Clearing the haze and seeing the forest

A proposal of economic incentives and financial mechanisms to combat deforestation, fires and haze in Indonesia

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EXECUTIVE SUMMARY

The twin challenges of **biodiversity loss** and **climate change** have brought the rapid deforestation in Indonesia to the world's attention. Hundreds of thousands of hectares of rainforest are being lost each year, especially in Sumatra and Kalimantan, to give way to palm oil and timber plantations and degraded land. The rich biodiversity of the archipelago is thus imperiled, with entire ecosystems and many species at the verge of extinction. The fires used for land clearing generate massive amounts of greenhouse gas emissions and episodes of **transboundary haze pollution**. Haze affects Indonesia, Singapore, Brunei and Malaysia during dry seasons and El Niño years, with severe public health consequences and economic impacts. The fires and haze of 1997-1998, arguably one of the worst environmental disasters of the 20th century, caused damages in the order of US$9.3 billion to countries in the region.

Many research efforts have been devoted to the issues of fire, haze and deforestation in Indonesia, but few have examined the proposed solutions as thoroughly as they have studied the problems. This paper intends to address this research gap by proposing and evaluating an integrated policy framework designed to steer the relevant actors in Indonesia towards forest conservation and sustainable management of palm oil and timber production, and away from continued deforestation and use of fire. The policy framework draws upon the principles of the Ecosystem Approach, which consider the maintenance of ecosystem services a priority of ecosystem management, and is comprised of economic incentives and sustainable financing instruments.

The Natural Capital Project, a joint venture between **WWF, The Nature Conservancy and the Woods Institute for the Environment at Stanford University**, is working to map ecosystem services**,** assess their values in economic and other terms, and incorporate those values into resource decisions. The present report is a contributing paper to the Natural Capital Project for its work in Borneo and Sumatra, two of the priority conservation regions for WWF around the world, and intends to be a contribution to the discussion of the sustainable development policies that Indonesia needs for its future.

The problems

Forest and biodiversity loss

Indonesia has the second fastest rate of deforestation in the world after Brazil. Deforestation is currently most intense in the lowlands of Kalimantan and in the Riau province in Sumatra. Lowland dipterocarp forests, heath forests and peat forests are the most threatened ecosystems, home to many iconic mammals. Habitat loss has taken many species to the verge of extinction.

Fire

Deforestation is intimately associated with fires in Indonesia. Fire has been used traditionally by rural communities for cultivation, but in recent decades it has been used at a large scale to convert forests to oil palm and timber plantations, frequently burning the land following logging operations. In addition, escaped fires from land clearings have destroyed vast areas of rainforest.

Rapid land use change and accumulated forest degradation have meant that fires can expand more easily into forests during the dry season, leading to an exponential increase in fire occurrence in the past three decades. Climate change is likely to bring an even higher risk of wildfires, due to higher temperatures and possibly more frequent and intensified El Niño events.

Greenhouse gas emissions and peat

Indonesia is currently the third largest greenhouse gas (GHG) emitter in the world behind the United States and China. Emissions from the forestry sector, primarily from forest fires and land use change, account for over 85% of the country's emissions.

The severity of the GHG emissions in Indonesia is explained by the abundance of peatlands, with 21 million hectares in forested swamps of Sumatra, Kalimantan and Papua. Peatlands are highly acidified and waterlogged soils with rich organic deposits. They become a net carbon source to the atmosphere when drained, after which they oxidize and are prone to burning. Fires in peatlands can generate subsurface burning that lasts for months due to the depth of some peat deposits.

Transboundary Haze Pollution

Haze pollution, the term used in Southeast Asia for smog from the combustion of biomass, is a large recurrent phenomenon in the region during the dry season due to widespread burning for land clearing purposes. Although the burning of forests contributes to haze, it is estimated that 60-90 % of the haze comes from the burning of peatlands in Sumatra and Kalimantan.

Haze episodes have been reported in 1980, 1982-83, 1987, 1991, 1994, 1997-98, 2002, 2005, 2006 and 2009. Haze pollution was especially catastrophic in 1982-83 and 1997-98. The economic impacts of haze have been well documented, especially for the 1997-1998 El Niño event. Although Indonesia suffers the brunt of the losses, the impacts on health, medical costs, lost productivity and tourism losses for Singapore, Malaysia and Brunei have been a source of friction with Indonesia, where most of the haze originates.

The drivers

Legal and illegal logging

Timber extraction has mushroomed in Indonesia in recent decades, owing to the steady demand for timber worldwide and the allocation of vast areas of logging concession lands. In 2002, exports of wood products accounted for 13% of Indonesia's exports, not counting the substantial value of the illegal trade.

Oil palm plantations

Indonesia exported 14.2 million tons of crude palm oil (CPO) in 2008, representing 44.5% of the world market. The government has allocated hundreds of thousands of hectares for plantations, and the area planted with oil palm has grown 35 times over since 1967 to occupy 6 million ha in 2005, from large plantations to small farms. Around 70% of this area was formerly forest, and increasingly, new plantations are being located in peatlands. Fire use has been common to clear land for palm oil.

Palm oil is highly profitable compared to traditional crops such as rubber, and has contributed to foreign exchange revenue, poverty reduction and economic development, taking center stage in Indonesia's development strategy.

Timber plantations

Industrial tree plantations have been promoted since the 1980s in Sumatra and Kalimantan to provide timber and pulpwood for mills. Like oil palm, they occupy mainly land that was formerly forest and fire is also used for land clearing.

Smallholder and migrant communities

Farmers burn plots during the dry season to grow crops like rice and pepper, boost soil nutrients, improve forage and eliminate pests. During a year of average rainfall, these fires are easily controlled, but with forest degradation and drought, fires escape more easily and may become ravaging wildfires.

Government transmigrant programs and spontaneous migration have increased population pressures in Sumatra and Kalimantan, leading to fire and deforestation.

Limitations in forest governance and enforcement of environmental law

The Indonesian government has struggled to articulate and implement a strong vision for forest conservation, facing pressures from economic interests, internal development needs, diverging goals and lack of coordination among government institutions. This results in contradictory laws for forest conservation, ambiguity in their stringency, requirements, and jurisdiction. Forest governance is still evolving with the decentralization model after the fall of Suharto in 1998.

The combat of environmental crime is not a high priority in the country, and many of the regulations on logging, land use and fire go unenforced. Lack of capacity is often cited as a reason for limited enforcement.

Land tenure conflicts

Communities that live in state forest land rarely have concession property rights over it, but customary usufruct rights called *adat.* The central government reserves the right to terminate *adat* and designate forest lands for other uses, leading to numerous takings of community land for plantations and logging concessions. The ensuing land tenure conflicts have led some to use arson as an instrument in land disputes.

The responses so far

Land use planning

Indonesia's forests are state land managed under the authority of the Ministry of Forestry (MoF) and are divided into conservation forests, protected forests and production forests. However, these designations do not always reflect the reality on the ground. Recently, land use planning has regained impetus with the government pledge to protect and restore Sumatra's remaining critical ecosystems and forests through detailed spatial planning to protect and connect high conservation value areas.

Fire management

Since the fires of 1997-98, fire detection and monitoring improved substantially, but management capacity is still insufficient. In response to the uncontrollable fire episodes, the Indonesian government banned the use of fire for land clearing in 2001 and is promoting zero-burning clearing for oil palm and timber plantations. The ban of fire, however, is unenforceable with small farmers, and it has been criticized for not acknowledging that fire can be used judiciously in certain circumstances.

ASEAN Transboundary Haze Agreement (THA)

The ASEAN THA was signed in 2002 to strengthen cooperation and implement preventive measures for haze in the ASEAN region. It provides a framework for cooperation among Southeast Asian nations to mitigate transboundary haze. The THA has coordinated fire and haze monitoring, and generated regional haze action plans, with guidelines for community based fire management, among others. The ASEAN Transboundary Haze Pollution Control Fund was established to pay for the activities of the treaty and is open to voluntary contributions from member countries. Unfortunately, Indonesia has not ratified the agreement, so progress overall has been slow.

Sustainable Palm Oil

The Roundtable on Sustainable Palm Oil (RSPO) was formed in 2004 in response to pressures to address the environmental and social impacts of palm oil production. RSPO has issued principles and criteria for sustainable palm oil, including guidelines for best management practices for existing plantations (including zero burning methods), among others. RSPO began a certification program in 2008.

Sustainable Forest Management

Multiple efforts exist for sustainable forest management in Indonesia including community forest management, although none has had an industry-wide effect. Akin to the RSPO, the Forest Stewardship Council (FSC) is an entity certifying sustainable forestry operations with an international standard of high legitimacy and credibility. Nevertheless, FSC certification is still incipient in Indonesia.

Reducing Emissions from Deforestation and Forest Degradation (REDD)

REDD promotes commitments by developing forest nations to reduce their rates of deforestation and thus their emissions, earning carbon credits that could be monetized in the carbon market or through public or private carbon funds. The Bali Action Plan from the UNFCCC COP13 in 2007 encouraged parties to undertake demonstration activities to reduce the drivers of deforestation and test REDD crediting methodologies. Indonesia has begun a demonstration project in Aceh province in Sumatra.

The Proposed Policy Framework

The rationale: forest fires and haze in the context of ecosystem services

Forests in Indonesia are a stock of natural capital that provides a bundle of ecosystem services at local, regional and global scales. Fires destroy or severely impair the capacity of the land to deliver these ecosystem services.

In the case of haze, the maintenance of air quality typically does not figure among the ecosystem services provided by forests. Forests, however, store the biomass pollutants present in haze as long as they are not burnt. Hence, the ecosystem service of ***"biomass pollution retention"*** is attributable to forests and peatlands given a land use without fire. This service yields the benefit of healthy air quality and prevents the damages associated with haze.

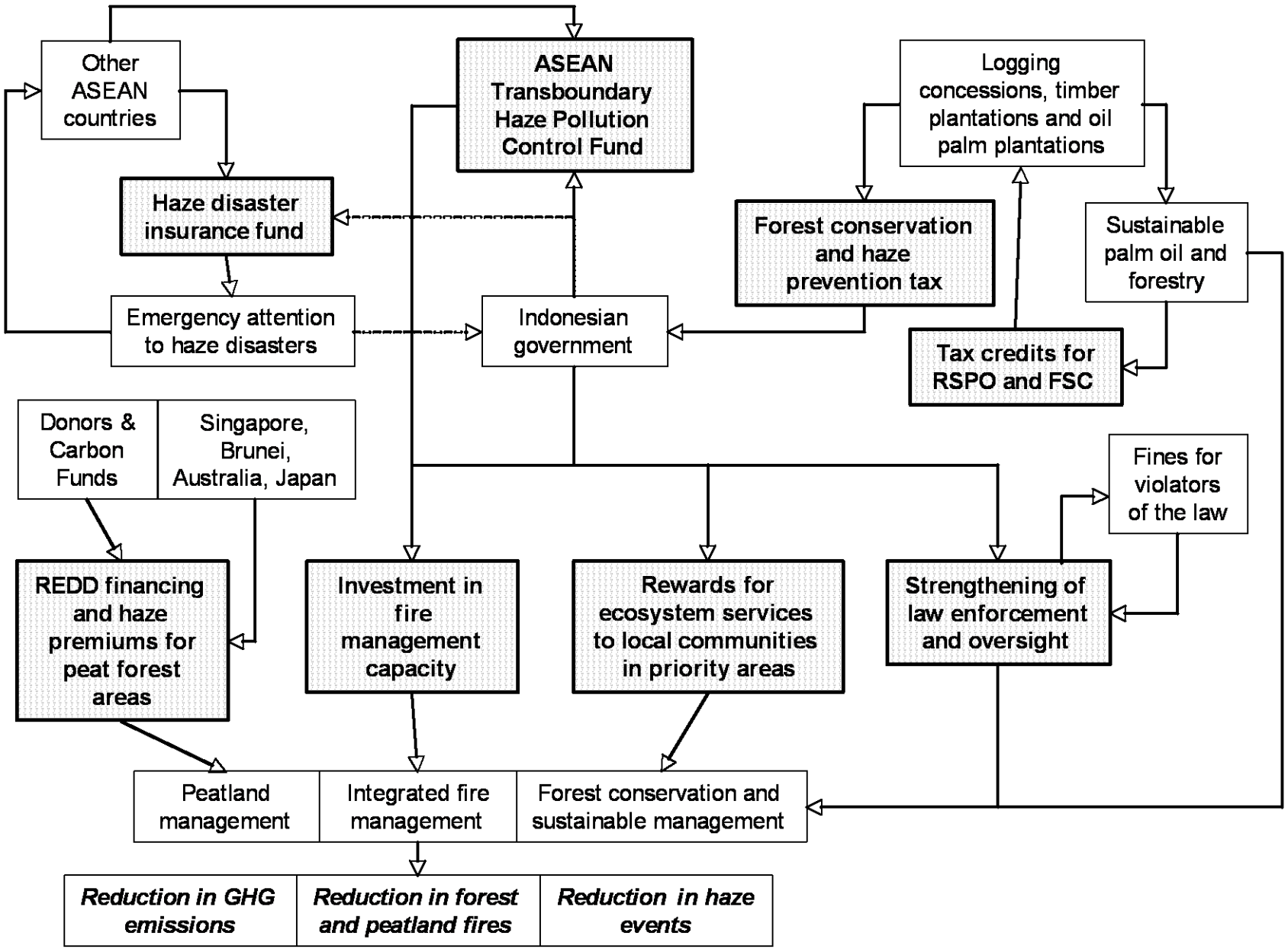
As a policy tool, REDD financing is based on the ecosystem service framework. REDD rests on the premise that the international community, as a beneficiary of the climate regulation benefits from carbon storage of existing tropical forests, should pay tropical forest countries to preserve that service by maintaining forests. REDD provides an opportunity for synergies of payments for carbon storage with investments for the prevention of forest fires and haze, which can also be defined in the context of ecosystem services. The policy framework is designed to maximize those synergies.

