristics can significantly alter the climate of that region (Couzin, 1999). In addition to climatic influences on the fire regime other factors such as ignition agents, length of the fire season, vegetation characteristics and human activities such as fire management policies and landscape fragmentation may greatly influence the fire regime in the next century.

Impact to the human health

In 1997/1998 forest fires at least 20 million of Indonesian peoples were directly and indirectly affected by fire. Black smokes contains many air pollutants: CO, CO_2, SO_2, $NO_{(x)}$ and NH4 and bacteria such as Streptococcus causes many diseases such as diarrhea, pneumonia, bronchitis and brain disturbance. Thousand of people in Riau, Jambi, South Sumatra, and Central, West and East Kalimantan were hospitalized for medical treatments. Black smokes that continued for at least two months in southern Sumatra at which time the lack of sunshine reduced food production and caused many peoples to seek emergency food sources. Hundreds of peoples also died in Irian Jaya because the transportation of food and other supplies could not reach their areas due to smoke.

Table 4. Estimated health and social impacts during the haze episode in 8 provinces in Indonesia, September-November 1997

Province	Population at risk	No. of outpatient visits	No. of inpatient	No. of lost working days	No. of days with limited activities
Riau	1,701,000	5,018	2,177	336,670	654,885
West Sumatera	2,411,000	7,112	3,086	477,197	928,235
Jambi	1,478,000	4,360	1,892	292,533	569,030
South Sumatera	2,355,000	6,948	3,015	466,114	906,675
West Kalimantan	1,478,000	5,452	2,366	365,765	711,480
Central Kalimantan	716,000	2,112	917	141,714	275,660
South Kalimantan	1,733,000	5,112	2,218	343,004	667,205
East Kalimantan	118,000	348	151	23,355	45,430
Total	12,360,000	36,462	15,822	2,446,352	4,758,600

Fires in Indonesia have resulted in human exposure to levels of air pollutants far in excess of those stipulated in the WHO guidelines. Chemical pollutants such as SO_2, NOx, O_3, CO and respirable fine particulate are harmful to human health. Air quality monitoring data (PSI or pollutant standards index) obtained from various institutions during the peak haze period showed that in areas close to the fires, the levels of air pollutants were 4-8 times higher than the values which have a significant health impact. Data collected through active surveillance from

September to November 1997 in eight provinces showed increases in the incidence of bronchial asthma and ARI (acute respiratory infection). According to the Indonesian Central Bureau of Statistics, among 12,360,000 people affected by the haze in 1997, there were about 1,802,340 cases of bronchial asthma, bronchitis and ARI. In several provinces, the total suspended particulate (TSP) threshold limit of 260 μg/m3 was exceeded; eg. in West Sumatera, by 5 - 10 times; in Riau, by 0.8 - 7 times; in South Sumatera, by 3.5 - 8 times; in West Kalimantan, by 0.5 - 7.3 times; and in Central Kalimantan, by 0.5 - 15 times.

Table 5. Number of cases of asthma, bronchitis, acute respiratory infection (ARI) and deaths in 8 provinces in Indonesia, September-November 1997

Province	Population at risk	Asthma	Bronchiti s	ARI	Death
Riau	1,701,000	41,028	7,995	199,107	75
West Sumatera	2,411,000	58,164	11,332	282,087	106
Jambi	1,478,000	35,650	6,947	172,926	65
South Sumatera	2,355,000	56,803	11,069	275,535	104
West Kalimantan	1,478,000	44,574	8,686	216,216	74
Central Kalimantan	716,000	17,574	3,366	83,772	29
South Kalimantan	1,733,000	41,800	8,145	202,716	69
East Kalimantan	118,000	2,846	555	13,806	5
Total	12,360,000	298,125	58,095	1,446,120	527

Source: Directorate-General, Communicable Disease Control & Environmental Health, Ministry of Health, Indonesia