The framework (Figure 1) introduces an environmental tax on palm oil and timber plantations to internalize environmental damages and provide revenue that the Indonesian government needs to address the fire and haze problem. It also includes incentives for rural dwellers to protect ecosystem services and internalize their benefits in their economy. At an international scale, the policy framework recognizes the impacts of haze on neighboring countries and the need for a compensatory mechanism. It also establishes the link of haze with REDD, so that Indonesia has a double incentive to manage peatlands and prevent fires and greenhouse gas emissions. Finally, the policies contemplate generating revenue for chronically underfunded activities of environmental law enforcement and fire management.

1. Forest conservation and haze prevention tax and credits for sustainable practices

The palm oil, timber and pulp industries in Indonesia hold a large share of historical responsibility for deforestation, illegal logging, fires and haze. On the other hand, these are highly profitable commodities. Hence, it is appropriate to introduce an environmental Forest Conservation and Haze Prevention tax on these industries, in order to generate earmarked revenue for the implementation of the policies included in this framework: law enforcement, investments in fire management capacity, rewards for ecosystem services for local communities and contributions to the ASEAN Transboundary Haze Pollution Control Fund. This tax would follow the polluter pays principle, making companies internalize the societal costs of deforestation, fire and haze. Even if the tax rate is not set high enough to change the cost equations in favor of sustainable practices, the revenue generated can be considerable. Despite the present drop in commodity prices, US $85 million could be collected yearly at a tax rate of 1% from palm oil alone, at 2008 production levels and July 2009 prices.

Figure 1 – Proposed Policy Framework (Main elements are in bold)



The tax could be charged as an additional levy on exports of crude palm oil, whereas for timber the tax would be more easily assessed per hectare of concession or plantation. To prevent an increase in illegal logging, law enforcement needs to be stepped up in parallel with the tax. The impact of the tax on Indonesian competitiveness is likely to be small, as Indonesia holds a dominant position in the palm oil market. In order to reward good behavior, the proposal includes deductions or exemptions from the tax for companies that follow sustainable practices and produce certified FSC timber and RSPO palm oil. These credits would provide an additional incentive for certification.

2. Investment in fire management capacity at a national level and through the ASEAN Transboundary Haze Pollution Control Fund

Fire response should not be a matter of responding to one-time disasters, but of addressing all the components of fire risk, which is exacerbated during El Niño events and in peatland areas. The Global Fire Assessment highlighted the need for institutional strengthening of fire management in Indonesia, as the big costs of suppression take up all the small budgets and leave limited resources for fire prevention.

The country should consider large investments in all the aspects of integrated fire management: prevention and information, detection and monitoring, preparedness, response, restoration and recovery. The level of funding needed is unknown, but certainly many times higher than the US$11.67 million spent by Indonesia during the 1997 fires, which as a crude comparison is 0.65% of what the US spent in Forest Fire Suppression in 2007. When evaluated against the cost incurred by Indonesians due to fire and haze events, an increased investment in fire management has enormous potential to reduce damages.

Ratification of the ASEAN Transboundary Haze Agreement would help Indonesia secure more funding through the ASEAN Transboundary Haze Pollution Control Fund, for activities such as monitoring and capacity building. However, expenses like salaries for firefighters, helicopters and fuel need other dedicated national sources of revenue. The proposed Forest Conservation and Haze Prevention Tax can provide such a source.

3. Haze Disaster Emergency Fund

Transboundary haze episodes are disasters that affect the health of human populations over great areas far beyond the main sources of fire. To help countries cope with the emergency expenditures needed when haze episodes occur, ASEAN could establish a Haze Disaster Emergency Fund under the Transboundary Haze Agreement. This fund would pool the risk of haze among all ASEAN countries much like an insurance policy for natural disasters, and would embrace the spirit of regional cooperation, giving emergency funds to affected countries regardless of where the haze originated.

The proposed Haze Disaster Emergency Fund could cover emergency medical attention and response measures of affected areas anywhere in the region. It could be managed by agreement by the Asian Development Bank, where the fund could be established independently or incorporated with specific provisions into the newly established *Asia Pacific Disaster Response Fund*. For Indonesia, contributing to this fund would mean making a good-will gesture of acceptance of responsibility for haze, which could trigger reciprocal gestures from Singapore, Brunei and Malaysia, such as investment in REDD and combating of illegal logging.

4. Rewards for ecosystem services (RES) to local communities in priority areas

Whereas a tax can be effective at the level of the timber and palm oil industry, equity and logistical concerns suggest the need to have positive incentives for rural communities to favor sustainable forest management and conservation over deforestation and fires.

In that spirit, the Indonesian government could support *Rewards for Ecosystem Services* (RES) to local communities for forest conservation and integrated fire management activities, with money from the Forest Conservation and Haze Prevention Tax as well as REDD financing. RES are conditional upon delivery of environmental services, as Payments for Ecosystem Services (PES), but do not preclude non-monetary rewards, making it easier to work with the *adat* land tenure system, as RES are not dependent on individual landholder property rights

The rewards would provide incentives to communities to preserve forest cover, shift from forest clearing to agroforestry and manage fire in a judicious way. They can also compensate communities for fire use restrictions in peatlands and during droughts. RES programs can be especially targeted to forested and non-forested peatland areas; as well as buffer zones of protected areas, where prevention of fire episodes is crucial.

The rewards could take many forms such as direct payments to households, payments to the community as a whole under a cooperative, infrastructure building, employment in fire brigades, and concessions over land rights granted to entire villages with the figure of community forestry licenses. The use of the forest conservation and haze prevention tax to finance rewards would guarantee a sustainable revenue stream, the lack of which is a problem for sustaining PES schemes worldwide.

5. REDD financing and haze premiums for peat forest areas

Indonesia has the potential to receive large amounts of money through financing for reducing emissions from deforestation and forest degradation. Peat forests are of particular interest for REDD, as they have the largest carbon stock per unit of area, when considering the deep peat deposits in the soil. Indonesia could find that by protecting its peat forests and deposits, it could achieve an impressive reduction in greenhouse gas emissions per dollar of REDD investments. Averting fires in peatlands is also the most important action to prevent transboundary haze due to the release of particulate matter from peat burning.

In anticipation of an international REDD regime, Indonesia could establish REDD demonstration projects in peat forests, particularly in the most threatened areas in Sumatra and Kalimantan. The projects would need to address land zoning and tenure, forest management, illegal logging, intentional burning, escaped fires, peat subsidence and oxidation. They would benefit from investments in fire management capacity and law enforcement, and could employ RES as a component of their action.

REDD projects in peatlands would not only generate carbon credits but also reduce the incidence of haze by measurable amounts by preserving the biomass pollution retention service of those forests. The inclusion of "haze credits" as a premium is a possibility to monetize this ecosystem service. Because of their location and co-benefits, targeted investments could be sought for the projects, particularly from Singapore, Brunei, Australia and Japan, as these countries could reap the benefits of reduction in haze as well as use the carbon credits.

6. Strengthened law enforcement and oversight

Without proper monitoring, enforcement and tax collection practices, companies and local communities could easily violate fire restrictions, evade taxes, receive tax deductions or payments when they are not entitled to and undermine the credibility of the government. Moreover, there are crimes such as illegal logging, wildlife poaching and open-air burning that need to be combated severely.

Indonesia requires numerous additional forest and customs inspectors, park rangers, environmental police, remote sensing and intelligence analysts, among others. The Forest Conservation and Haze Prevention Tax could bridge the funding gap by providing dedicated revenue for environmental law enforcement. In addition, law enforcement can procure its own internal financing, by instituting and collecting fines and penalties to companies and individuals that violate the law.

The expectations

The policy framework proposed attempts to turn the links between deforestation, fires, haze and greenhouse gas emissions into a powerful set of incentives for forest conservation and sustainable management. In anticipation of the decision on REDD in Copenhagen in December 2009, Indonesia needs to align its policies to make best use of the scheme and sharply reverse the trends in forest loss and reduce forest fires and haze. However, REDD funding is not yet guaranteed, so Indonesia should keep other options open to finance economic incentives, enhanced fire management, emergency funds for haze events and law enforcement. It is hoped that some of the ideas presented here will be taken forward and improved for this purpose.

1. Introduction

The twin challenges of biodiversity loss and climate change have brought the rapid deforestation in Indonesia to the world's attention. Hundreds of thousands of hectares of rainforest are being lost each year, especially in Sumatra and Kalimantan, to give way to palm oil and timber plantations and degraded land. The rich biodiversity of the archipelago is thus imperiled, with entire ecosystems and many species at the verge of extinction. The fires used for land clearing generate massive amounts of greenhouse gas emissions and episodes of transboundary haze pollution. Haze affects Indonesia, Singapore, Brunei and Malaysia during dry seasons and El Niño years, with severe public health consequences and economic impacts.

Many research efforts have been devoted to the problems of fire, haze and deforestation in Indonesia, particularly after the severe fires of 1997 and 1998. There is a thorough understanding of the causes and costs of fires and haze. Various studies have issued recommendations, but few have examined their proposed solutions as thoroughly as they have examined the problems. This paper intends to address this gap by proposing an integrated policy framework of economic incentives and sustainable financing to steer the relevant actors in Indonesia towards forest conservation and sustainable management of palm oil and timber production, and away from continued deforestation and use of fire. This policy framework includes the following instruments: *1) a Forest Conservation and Haze Prevention Tax and credits for sustainable practices; 2) Investments in fire management capacity; 3) a Haze Disaster Emergency Fund; 4) Rewards for Ecosystem Services to local communities; 5) REDD financing and haze premiums for peat forest areas; and 6) Strengthened law enforcement and oversight*. Each one of them is analyzed in terms of its potential, limitations and challenges of implementation.

The policy framework draws upon the principles of the ecosystem approach[1], which consider the maintenance of ecosystem services a priority of ecosystem management (CBD, 2007). To do this, the paper proposes the definition of the ecosystem service of *biomass pollution retention* in order to define haze and forest fires in ecosystem service terms and create parallels with the carbon sequestration and storage services. In addition, the policies explored are careful in being coherent with the Indonesian regulatory and legal context and build upon some existing international policy responses and initiatives, such as the ASEAN Transboundary Haze Agreement (ASEAN THA), Reducing Emissions from Deforestation and Forest Degradation (REDD), Payments for Ecosystem Services (PES), the Roundtable on Sustainable Palm Oil (RSPO) and the Forest Stewardship Council (FSC). Furthermore, they draw from well-established principles of environmental law and policy including the precautionary principle; the polluter pays principle, the good neighborliness principle[2] and the sustainable development principle (Beder, 2006; UNEP, 1985).

The paper is structured as follows: The problems of forest loss, greenhouse gas emissions and transboundary haze pollution are first described in a background section, followed by a second section of an analysis of their different drivers. The third chapter reviews the principal policy

[1] Defined by the Convention on Biological Diversity as "*A strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way"* (CBD, 2007)

[2] In reference to the responsibility of states not to cause damage to the environment of other states or of areas beyond the limits of national jurisdiction.

responses that have been implemented and suggested so far to address the problems. The fourth section defines forest fires and haze in the context of ecosystem services and the fifth section presents the proposed policy framework with a detailed analysis of each proposal.

This report is the product of an extensive literature review, coupled with consultations and questionnaires with Indonesian and international experts from various backgrounds that reviewed the policy framework and provided valuable insights and critiques regarding the likely effectiveness, feasibility and side effects of suggested policies, as well as suggesting modifications or additional policy instruments.

It is worth mentioning, however, that some dimensions of the problem still need to be explored further and go beyond the scope of this paper. Deforestation in Indonesia is occurring also due to external factors such as the growing global demand for palm oil and timber and international black markets for illegal forest products and wildlife. Policies at the international level to address these demand-side issues beyond Indonesia and the ASEAN region are also crucial but are not analyzed in this framework. Furthermore, governance factors of institutional structure, organization and jurisdiction within the Indonesian government are only covered superficially in this project and need to be considered more deeply for comprehensive solutions to the problems.

The present scholarly paper is a contributing paper for **The Natural Capital Project**, prepared at its request. **The Natural Capital project is** a joint venture between **WWF, The Nature Conservancy and the Woods Institute for the Environment at Stanford University**. The Natural Capital Project is working in Borneo and Sumatra and several locations around the world to map and quantify ecosystem services**,** assess their values in economic and other terms, and incorporate those values into decision-making.

2. The triangle of peat and fire: Forest loss, greenhouse gas emissions and transboundary haze pollution

Forest and biodiversity loss

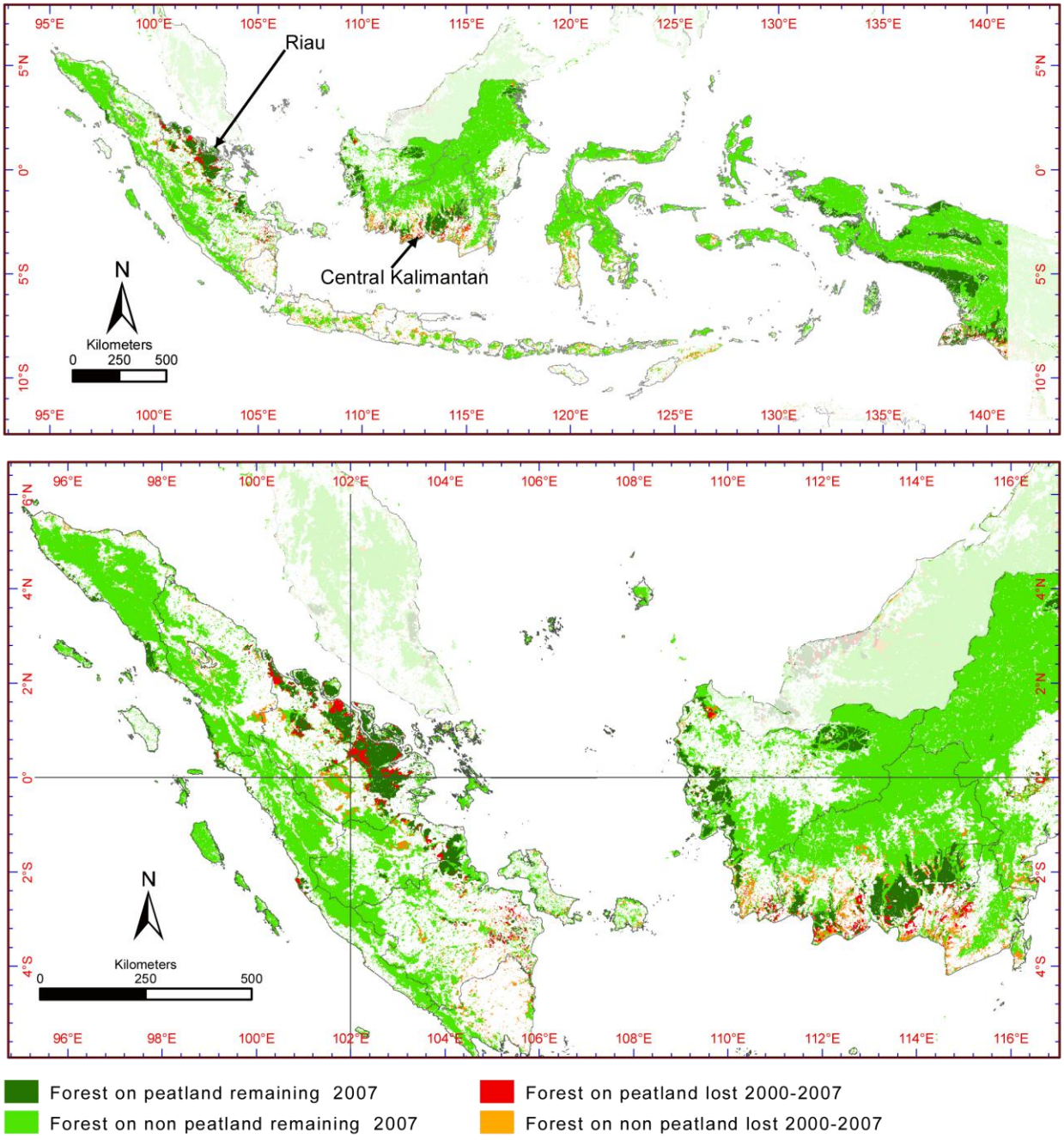
An archipelagic nation of 17,508 islands, Indonesia boasts the third largest tropical forest area in the world, 88.5 million ha (Butler, 2009) after Brazil and the Democratic Republic of Congo. With 206.3 million people as of 2000, the country is also the fourth most populous in the world, although more than 121 million were concentrated in the island of Java alone (BPS, 2000). Indonesia has the second fastest rate of deforestation in the world after Brazil, 1.8 million ha/yr from 2000-2005, with forest cover declining from 82% in the 1960s to 49% today (Venter et al., 2008; Butler, 2009). Deforestation as a large-scale phenomenon began in the 1960s following the opening of forest lands for logging concessions by President Suharto. Sumatra (470,000 km^2, population 43.3 million), has suffered the largest loss of forests, followed by Kalimantan (539,460 km^2, population 11.3 million), the Indonesian part of Borneo, shared with Malaysia and Brunei. Western New Guinea (420,540 km^2, population 2.2 million), the Indonesian part of New Guinea, remains the most forested of the larger islands (BPS, 2000) (Maps 1 and 2).

In Sumatra, the remaining large blocks of forest left are in the northern province of Aceh, the western ridges of the island and the peat forests in the province of Riau. By 2000, forests covered only 155,454 km^2, representing a loss of 25% since 1990 (Gaveau et al., 2007). Across the Strait of Malacca facing Singapore and Malaysia, the lowland peat forests in Riau are currently experiencing the highest rate of conversion. WWF Indonesia documented a staggering decline of 82% of forest cover in Riau between 1982 and 2007, due to conversion by industrial plantation companies (Uryu et al., 2008) (Map 2).

In Kalimantan, deforestation began later in the 1980s and intensified in the 1990s and 2000s, particularly in lowland areas. WWF Germany, found that between 1985 and 2005, Borneo lost an average of 850,000 ha of forests annually, with deforestation rates rising to 1.3 million ha/yr in 2002, 1.2 million of those in Kalimantan (Rautner et al., 2005). By 2000, rainforests covered 52% of the island compared to 75% in the mid-1980s (Map 2). The central and more mountainous part of Borneo still has vast expanses of continuous forests. In Western New Guinea, deforestation is a recent phenomenon but is expected to intensify with growing pressure for land and resources.

Sumatra and Borneo have lowland forests, peat swamp forests, freshwater swamp forest and montane forest ecoregion types (WWF, 2001). In addition, Borneo has mangroves and heath forests. Peat forests are located on peat substrates and are found in coastal areas and swamps (Rautner et al., 2005). The heath forest or *Kerangas*, famous for its carnivorous plants, is the driest form of rainforest and is highly vulnerable to fire. Rautner estimated that this forest would disappear in Borneo by 2010. Montane forests are the most preserved type of forests in both islands. The lowland rainforests are astoundingly diverse and famous for their high-value hardwood dipterocarp trees. Lowland and peat swamp forests are home to many endangered mammals including the Sumatran tiger, the Malayan tapir, the two-horned Sumatran rhinoceros, the Asian elephant, the Orangutan and the Proboscis monkey.

Map 1: Deforestation in Indonesia and Map 2: Enlargement for Sumatra and Borneo.
The maps show deforestation in the country from 2000 to 2007, distinguishing peat forest from non-peat forest and clearly showing hotspots of deforestation in Riau and Central Kalimantan provinces. The maps were produced by SarVision – Wageningen University in collaboration with the Indonesian Ministry of Forestry and were previously published by WWF Indonesia (Uryu et al., 2008)



Indonesia is a megadiverse country on many counts. It has the highest number of mammal species in the world (670), and is third for reptiles and fourth for birds, among others (WRI, 2008). Hundreds of species are threatened by habitat loss, but also by poaching and wildlife trafficking. The Global Mammal Assessment (IUCN et al., 2008) has Indonesia at the top of its list for both the number and percentage of endangered mammals (183 and 27% respectively). In Sumatra, the situation is dire. There are no more than 500 Sumatran tigers and 300 Sumatran rhinoceros left in the wild (Nellemann et al., 2007).

Fires

Deforestation is intimately associated with fires in Indonesia. Fire has been used traditionally by rural communities for cultivation but in recent decades it has been used intentionally at a large scale to convert forests to oil palm and timber plantations, usually burning the land following logging operations (Roderick et al., 2001). In addition, escaped fires from land clearing have destroyed vast areas of rainforest. During the El Niño episode of 1982-1983, 3.6 million ha were burnt in Kalimantan (Mori et al., 2000), 0.8 million of those being primary forest. During the El Niño event of 1997-1998, rainfall was reduced to 10% of normal volume in Kalimantan. Around 10 -11.7 million hectares of vegetation were burnt in Indonesia depending on the estimate used (Hoffman et al., 2004; Tacconi, 2003), making it one of the worst environmental disasters in the 20th Century.

The direct economic damages from fires are substantial for Indonesia. Glover and Jessup calculated a total loss of US$2,788 million for the 1997 forest fires (not counting those in 1998). The losses included loss of ecosystem services provided by forests and their benefits, such as destroyed timber, crops and plantations, and loss of readily "capturable" biodiversity, inferred by willingness-to-pay estimates for forest conservation. Another study with a different methodology by BAPPENAS –the National Development Planning Agency–, and the Asian Development Bank covering both the 1997 and 1998 episodes calculated fire damages to be of the order of US$9.3 billion (Gouyon and Simorangkir, 2002). Glover and Jessup (1999) did not attempt to value the benefits of fire, although these are significant. Tacconi (2003) estimates that the use of fire reduces the planting costs for timber and palm oil respectively by US$68 and US$117 per hectare.