Role of forest

When forests are used to produce sawn timber, plywood or other industrial wood products, C can be sequestered for long period. The length of time depends on how the timber is treated and used (Brown et al, 1996). The growth rate and the carbon sequestration potential of forest decline towards plant maturity. In matured forests, growth rate is largely offset by wood decay (Chaturvedi, 1994). Nature and climax forests are neither sources nor sinks of atmospheric carbon (Dabas and Bhatia, 1996). It is said that forests that experience a net loss of biomass

volume through mortality due to disease or fire become net carbon emitter (Kyrklund, 1990). Research done by Susan et al (2002) shown that 0.81-2.57 Gt of carbon were released to the atmosphere in 1997 as a result of burning peat and vegetation in Indonesia. This is equivalent to 13-40 % of the mean annual global carbon emission from fossil fuels (6.4 Gt per year) and contributed greatly to the largest annual increase in atmospheric CO2 concentration detected since record began in 1957 (Houghton et al, 2001). Fire risk is increased in burnt peatlands and caused recurrent fires which finally the carbon sink function is destroyed. 35 Tg per year tropical peat only (Siegert et al, 2005). There is trend that sharp increase of CO2 since 1957 with the largest occurs in 1997, 2002 and 2003.

CONCLUSION

Natural resources need to be exploited in order to match the public consumption, unfortunately an over exploitation will have direct and indirect response of the ecosystem which finally lead to the environmental destruction that highly cost and lost of the natural resources. To protect from all environmental destruction then sustainable natural resources management is highly appreciate.

It had been well known that the impacts of fire to the environmental condition worsen year by year, unfortunately the efforts to minimize seems politically sounds not environmentally hence there is no significant results reached.

REFERENCES

ADB/ASEAN. 1999. Final report, RETA 5778: Strengthening the capacity of the Association of Southeast Asian Nations to Prevent and Mitigate Transboundary Atmospheric Pollution.

BAPPENAS. 1999. Final report of planning for fire prevention and drought management project: ADB-ADTA INO 2999. 3 Vols. Jakarta.

Brunig, E.F. 1971. On the ecological significance of drought in the equatorial wet evergreen (Rain) forest of Sarawak, Borneo. In: The water relations of Malaysia Forests. From the first Aberdeen Hull Sysposium of Malaysian Ecology, held in Hull, 1970, edited by J.R.Flenley, 66-96. Hull, UK: Department of Geography, University of Hull.

Glover, D and T. Jessup. 1999. Indonesia's fires and haze: the cost of catastrophe. Singapore and Ottawa: The Institute of Southeast Asian Studies (ISEAS) and the International Development Research Centre (IDRC)

Goldammer, J. G. 1993. Fire Management. In : Pancel, L. (ed.). Tropical forestry handbook. Vol. 2 : 1221 - 1267.

Goldammer, J.G. 1995. 1994-A year of International fires. International Forest Fire News. No.12.Pp.FAO/ECE/ILO

Hess, P. 1994. Forest fire in East Kalimantan 1982/1983: Effects damages and technical solutions-the potential of residual stands after affected by fire. Paper presented in the workshop of forest rehabilitation and forest protection from fire. Samarinda, 31 January- 2 February 1994. 20 pp.

Purnama, B. 2003. Pengelolaan hutan lestari sebagai dasar pertimbangan peran sektor kehutanan. 12 pp.

Qadri, S.T. 2001. Fire, Smoke and Haze. ASEAN-ADB. 246 pp.

RePPProT. 1990. A National overview from the Regional Physical Planning Program for Transmigration. UK Overseas Development Administration and Directorate BINA Programme. Indonesian Ministry of Trnasmigration, Jakarta.

Schindler, L. 1998. The Indonesian fires and SE Asean Haze 1997/98. Review, Causes and Necessary steps. Paper presented at the Asia - Pasific regional workshop on transboundary atmospheric pollution. Singapore, 27 - 28 May.

Schweithem, J. 1998. The fire this time : An overview of Indonesia's forest fire in 1997/1998. WWF Indonesia.

UNCHS. 1999. Inter-agency report on Indonesian forest and land fires and proposal for risk for reduction in human settlements. UNCHS (Habitat), UNDP, UNHD and ADPC. 36 pp.

UNEP. 1999. Global Environmental Outlook 2000. Earthscan Publications, Ltd. London.

WWF. 1997. Indonesias fire: 30 Orangutans dead, other species threatened. WWF press release. 2pp.