Before 1960, forest wildfires were not a common occurrence in the rainforests in Sumatra or Borneo since they do not have a natural fire regime due to the abundant rainfall. However, rapid land use change has meant that fires can expand more easily into forests during the dry season, leading to an exponential increase in fire occurrence in forests in the past three decades and an actual change in the fire regime (Shlisky et al., 2007). The problem is exacerbated by El Niño episodes, which cause persistent drought for several months in Indonesia and occur at irregular intervals every few years. Although 26 out of 28 recorded droughts in Indonesia since 1877 have been associated with El Niño (Applegate et al., 2002), El Niño alone is not the only trigger of fires. The El Niño event in 1982 was stronger than the one in 1997-1998, but the forest area burnt was three times larger in the more recent episode (Global Canopy Programme, 2007), indicating that accumulated degradation made forests much more vulnerable to fires (Mori, 2000). Climate change is likely to bring an even higher risk of wildfires, due to higher temperatures and possibly more frequent and intensified El Niño events (Case et al., 2008).

Forests that have been logged or previously burnt are more vulnerable to fire as logging roads provide an avenue for fire expansion and logging debris becomes an abundant source of fuel. In addition, the loss of canopy cover increases temperature and wind speed and decreases humidity. Fire-prone grasses invade the clearings, particularly the alang-alang *Imperata cylindrica* (Gouyon and Simorangkir, 2002). Degraded peatlands are also very vulnerable to fire. Tacconi (2003) indicates that 2,124 million ha of peat swamp forests burnt in 1997-1998. In Riau province, 2005 was actually a more severe year for peat burning. Almost 20,000 hotspots – recorded fires within a 1 km^2 area– were detected in the province, compared to under 15,000 for 1997-98 (Uryu et al., 2008).

Intact forests are less vulnerable to fires under normal weather conditions because the biomass and litter have higher water content, there is a closed canopy and ambient air humidity is higher inside the forest. WWF Indonesia showed that protected areas in Riau were sheltered from fire episodes due to the high canopy closure of those forests (Uryu et al., 2008). Nonetheless, fires can enter dense forests in periods of exceptional drought, when ambient air humidity is relatively low and the forest floor is covered with dry litter (Davies, 2001; Mori et al., 2001).

Greenhouse gas emissions and peat

Surprisingly to many, Indonesia is currently the third largest greenhouse gas (GHG) emitter in the world behind the United States and China. Emissions from the forestry sector are by far its largest share, with 2,563 MtCO2e, accounting for over 85% of the country's emissions and 34% of the global emissions from land use, land use change and forestry, as estimated for the year 2000 (PEACE, 2007).

The abundance of peatlands in Indonesia is the reason why GHG emissions from forest fires and land use change are much more severe here than in other tropical areas of the world. Indonesia has 21 out of 25 million hectares of peat in Southeast Asia, and most of these deposits are in forested swamps of Sumatra, Kalimantan and Papua. Peatlands are highly acidified and waterlogged soils with rich organic deposits in an anoxic environment. Peat becomes a net carbon source to the atmosphere when drained, generating desiccation, compaction and oxidation (Takashi et al., 2007; Roderick et al., 2007). Furthermore, fires in peatlands can generate subsurface burning, which lasts for months due to the very high organic matter content of the soil. Areas that have already burnt are still vulnerable, as peat deposits can be up to 10 m deep (Glover and Jessup, 1999). Uryu (2007) indicated that for a severe El Niño episode when the water table is very low, fires in peatlands may consume a layer of up to 50 cm of peat on average, whereas for a fire in a regular dry season, up to 15 cm of peat layer may burn. El Niño events are thus much more severe in terms of carbon emissions.

The Indonesia Forest and Climate Alliance (2007) indicated that emissions from peatlands were on average 1061 Mt CO_2/yr between 1990 and 2002 for Sumatra; and 1400 Mt CO_2/yr from episodic fires across Indonesia between 1997 and 2006. Wetlands International estimates that around 600 Mt of CO_2 are released annually just from the decomposition of dry peat in Indonesia (PEACE, 2007). At a US$10 price of carbon per metric ton, the average emissions from peatlands per year would be worth US$14 billion.

As an indication of the relative importance of peatland emissions for overall land use change emissions, Uryu et al. (2008) estimated the proportion of CO_2 emissions from land use change in Riau province from 1990 to 2007. (Table 1)

Table 1: Estimated CO_2 emissions from land use change in Riau, 1990-2007 (From Uryu et al., 2008)

SOURCE	CO2 EMISSIONS 1990-2007 (Gt)
Deforestation	1.17 (32%)
Forest degradation	0.32 (9%)
Peat decomposition	0.78 (21%)
Peat burning (From 1997 onwards only)	1.39 (38%)
TOTAL	3.66 (100%)

Transboundary Haze Pollution

Haze pollution, the term used in Southeast Asia for smog from the combustion of biomass, is a large recurrent phenomenon in the region during the dry season due to widespread burning for land clearing purposes. Haze pollution that originates in Sumatra, particularly in Jambi and Riau provinces, travels with the wind and affects peninsular Malaysia and Singapore, as well as Southern and Central Sumatra. Haze that originates in Kalimantan is frequently dispersed northward, impacting Kalimantan itself, Sabah and Sarawak in Malaysia as well as Brunei Darussalam. Although the burning of forests contributes to haze, it is estimated that 60-90 % of the haze comes from the burning of peatlands –forested and non forested– in Sumatra and Kalimantan (Tacconi, 2003), as this generates substantially more smoke and particulate matter than forest fires on mineral soils. For this reason, haze is not as severe a problem in other regions of the world with widespread fires.

Haze pollution was especially catastrophic during the extensive fires that took place during El Niño years of 1982-83 and 1997-98. In the latter episode, extensive clouds of haze persisted for weeks covering Sumatra, Borneo, Peninsular Malaysia, Western New Guinea and affecting Thailand and the Philippines. In addition to the direct damages by fires and the sharp increase in greenhouse gas emissions, the haze itself caused a public health emergency and severe economic losses. During the latter part of 1997, more than 35 million people were exposed to abnormal haze levels (Glover & Jessup, 1999). For instance, the city of Kuching, in Sarawak, experienced smoke concentrations of 990 $\mu g/m^3$, over 20 times its normal value (Davies, 2001). Although more than a decade has passed, the pressures on the forest persist, and smaller but still serious haze episodes are regular occurrences during dry years. Haze episodes have been reported in 1980, 1982-83, 1987, 1991, 1994, 1997-98, (Roderick et al., 2001), and more recently in 2002, 2005, 2006 and 2009 (Uryu et al., 2008; Antara, 2009).

Haze contains numerous pollutants including carbon monoxide, ozone, nitrogen dioxide, benzene, acrolein, formaldehyde, inhalable particulate matter (PM_{10}), finer particulate matter ($PM_{2.5}$) and benzopyrene. Smaller particulates are more hazardous for human health because they reach the lower respiratory tract (Ostermann and Brauer, 2001). In Indonesia alone, there were 267,000 hospitalizations, and 11.6 million people were estimated to have fallen ill as a result of the 1997-1998 haze episode (Glover and Jessup, 2009). There was an increase in acute respiratory illnesses in children and chronic lung disease in adults. Furthermore, there is some

indication, albeit inconclusive, of long-term health effects of exposure to haze (Ostermann and Brauer, 2001).

Besides the degradation of air quality, haze has additional environmental impacts due to the clouding of the sun and deposition of particulate matter. In 1997-98, haze reduced the photosynthetic ability of standing forests, crops and plankton, and affected marine ecosystems by fertilizing the coastal areas with iron, which resulted in red tides, coral reef deaths and declines in fisheries (Global Canopy Programme, 2007).

The economic impacts of haze have been well documented, especially for the 1997-1998 event. There were severe productivity losses from the closure of schools and businesses for days and weeks, as well as lost labor days from ill workers. The impact on tourism was acutely felt in Singapore, as many visitors postponed or cancelled their trips. Many flights were cancelled due to the impaired visibility and various ship and aircraft collisions were reported as a consequence. Glover and Jessup (2009) calculated the total damages strictly from haze for the 1997 episode: US$1,012 million for Indonesia, US$310 million for Malaysia and US$104 million for Singapore. For Indonesia, these damages included medical costs, lost productivity, indirect health impacts and tourism losses.

Drivers of fire and deforestation

Deforestation and the use of fire have multiple drivers, but the most significant are the timber and logging industry, commercial oil palm plantations, small farmers and migrant settlers (Sunderlin and Resosudarmo, 1996). Root causes for these drivers are the steady demand for timber worldwide, the increasing global demand for palm oil, a complex history of government policies and interventions over forests, as well as population pressures by internal population growth and spontaneous and planned migration into the outer islands. Wunder (2004) suggests that, in Indonesia, deforestation as a lucrative enterprise takes precedence over deforestation as a means to overcome immediate poverty; hence industrial-scale timber harvesting and forest conversions to palm oil and timber are more prevalent. However, farmers and migrants also contribute to encroachment into protected forest, logging and burning (World Bank, 2001).

The deforestation drivers vary by province and are very dynamic and intermingled, so attributing relative weights to each of the drivers and root causes for the entire country is difficult and contentious. Nonetheless, some studies have quantified their importance. The World Bank (2001) estimated that 34 % of fires in 1997 and 1998 were caused by large-scale land conversion, 25% by shifting cultivation, 17% by permanent agriculture, 8% by *transmigration* projects and 14 % by arson. Only one percent of fires were caused by natural causes. More recently, WWF Indonesia produced a technical report about deforestation in Riau province in Sumatra (Uryu et al., 2007). In that province, the palm oil and paper industry were shown to be the principal causes of deforestation from 1982 to 2007, which reduced forest cover in Riau from 78% to 27% (Table 2).

Table 2
Land covers replacing cleared forests in Riau Province (1982-2007) (Uryu et al., 2008)

LAND COVER	AREA ON FOREST CLEARED 1982-2007 (ha)	PERCENT OF TOTAL FOREST CLEARED
Industrial oil palm plantations	1,113,090	28.7%
Acacia pulpwood plantations	948,588	24.4%
Waste lands – deforested but unused afterwards	659,200	17.7%
Smallholder oil palm plantations	279,242 (estimated)	7.2%
Other land covers (infrastructure, rubber, coconut, other plantations)	701,984 (estimated)	18,1%
Unknown land use	178,405 (estimated)	4.6%

The Indonesian government has had longstanding policies that promote conversion of forest to other land uses. It has allocated millions of hectares of state forest land to logging concessions and plantations, subsidized physical capital and given free use of standing timber (Glover and Jessup, 1999). It has also promoted the resettlement or transmigration of millions of people in the outer islands to reduce population pressures in Java, and has encouraged oil and gas exploration in forests (Roderick et al., 2001). Many of these policies have been implemented as development strategies to build a solid export-based economy and encourage economic activity in Sumatra, Kalimantan and other outer islands, and have gone hand in hand with road building, currency devaluation and rural development policies. Wunder (2004) concludes that Indonesia's development policies have had the perverse effect of encouraging more deforestation, although they have achieved some level of poverty reduction.

In the context of worldwide deforestation drivers, Wunder (2004) came to the conclusion that policies directly outside of the forest sector have a disproportionate effect in encouraging deforestation, particularly road building, which lowers transport costs and opens up land; and the promotion and subsidy of export-led growth through very land-intensive sectors, both of which are present in Indonesia. As for land tenure policies, they are shown to have ambiguous effects in terms of net deforestation, as forest conversion as a prerequisite to land rights encourages deforestation, but granting tenure rights to standing forests doesn't necessarily encourage forest conservation but rather agroforestry (Chomitz et al., 2007). This ambiguity exists in Indonesia as well.

Legal and illegal logging

Timber extraction has mushroomed in Indonesia in recent decades, due to high international demand, the abundance of valuable timber such as ramin, high levels of debt of the timber industry, overcapacity in the timber processing sector –which promoted extraction just to feed timber mills, and limited law enforcement (Eliasch, 2007; Nellemann, 2007). Furthermore, illegal timber is smuggled in large quantities to Malaysia (Global Canopy Programme, 2007) and on to other markets. Protected areas have not escaped this threat and have chronically been plundered for timber, with 37 of 41 parks having reported these problems (Nellemann, 2007).

In 2002, exports of wood products (pulp, paper, wood and wooden furniture) accounted for 13% of Indonesia's exports, around $7.6 billion. In East Kalimantan, the annual loss from unpaid taxes from illegal logging is estimated at over € 75.5 million a year (Rautner et al., 2005).

The data in Table 2 shows that 17% of cleared forest in Riau remained as wasteland and became degraded land. Plantation companies clear more land that they intend to convert because deforestation is encouraged by the rents derived from logging in the interim while the plantations are growing (WRI, 2009).

Oil palm plantations

Indonesia exported 14.2 million tons of crude palm oil (CPO) in 2008, representing 44.5% of the world market (Xinhua, 2009). The demand for palm oil has increased worldwide, to the point where in 2002 it accounted for 51% of global trade in edible oils (Rautner et al., 2005). Oil palm plantations are concentrated in the provinces of Riau, South Sumatra, North Sumatra, West Kalimantan, Jambi and Central Kalimantan, operated at various scales from large conglomerates and state-owned enterprises to small farmers (Gouyon and Simorangkir, 2002), the latter of which are responsible for thirty percent of oil palm production (Rautner et al., 2005). The area planted with oil palm has grown 35 times over since 1967 to occupy currently 6 million ha in 2005 (IFCA, 2007). Around 70% of this area was formerly forest, and increasingly, new plantations are being located in peatlands. Fire use has been common to clear land for new plantations, for clearing rows of debris and for replanting, but once the plantation has achieved maturity, fire risk decreases (Suyanto et al., 2004).

Timber plantations

Industrial tree plantations (*Hutan Tanaman Industri-HTI*) have been established since the 1980s in Sumatra and Kalimantan to provide timber and pulpwood for mills, encouraged by various government subsidies (Rautner et al., 2005; Suyanto et al., 2004, Mori et al., 2000). Fast growing *Acacia mangium* trees are the most commonly used species. In areas like Riau, their expansion is at a similar scale to that of oil palm. Like oil palm, they occupy mainly land that was formerly forest. Fire is also used for land clearing, and plantations remain at risk of fire during the first years of growth (Uryu et al., 2008).

Smallholder and migrant communities

Among rural communities in Sumatra and Kalimantan, fires have historically been the preferred method for land clearing. Soils are not as rich or fertile as those in Java, so farmers burn plots during the dry season to grow crops like rice and pepper, boost soil nutrients, improve forage and eliminate pests. Fires are also employed to facilitate access to fishing areas and for harvesting timber. As for many rural societies, fire is essential for their livelihoods (Suyanto et al., 2004; Myers, 2006). In inner areas of Kalimantan, fire has been used by *Dayak* natives for swidden agriculture, where an area of forest is burnt, cultivated and later left to fallow for a number of years. When a secondary forest has grown, it is burnt again to capture nutrients.

During a year of average rainfall, fires from smallholders are the most common fires in the country (Roderick et al., 2001). They are easily controlled and do not cause major damages.

However, with forest degradation, drought and increased road densities, traditional fire control practices are not effective (Pierce Colfer, C., 2002). The most dangerous traditional fire practice, according to Roderick et al. (2001), is the clearing of swamps in Southern Sumatra for *Sonor* rice. These fires escape easily and have become ravaging wildfires.

Given the high concentration of the Indonesian population in Java, Bali and Madura, the government has had an official transmigration and resettlement policy directing people towards the outer islands and instituting agricultural schemes. Transmigrant programs and spontaneous migration have increased population pressures in Sumatra and Kalimantan, leading to fire and deforestation, worsened by the lack of foresight from the government and the absence of traditional knowledge of these new environments by newcomers. One egregious example was the "one million hectare" rice project in Southern Kalimantan, promoted at the end of the Suharto regime, which attempted to drain a peatswamp to promote rice farming. The results were devastating, as 15,000 ha of peat forest collapsed after being drained by canals, the land burned and was useless for rice. Tacconi (2003) mentions that this project was the main source of haze from Kalimantan in 1997.

Limitations in forest governance and enforcement of environmental law

Decentralization happened swiftly in Indonesia after the fall of president Suharto in 1998, with the result that provincial, district (Kabupaten) and municipal (Kota) governments assumed a much greater autonomy in government and obtained greater shares of timber revenues (Barr et al., 2006; Cotula & Mayers, 2009). However, the power vacuum and power scramble that occurred in the process favored illegal logging and deforestation, as there was little enforcement, uncertainty over the jurisdictions of national vs. provincial and district governments, plus many opportunities for corruption, like the granting of concessions by district governments with little oversight, or kickbacks from illegal logging. These situations led to a partial recentralization of forest management by the Ministry of Forestry. Although forest governance in Indonesia has improved since then, it is still affected by corruption and ambiguity of jurisdiction and of rules for revenue sharing (Cotula & Mayers, 2009).

The Indonesian government has struggled to articulate and implement a strong vision for forest conservation, facing pressures from economic interests, internal development needs, diverging goals and lack of coordination among government institutions. This results in contradictory laws for forest conservation, ambiguity in their stringency, requirements, and jurisdiction (IFCA, 2007; PEACE, 2007) or in the non-implementation of regulations, which is pointed out by Eaton (2001) as the main reason why fire policy failed to manage the 1997-1998 fires. For that episode, Roderick et al (2001) indicated that the Police and Armed Forces had coordination problems with the Environment Ministry, then in charge of fire prevention (Roderick et al., 2001). On the other hand, the Ministry of Forestry is influenced by the interests of plantation companies (Uryu et al., 2008), hampering its role as regulator of the industry. This might explain sudden changes in regulations, such as a moratorium on peatland conversion, which had been in place since 2007, but was rapidly reversed in early 2009 (Butler, 2009b).

The combat of environmental crime is not a high priority in the country, and many of the regulations on logging, land use and fire go unenforced (Gouyon and Simorangkir, 2002). Lack of capacity is often cited as a reason for limited enforcement, for instance, to control illegal

logging and squatters on protected areas (Nellemann, 2007; Onishi, 2009). The judicial avenue is limited in its success as well. Although there were a number of companies that were fined and obliged to pay compensation for the 1997-1998 fires, Rautner et al. (2005) reported that The Indonesian Forum on the Environment (WALHI) sued twenty companies over forest fires in Riau in 2005 but only one lawsuit was actually followed through.

Land tenure conflicts

Most forested land in Indonesia is state-owned, but the central government has issued many plantation and logging concessions on it. In addition, there are ample areas classified as state forest land which are actually not forested. In contrast, communities that live in state forest lands rarely have concession property rights over it, but do have customary usufruct rights to land called *adat*. Although the local and central governments recognize *adat* in principle, the subdistrict governments must demarcate it officially according to the Forestry Law of 1999. In any case, under the Basic Agrarian Law of 1960, the central government reserves the right to terminate *adat* and designate forest lands for other uses consistent with national interests and legislation. This has led to numerous takings of community land for plantations and logging concessions, with no recourse available to communities. Although compensation is required, in many cases it does not occur (Cotula & Mayers, 2009). Eliasch (2007) indicates that at least 400 communities in Indonesia have been affected by land conflicts due to the expansion of oil palm plantations.

Fire has been used as an instrument in land disputes (Glover and Jessup, 1999; Tomich et al., 2004; Pierce Colfer, 2002). Many reports documented the use of arson in 1997 and 1998. Fire was used by smaller communities to burn plantation lands, but also by plantation owners to procure community land by degrading it purposefully to facilitate a takeover. Perceived injustices in land tenure have also decreased the willingness of local communities to extinguish fires in plantation land (Suyanto et al., 2004).

Benefits from other land uses

The tragedy of forest loss is not matched by the benefits derived from deforestation, but it would be unfair to negate them. Indeed they provide an impetus and a rationale for Indonesia to continue converting forests into plantations. Indonesia's exports have generated ample foreign exchange revenues for the country and elevated national incomes. Palm oil, in particular, is highly profitable, with a Net Present Value of $114 per ha at 20% discount rate, compared to US$1 per ha for rubber, and has contributed to poverty reduction and economic development. Unsustainable logging has an NPV of $1,080 (Chomitz et al., 2007).The global marketplace has benefited from a continuous supply of palm oil, timber and pulp.

Wunder (2004) arrived to the sobering conclusion that tropical countries with the lowest rates of deforestation had preserved their forests more as an outcome of neglect of economic development of remote areas, than out of active conservation of those places. Indonesia's interests in the development of Sumatra and Kalimantan have facilitated deforestation. Chomitz (2007) reiterates the historical difficulty of reconciling poverty reduction with forest conservation, but points out several policies that can favor both objectives: the financing of forest ecosystem services, the equitable assignment of land rights, efficiency in land use

regulations, changes in regulation and incentives to favor forest conservation and agroforestry, and careful planning of infrastructure expansion, among others.

3. Existing policy responses

The severity of deforestation, fires and haze in Indonesia has prompted multiple policy responses at the local, national, regional and international level. Given the complexity of the problem and its multiple scales, only the most salient of these are mentioned in this section.

Land use planning

Indonesia's forests are state land managed under the authority of the Ministry of Forestry (MoF). There are various categories of forest land use (Table 3), stemming from the 1982 Forest Land Use Consensus Plan (TGHK). However, some of the 144 million ha classified as state forest lands were not forest at the time of classification (Majid Cooke, 2006). Although the Ministry of Forestry is the most powerful land use decision making entity, the Ministry of Environment and the National Development Planning Agency also have involvement in spatial planning granted by the Land Use Management Act of 1992 (Majid Cooke, 20006).

Regarding land tenure, the Ministry of Forestry has in recent years issued regulations concerning land tenure for communities, instituting the figures of Community Forest Plantations, Customary Forests, and Community Forests, with the objective of improving the definition of access rights to forests (Masripatin, 2009). These categories present hope for a more strict recognition of *adat* rights of communities.

Table 3.

Forest land use categories in Indonesia. Sources: Forestry Law 41/1999 and Chomitz et al. (2007).

FOREST LAND USE	DESCRIPTION	AREA
Conservation forest a. Wildlife sanctuary (e.g. nature reserve and wildlife reserve) b. Natural preservation (e.g. national park, grand forest park, and recreation park) c. Hunting park	Forest area destined for conservation of ecosystems and biodiversity.	22.5 million ha
Protected forest	Forest area designated for water regulation, flood prevention, erosion control, prevention of saltwater intrusion and maintenance of soil fertility.	
Production forest	Forest area designated for the production of forest products.	Natural production: 46 million ha. Planted production: 2.5 million ha. License or concession: 43.2 million ha

More recently, there have been spatial plans issued for Sumatra and Kalimantan where boundaries for different land uses have been clarified. In an unprecedented move, during the World Conservation Congress in Barcelona in 2008, Indonesia's central government and the ten provinces in Sumatra pledged to protect and restore Sumatra's remaining critical ecosystems and forests through detailed land use planning. The plan is based on the protection of high conservation value areas beyond protected areas, the creation of corridors and the restoration of environmental goods and services. As for Kalimantan, WWF and other conservation organizations have been advocating for a commitment to the protection of the "Heart of Borneo", 20 million hectares encompassing the core of the Borneo rainforest across Indonesia, Malaysia and Brunei (Rautner et al., 2005). This effort has the added complexity of trinational cooperation. But with the precedent of the Coral Triangle Initiative, a partnership among Indonesia, Malaysia, the Philippines, Timor Leste, Papua New Guinea and the Solomon Islands, signed in 2009 to protect marine life in the Coral Triangle region (CTI, 2009), hopes are high that such cooperation can be fruitful.

Land use planning is a critical element to address deforestation and hopefully, the Sumatra and Kalimantan land use plans will be enforced appropriately. However, even within land-use plans the interests of converting forests for plantations have often trumped conservation interests so problems are likely to occur. Not only are there still large tracts of forests designated for planned conversion into plantations, but there is also unplanned deforestation with little enforcement, including encroachment into protected areas. Several authors have called for restrictions and moratoriums in land allocation to concessions as a policy measure to prevent further deforestation, haze and fire (Tacconi, 2003; Applegate et al., 2002).

One major land use planning problem is the use of degraded lands, which have increased in size due to the numerous uncontrolled fire seasons in recent decades. In order to prevent new deforestation, new oil palm or pulpwood plantations could be redirected to degraded land instead of forested land, and indeed, a government regulation decreed that plantations should not clear more land (Regulation 24/2002). However, the regulation was later revoked (Regulation 6/2007) (Uryu et al., 2008). Although it makes sense to use degraded land for new plantations, the economics are less favorable for plantation companies than clearing forest. Establishing plantations on degraded land requires investments to rehabilitate the soil (Rautner et al., 2005) and does not provide companies with revenue from timber extraction prior to clearing (WRI, 2009).

Fire management

Since the fires of 1997-98, fire detection and monitoring improved substantially. However, fire management capacity is still insufficient according to the Global Fire Assessment (FAO, 2007), despite improvements like the establishment of highly-trained fire brigades in areas vulnerable to fire.

In response to the incontrollable fire episodes, the Indonesian government issued the regulation 4/2001 that forbids the use of fire for land clearing. As an alternative, the government is promoting zero-burning clearing for oil palm and timber plantations, which has been in place in Malaysia for several decades after the government banned open air burning as well. The ban of fire, however, is unenforceable with small farmers, as they have no alternative cheaper methods

for land clearing. Many authors criticize such a ban (Shlisky et al., 2007; Tomich et al., 2004; Tacconi, 2003), indicating that fire is a necessary tool that has its place and can be used in a judicious way, and that by criminalizing fire, people may have the incentive not to control them but to flee from them for fear of being prosecuted (Myers, 2006). These authors suggest an alternative approach: enforcing absolute restrictions on fire on certain high-risk locations like peatlands and during high-risk times (e.g. El Niño episodes), and otherwise allow fires as long as best management practices are employed (Suyanto et al., 2004). This would focus enforcement efforts in space and time while allowing communities to benefit from fire when the risk is low. These recommendations echo Myers (2006) definition of Integrated Fire Management, as an *"approach to addressing the problems and issues posed by both damaging and beneficial fires within the context of the natural environments and socio-economic systems in which they occur, by evaluating and balancing the relative risks posed by fire with the necessary ecological and economic roles that it may plan in a given landscape."*

ASEAN Transboundary Haze Agreeement

The ASEAN Transboundary Haze Agreement (THA) was signed in 2002 and entered into force on 25 November 2003, to strengthen cooperation and implement preventive measures for haze in the ASEAN region. It provides a framework for cooperation among Southeast Asian nations to mitigate transboundary haze. The ASEAN THA has generated regional haze action plans, with guidelines for zero burning, community based fire management, fire suppression plans, among others. Unfortunately, Indonesia has not ratified the agreement, so progress has been slow.

The ASEAN THA invokes the following principles: the precautionary principle, the sovereign right of states to exploit their own natural resources, solidarity among states in accordance to each nation's needs and capabilities, responsibility to ensure that activities within a country's borders do not harm the environment and human health of other States, sustainable forest management, and appropriate involvement of stakeholders (ASEAN, 2003). However, the treaty does not invoke the polluter-pays principle. The THA requires parties to cooperate by controlling sources of land and /or forest fires, develop monitoring, assessment and early warning systems, exchange technology and information and provide mutual assistance, particularly in the event of a haze episode. The THA also demands countries to take internal administrative or legal measures to implement the agreement.

Despite the lack of ratification of the THA by Indonesia, there are cooperation projects between Singapore, Malaysia and a number of Indonesian provinces, primarily for capacity building. In terms of monitoring, the ASEAN Specialized Meteorological Centre provides fire danger information since 2000 (FAO, 2007) and has developed an early warning system. The THA established the ASEAN Coordinating Centre for Transboundary Haze Pollution Control to further develop these activities. In addition, the ASEAN Peat Management Initiative was established to guide sustainable use of peatlands. In order to fund the activities of the treaty, the ASEAN Transboundary Haze Pollution Control Fund was established with seed funding of $500,000 and is open to voluntary contributions from member countries (ASEAN, 2009).

Sustainable Palm Oil

In response to pressure to address the environmental and social impacts of palm oil production, the Roundtable on Sustainable Palm Oil (RSPO) was formed in 2004 as a not-for-profit

organization, bringing together oil palm producers, buyers, processors, traders, environmental and development NGOs, including WWF Indonesia. RSPO has issued principles and criteria for sustainable palm oil, covering a wide range of issues including best management practices of existing plantations, environmental responsibility and conservation, development of new plantations, financial viability, community relations, and workers' rights, among others. RSPO began a certification program in 2008 and expected 1.5 million metric tons of certified CPO to enter the market in late 2008 (RSPO, 2009).

RSPO guidelines list numerous best management practices for existing plantations, including nutrient recycling strategies, waste and effluent management, integrated pest management, limited and controlled use of pesticides and conservation of nearby areas of high conservation value. In reference to plantations on peat soils, RSPO criteria specify that there must be water management with water control structures to maintain a high water table and prevent subsidence of peat soils (RSPO, 2007).

RSPO criteria clearly state that no new plantings since November 2005 can be certified RSPO if they have converted primary forest or High Conservation Value forests[3]. It demands an environmental impact assessment for new plantings and indicates that degraded land should be used first and that plantings on extensive areas of peat need to be avoided. In addition, it forbids the use of fire to clear land. Furthermore, RSPO criteria do not allow the establishment of plantations in community lands without their free, prior and informed consent; and requires due compensation for all land acquisitions and cession of rights (RSPO, 2007).

Also included among RSPO guidelines is the zero burning method (mechanical land clearing), which is common in oil palm plantations in Malaysia for replanting operations. Zero burning methods generally have higher upfront costs than fire and require heavy machinery (Suyanto et al., 2004). However, they provide benefits in the long term, because more nutrients return to the soil and replanting can take place without waiting for vegetation to dry to set a fire. Zero burning, however, may have undesirable side effects, such as soil compaction and erosion (Roderick et al., 2001), and pest infestation (Gouyin and Simorangkir, 2002). It also gives a "messier" look, which is unappealing to many plantation owners (Gouyon and Simorangkir, 2002). The RSPO criteria indicate that the ASEAN Zero Burning guidelines should be followed, where fire should only be used for burning waste and replanting in the case where it is the "most effective and least environmentally damaging option" for mitigating pest and disease outbreaks (RSPO, 2007).

Sustainable Forest Management

There are multiple criteria for sustainable forest management, both for logging natural forest and for planted forests. Their breadth and complexity is higher than with sustainable palm oil because the types of forests and exploitations to be considered are very diverse. However, in reference to the establishment of new timber plantations and peatland management in Indonesia, very similar principles to the RSPO criteria can be applied to forests. In addition, in terms of fire management, it is important to have integrated fire management plans, remove debris from logged forest to reduce fuel loads, use timber residue in pulp mills, employ controlled burns of

[3] Those that are globally significant for biodiversity, contain rare ecosystems, provide ecosystem services in critical situations and are key to the livelihoods of local communities.

residues and establish fire barriers to prevent wildfire expansion (Gouyon and Simorangkir, 2002; Suyanto et al., 2004; Myers, 2006). Zero burning has also been studied for timber plantations, but the cost benefits are not as evident as for oil palm plantations. Although fertilizer costs decline, pest control costs increase as does the risk of fire during early stages of growth. (Gouyon and Simorangkir, 2002).

The Forest Stewardship Council (FSC) is an entity with a role akin to that of RSPO of certifying sustainable forestry operations with an international standard with high legitimacy and credibility. The international standard is general but it allows for further specification at a country-level. FSC can provide entry into the market of sustainably harvested wood, which commands premium prices worldwide. Nevertheless, FSC certification is still very incipient in Indonesia, because certification is expensive and the financial benefits derived from it are not immediately realized (Gouyon and Simorangkir, 2002). As of 2009, 1.09 million ha of forest were certified in the country (FSC, 2009).

FSC criteria proscribe forest conversions to plantations, except in few exceptional cases. They also promote the conservation of High Conservation Value forests, require the respect of local communities and indigenous peoples, demand management plans, as well as monitoring and assessment for forestry operations, and mention that measures should be taken to minimize the incidence of fire (FSC, 2002). As mentioned, FSC criteria are general and they ought to be specified for the Indonesian context, with more detailed references to peatland and fire management.

FSC certification is by no means the only sustainable forestry effort in place. At the smallholder level, various programs have begun for sustainable forest management, such as the RUPES program (Rewarding the Upland Poor for Environmental Services), in which, for instance, local communities are given incentives to follow sustainable agroforestry and forestry practices (Kerr et al., 2008)

Reducing Emissions from Deforestation and Forest Degradation

REDD refers to the generation of carbon credits through avoided deforestation and forest degradation, an activity that was excluded from eligibility under the Clean Development Mechanism (CDM) of the Kyoto Protocol. Proposed in 2005 by a group of rainforest nations including Costa Rica and Papua New Guinea, REDD promotes commitments by developing forest nations to reduce their rates of deforestation and hence their emissions, and earn carbon credits that could be monetized in the carbon market or through public or private carbon funds. Deforestation emissions encompass represent an estimate of 18% of yearly global GHG emissions (Stern, 2007), and reducing deforestation is considered one of the least costly emission reduction activities with additional significant co-benefits that the world has available in the short term. For these reasons, there has been considerable enthusiasm in the international community to include REDD as an integral part of a post-2012 climate change agreement in Copenhagen. The Bali Action Plan from COP13 in 2007 encourages parties to *"identify options and undertake efforts, including demonstration activities, to address the drivers of deforestation"*. These demonstration activities have begun in earnest, with various carbon funds facilitating the process, such as the World Bank's Forest Carbon Partnership Facility, and Australia's International Forest Carbon Initiative. The expertise from these projects will serve to

scale up REDD for full implementation after 2012, provided that the international community agrees on REDD as a building block of a global climate agreement.

There are high hopes that REDD can reduce the incentives to clear forests, making it more profitable to protect them because of the value of their standing carbon (Uryu et al., 2008). Much depends, however, on the decisions to be made at the international level on technical aspects of REDD, including the deforestation baseline setting (whether it should be historical, projected or include a weight by the country's forest stock), the eligibility of REDD credits as offsets, and the requirements for additionality, leakage and permanence.

In reference to the baseline for REDD crediting, Indonesia would likely favor a projected baseline approach, demanding credits for the opportunity cost of not deforesting a substantial portion of its forest that could be converted for other uses otherwise. In terms of scope of action, the current discussion on avoided deforestation is geared towards national level implementation, as opposed to the project level, as the current CDM operates. Although this addresses the issue of emission leakage within national boundaries and enables measuring of deforestation through remote sensing as the main means of accounting, it increases the risk that the earnings derived from credits will not actually reach those who are conserving the forests. Governments would need effective methods to distribute the benefits, and their absence could hamper reductions in deforestation rates.

In Indonesia, REDD demonstration projects have begun. One pioneering arrangement is occurring in Aceh province in Northern Sumatra, where Fauna & Flora International and Carbon Conservation from Australia are coordinating a project in the Ulu Masen forest to reduce deforestation by 85% in 750,000 ha of the region and generate 3.3 million carbon credits annually with an estimated value of US $ 16.5 million, to be directed at forest conservation and alternative livelihoods (Cotula & Mayers, 2009; FFI, 2009).

4. Forest fires and haze in the context of ecosystem services

Forests in Indonesia are a stock of natural capital that provides a bundle of ecosystem services at local, regional and global scales. In reference to the framework of the Millennium Ecosystem Assessment (2005), some of these are supporting services (provision of habitat for valued biodiversity –such as orangutans–, production of oxygen, carbon sequestration, soil retention); provisioning services (of timber, non-timber forest products), regulating services (water flow regulation) and cultural services (aesthetic values, existence values –knowing that animals like hornbills and tigers exist there).

The benefits derived from conserving forests in Sumatra and Kalimantan and preventing fires and haze accrue to many. The people of Singapore, Brunei and Malaysia would benefit from improved air quality, as would the Indonesian provinces affected by haze. The Indonesian people in general benefit by preserving the integrity of their protected areas at risk of fire. The watershed services of forests (water regulation, erosion control) cover many beneficiaries in the basins, whereas the carbon sequestration and habitat preservation services provide global benefits for the international community. There are thus a bundle of services where it is hard to disaggregate the economic marginal benefits of each service to each beneficiary (Kelsey et al., 2008). This presents a problem for policies that aim to internalize costs and benefits in ecosystem management and align incentives for conservation, in consonance with the ecosystem approach (CBD, 2008). Nevertheless, aggregate values may be estimated. In its economic valuation study of Leuser National Park in Sulawesi, Van Beukering et al. (2003) showed that conservation of the park would yield greater economic benefits than conversion over a 30 year period, with the greatest benefits derived from water supply, flood mitigation and carbon storage.

Forest fires

Forest fires in Indonesia can be divided into two classes: fires used to clear land in logged forest and fires spreading accidentally into forests. In the first case, arguably more common in Indonesia, fires are the finishing touch to deforestation and they are set deliberately on land that has been logged and bulldozed, in order to clear the debris and remaining trees and prepare the land for plantations. In the second case, forests start burning by fires propagated by accident or negligence from nearby agricultural or plantation clearings. Fires by arson would fall in both categories. In any case, fires destroy or severely impair the capacity of the land to deliver ecosystem services. In other words, the natural capital of forests is liquidated and humans stop enjoying its benefits.

Rainforests in Sumatra and Borneo do not have a natural fire regime. According to Shlisky et al. (2007), they are classified as a fire-sensitive ecosystem, where many tree species have thin barks and do not possess adaptations to fire (Rautner et al., 2005; Myers, 2006). When fires propagate in an undisturbed forest during a drought, the damages are long-lasting. Multiple species of trees die, entire animal communities are ravaged and restoration of the original forest cover takes decades. In the 1997-1998 fires, orangutans died in fires or escaped to cultivated areas, where they were attacked by residents (Nellemann et al., 2007). If burning occurs repeatedly, the original forest never recovers as succession processes deflect to another fire-prone community (Davies, 2001; Mori, 2000; Shlisky et al., 2007). Even if there is no deforestation and the burnt

forest remains standing, fires negatively affect most ecosystem services. Fires leave ashes and burnt biomass on the ground that can be transported with runoff, causing water pollution and siltation problems, affecting fish and other aquatic life (Glover and Jessup, 1999; Myers, 2006). Carbon dioxide is released back into the atmosphere, many animals perish or see their habitat transformed in ways they cannot return to, valuable timber is lost and the scenery loses its aesthetic appeal.

Within an ecosystem services framework, the damages of forest fires can be assessed in economic terms by valuing the benefits that have been lost or the damages that could have been avoided in the absence of fires. There have been various attempts at quantifying these losses. Glover and Jessup (1999), for instance, estimated a loss in flood protection value of the forests burnt in 1997 of US$413 million, and US$1.3 billion in terms of erosion control loss. Naidoo et al. (2008) modeled the possible health costs from increased fires that would result if a proposed clearing of 1.8 million ha in northern Kalimantan for oil palm went forward. Their estimate of potential damages on four cities in Borneo was highly dependent on the future road densities and weather patterns in the region, and ranged from a negligible US$70,000 for a normal year to US$17.23 million for an El Niño year. The carbon storage losses would be significantly more substantial, as their estimated equivalent values for the lost biomass would be US$1.7 billion to US$3.4 billion.

Haze

The maintenance of air quality typically does not figure among the ecosystem services provided by forests because forests do not actively clean or absorb pollutant concentrations in the atmosphere. On the other hand, forests can affect air quality negatively when they are disturbed by humans and burnt, more so if they have a peat substrate that generates vast plumes of haze pollution. In this case, forests would seem to be providing an "ecosystem disservice" instead. In the Indonesian case, however, this is not the case because forests do not have a natural fire regime. Almost all fires are anthropogenic in nature, and so is the disservice.

At a closer look, however, it is possible to argue for including an ecosystem service linked to air quality among the services provided by forests. This is founded on the definition of services provided by Fisher et al. (2009) that distinguishes services from benefits: *"Ecosystem services are the aspects from ecosystems utilized actively or passively to produce human well being"*, the actual benefit. The distinction is important, because benefits are the measurable effect in human welfare, and services are providers of these benefits. For instance, an ecosystem might provide a wonderful scenery (the service), but the actual benefit is recreation, when the scenery is enjoyed by humans (Boyd and Banzhaf, 2007). Similarly, crop pollination is an ecosystem service, but the actual benefit to humans is the production and consumption of food crops.

Carbon sequestration and carbon storage provide an analogous example to define the role of haze in the ecosystem services framework. When photosynthesizing, forests absorb carbon from the atmosphere and incorporate it into their biomass, and as long as there is a net growth in biomass, carbon sequestration is occurring. This in turn reduces the concentrations of CO_2 in the atmosphere, which gives humans the benefit of mitigating global climate change and its harmful effects on human populations. However, not all forests are actively sequestering carbon on a net basis and may become a net source of carbon to the atmosphere, particularly old-growth forests.

And yet, these forests are important for their overall carbon storage service, because as long as they remain alive they are preventing the release of carbon in their biomass to the atmosphere.

This has a clear analogy and linkages with haze pollution (Table 4). Forests do not actively cleanse the air of haze pollution or sequester particulate matter in smog from the atmosphere, but they indeed *store the biomass pollutants present in haze as long as they are not burnt.* Hence, the ecosystem service of **"biomass pollution retention"** is attributable to forests and peatlands given a land use without fire. This service yields the benefit of healthy air quality and prevents the damages associated with haze. Degraded peatlands, where the forest has been felled and the land drained, cannot provide the biomass pollution retention service in a reliable way because they are at high risk of burning. Having defined the service of biomass pollution retention, it is possible to think of ways of quantifying and valuing it, enabling beneficiaries to invest in peat forest conservation to reflect these values in policy, and where feasible pay for preservation of ecosystem services.

BOX 1: How much is a hectare of peat forest in Riau worth for Singapore?

One way to capture the economic value of the *biomass pollution retention* service is to look at the damages incurred when there is a haze episode and the service is not operating. If Singapore is interested in avoiding the costs of these damages, it might find it cost effective to invest in the protection of peat forests in Riau by an amount equivalent to the costs, prorated by the annual risk of haze episodes, assuming that by and large all the haze pollution in Singapore originates in Riau and that the investment can prevent much of the burning. More refined calculations of this cost effective level of investment for Singapore could be made with the aid of actuarial methodologies for natural disasters employed by insurance companies.

As part of the definition of the risk of haze episodes, a descriptive model of the contribution of the burning of each hectare of peat to levels of economic damage in Singapore can be constructed. Knowing the area of peat forests, peat soils and the median peat depth of various soil units it is possible to estimate a volume of organic matter available for burning in the future. Uryu et al. (2008) also document the mean depth of peat deposits that burnt during El Niño and normal years in Riau, which is useful to calculate the risk factor for haze episodes of various intensities given expected return periods of El Niño episodes. With this information, plus data from previous haze episodes about economic damages and extent of fires, a relation can be traced between the extent of peat fires and the haze levels in Singapore. This data could be useful for Indonesia to calculate the value of a "haze credit" per ha of peat, that could be sold to generate revenue for peatland and forest protection

A coarse model like the one described would need refinement with the addition of more variables, certainly, but the lack of precision should not necessarily prevent use of the results, as the risk of haze would always be hard to model precisely given that it is mediated by an anthropogenic land use and by an irregular climate variable.

Table 4 - Linkages of carbon storage and biomass pollution retention

Ecosystem service	Benefits	Land use practices that preserve ecosystem services
Carbon storage	Mitigation of global climate change	Forest conservation, water management in peatlands, fire prevention
Biomass pollution retention	Healthy air quality, avoidance of haze	

Linkages with REDD

REDD financing is based on the concepts of carbon offsetting and payment for ecosystem services. After Wunder (2005), CIFOR defines payment for ecosystem services as a *"Transaction in which units of environmental service, or a form of land use likely to secure the service, is bought by at least one environmental service buyer from a minimum of one environmental service provider if and only if the provider continues to supply that service"* (Eliasch, 2007). Following that definition, REDD rests on the premise that the international community, as a beneficiary of the climate regulation benefits from carbon storage of existing tropical forests, should pay tropical forest countries to preserve that service by maintaining forests. As a second premise, REDD determines that the buyers should be the developed countries with emission reduction requirements, that historically have emitted most greenhouse gases and need to compensate tropical forest countries for the opportunity costs of not converting natural forests to other land uses.

REDD payments are hence a rent payment on the forest in order to maintain their carbon stock. In the international context, Indonesia would receive REDD payments based on the carbon stock preserved, or on the decline in the rate of its loss, which can be estimated with detection of change through remote sensing, fire mapping and carbon stock mapping. However, implementing carbon stock payments on the ground at the landholder level is technically and logistically challenging.

As a complement or alternative to carbon payments, fire management practices could be used as units for rewarding landholders for the maintenance of the carbon stock, with the assumption that the absence of fire leads to a preserved carbon stock. In addition, the presence of fires detected with remote sensing hotspots is useful to determine non-compliance with these measures. Certainly, there can be deforestation without fire, or fire even in the presence of fire management practices, but with the appropriate safeguards, using these practices as complements to carbon storage payments facilitates the implementation and scaling-up of avoided deforestation payments and incentives on the ground.

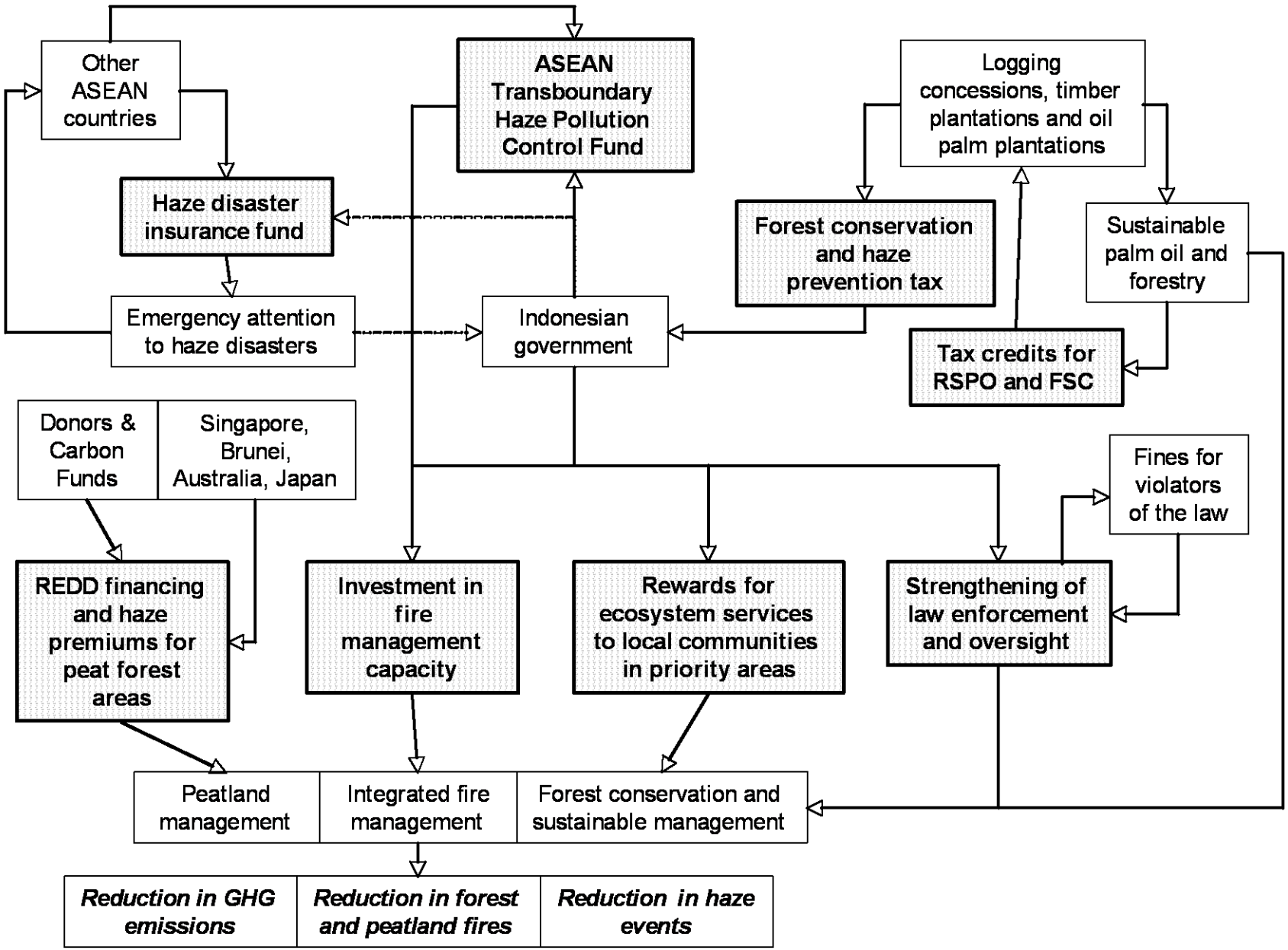
5. Investments, incentives and financing mechanisms to address deforestation, fire and haze

Having clarified the place of deforestation, forest fires and haze within the context of ecosystem services, and analyzed the science, economics and policy behind them, the policy framework here defined was designed with the principles of the Ecosystem Approach in mind, particularly Principles 4 and 5 (CBD, 2007). Principle 4 states that there is a need to understand and manage ecosystems in an economic context, in order to *"a) Reduce those market distortions that adversely affect biological diversity; b) Align incentives to promote biodiversity conservation and sustainable use; and c) Internalize costs and benefits in the given ecosystem to the extent feasible."* Principle 5 states that the conservation of ecosystem services should be a priority for the ecosystem approach. Criteria of effectiveness of implementation, feasibility and equity were used to evaluate each of the policies within the framework.

The policy framework outlined in Figure 1 has several interlinked components of economic incentives, financing arrangements and enforcement measures that work together to direct the various agents involved towards sustainable fire management, as well as reduce the immediate impacts of haze events on the population of Indonesia and neighboring countries. The framework introduces additional costs for palm oil and timber plantations to internalize environmental damages and provide revenue that the Indonesian government needs to address the fire and haze problem. It also includes incentives for rural dwellers to protect ecosystem services and internalize their benefits in their economy. At an international scale, it recognizes the impacts of haze on neighboring countries and the need for a compensatory mechanism. This way, Singapore, Malaysia and Brunei have an incentive to invest in Indonesia to protect its peatlands and Indonesia to join the Transboundary Haze Agreement. The policy framework also establishes the link of haze with REDD, so that Indonesia has a double incentive to manage peatlands and prevent fires and greenhouse gas emissions. Finally, the policies contemplate generating revenue for chronically underfunded activities of environmental law enforcement and fire management.

Engel et al. (2008) argue that a combination of policy instruments is necessary where several sources of market failure coexist, so there is no single policy instrument that can be a silver bullet for solving complex environmental problems. Hence, these incentives and instruments would be better implemented as a package where its components complement each other as well as the existing initiatives and regulatory framework. The framework however, is not comprehensive, as it does not address the demand-side management of palm oil and timber, nor does it examine possibilities of reform of the complex institutional structure of forests, fire and environmental governance in Indonesia. These issues are by no means minor, but they fell outside the scope of the paper.

Figure 1 – Proposed Policy Framework (Main elements are in bold)



1. Forest Conservation and Haze Prevention tax and credits for sustainable practices

Indonesia needs substantial resources to address the causes and consequences of fires, haze and forest destruction. Money is already needed to combat illegal logging and encroachment in protected areas and production and conservation forests, as well as enforce existing policies such as bans on open air burning. In addition, in the event that the policies outlined here are adopted, they will not succeed unless there are appropriate monetary commitments from the government to support their implementation, monitoring and enforcement. Although the international community has an interest and a responsibility to contribute to preserving the carbon stock of Indonesia's forests with REDD financing mechanisms, Indonesia itself derives significant benefits and should thus devote its own resources to mitigate forest fires, transboundary haze and forest loss.

The palm oil, timber and pulp industries in Indonesia hold a large share of historical responsibility for deforestation, illegal logging, fires and haze. On the other hand, these are profitable commodities. Given the externalities at work, it is appropriate to introduce an environmental Forest Conservation and Haze Prevention Tax on these industries, which generates earmarked revenue for the implementation of the policies included in this framework: law enforcement, investments in fire management capacity, rewards for ecosystem services for local communities and contributions to the ASEAN Transboundary Haze Pollution Control Fund. This tax would follow the polluter pays principle, making companies internalize the societal costs of deforestation, fire and haze, in an efficient way in accordance with the economic theory of Pigouvian taxes (Engel et al., 2008). In order to reward good behavior, the proposal includes deductions or exemptions from the tax for companies that follow sustainable practices and produce certified FSC timber and RSPO palm oil.

After reviewing policies that encourage or hinder deforestation worldwide, Wunder (2004) supports taxing timber and oil palm as a policy alternative to reduce deforestation in Indonesia. Applegate et al. (2002) support its use to raise revenue for restoration. Developing countries have abundant experience with environmental taxes on gasoline. Colombia and the Philippines have experience with water pollution taxes, whereas Tanzania has taxes on fertilizers. Malaysia instituted an environmental tax since the 1980s for untreated palm oil effluents, which became a major source of water pollution (Bluffstone, 2003).

Tax design

There are various alternatives to design a Forest Conservation and Haze Prevention Tax, with different implications for administrative feasibility, revenue raising capacity, remediation of environmental impacts, efficiency and equity. A tax can be used as a revenue-raising mechanism, a behavior-change mechanism, or both. Tax evasion is high in Indonesia, so the tax needs to be collected in a way that minimizes this problem.

Currently, there are export taxes on crude palm oil as well as taxes on timber exports, so the Forest Conservation and Haze Prevention Tax could be added as a surcharge to the export taxes. Another option is to assess the tax based on the area of plantations and concessions, having

companies pay a tax rate per hectare per year. With export surcharges, pulp, timber and palm oil for domestic consumption would not pay the environmental tax. With land taxes, tax collection in communal lands and by smallholders would be difficult to enforce.

For palm oil, it seems more plausible to assess a surcharge on currently existing export taxes than to institute a new land tax, which would be fraught with complications given the murkiness of the land tenure situation in many parts of the country. Exempting the domestic market from the tax would support the policy of the Indonesian government of preserving low prices for local consumers. It would be necessary, however, to charge the tax on processed palm oil products for export to prevent tax evasion. For timber in particular, pegging the environmental tax to export taxes might be more difficult given the difficulty in monitoring the exact quantities exported (Chomitz et al., 2007). In that case, assessing the taxes by the amount of land on concession or plantation lands might be more optimal.

How high should the Forest Conservation and Haze Prevention Tax be? Pigouvian tax theory indicates that in order to reduce the negative environmental externalities of an economic activity to an optimal efficient level, a tax needs to be assessed in knowledge of the marginal benefits to society and the marginal costs to the firms of units of environmental improvements or behavior change. However, these values are seldom known, so it is common worldwide to define taxable activities and levels of taxation with predefined environmental standards or with revenue raising goals in mind (Bluffstone, 2003).

In the case of palm oil and timber plantations, the environmental damage is not redressed necessarily by a reduction of current production, but by changing the practices of production and generating funds for environmental action. Therefore, a Pigouvian tax needs to be high enough to motivate changes in behavior, namely incentivizing zero burning methods for land clearing and replanting, integrated fire management in plantations, peatland management and other environmentally conscious practices. Plantations which follow these practices would receive deductions or exemptions from the tax. Those who do not are faced with the choice of paying more for producing in a less sustainable manner. Tax revenue can be used to mitigate the increased risks of wildfire, haze and past environmental impacts of production.

Unfortunately, a Pigouvian tax like the one just described seems difficult to implement politically in Indonesia for several reasons. First, the government has banned the use of fire for land clearing for plantations through regulation 4/2001. It may not be viable to tax those who burn, when they should be prosecuted under existing law. Secondly, the tax rate would need to be sufficiently high to encourage the shift to sustainable practices, which may affect the competitiveness of the industry. Companies may lobby against the tax arguing that it should be applied to other sectors of the economy as well. Thirdly, Indonesia does not have a history of using environmental taxes, so it may be difficult to get political buy-in for the introduction of a new tax.

In the face of these difficulties, a second best option is to institute a tax at a low rate, exclusively for revenue raising, only slightly affecting the cost equation in favor of sustainable practices. That tax would be a small surcharge on currently existing export levies, one whose impact is marginal for individual producers and for the global demand but in the aggregate can generate substantial revenue for the government. Such a tax will be easier to institute politically and would face less resistance. The optimal rate of the tax would be informed by the government

revenue needed to address the problem and fund the policies described in this paper. Although the behavior change component would be diminished, the tax would still be very useful as a revenue raising mechanism (Box 2).

Box 2 – Estimates of revenue raising potential for a forest conservation and haze prevention tax on palm oil

Indonesia produced 14.2 million tons of Crude Palm Oil (CPO) for the world market in 2008. Currently, the export tax is indexed to the world market price, beginning at 0% for CPO reference price below US$700, and climbing to 25% for prices above US$1,250 per metric ton (Palm Oil HQ, 2009).

With CPO futures prices hovering below US$600 in July 2009, the Indonesian government is not collecting revenue for the export tax. If it charged a small 1% Forest Conservation and Haze Prevention Tax on CPO it could collect up to US$85.74 million per year, US $42.87 million with a 0.5% rate. If the price rose to $1,000/ton, it could collect up to US$142.9 million per year assuming 0% evasion.

Even with a low tax rate, the tax could allow deductions for palm oil certified by the Roundtable on Sustainable Palm Oil (RSPO) and forest products certified under the Forest Stewardship Council (FSC). Currently, the incentives for producers to grow certified FSC wood and RSPO palm oil are mostly premium prices paid in export markets by consumers demanding sustainable products. If these products get a tax incentive in Indonesia but uncertified palm oil and timber do not, it will facilitate the expansion of certified plantations and forests in Indonesia by reducing relative costs. An additional incentive to the tax deductions might be to include the companies in an environmental performance list that would increase the companies' reputation and improve their public relations, akin to the Program for Pollution Control Evaluation and Rating (PROPER) which is an Indonesian public disclosure scheme for industrial pollutants (García López, 2004).

Another advantage to using certification schemes as tax deduction criteria is that the Indonesian central government can rely on monitoring by certifiers to verify the sustainability of company practices, thus reducing the need for government monitoring. Also, the certification schemes are evolving, becoming more stringent and incorporating more locally relevant criteria, making the policy flexible and adaptable for the future.

Making the case for a tax

No matter how well designed a tax is, it is likely to meet stiff resistance given the power of the pulp, oil palm and timber industries. Does this mean that the environmental tax idea is not applicable to Indonesia? No, but strong arguments need to be summoned to gain political support for the idea to be carried forward.

The industry will argue that they have already improved their practices and are utilizing zero burning techniques for land clearing and replanting, so they are no longer contributing to fires and haze. In response to that, it should be argued that the tax compensates for an externality incurred not only at present but historically, and that funds need to be raised to manage the risks of fire and haze and the costs of protecting remaining forests. These costs are higher now given the vast expanses of degraded forests, many of which were the result of clearings for plantations in previous years. The industry needs to bear this tax in recognition of its historic responsibility

toward the problem. However, rewarding good current behavior is necessary; hence the tax deductions proposed.

On the other hand, the legal timber and pulp industry will argue that a new tax will further encourage the black market of illegal logging and work to the detriment of legal exports. Rautner et al. (2005) cite a production cost differential of \$53 /m^3 to deliver legal wood to the mill vs. illegal wood. This is a logical concern so it is very important that part of the revenue from this new tax is used for stepped up law enforcement on illegal logging and tax evasion. Otherwise, the tax will indeed result in even higher levels of illegal timber.

Another argument against an environmental tax is that it will negatively affect the competitiveness of Indonesian palm oil, pulp and timber as these are already subject to national and local levies of various kinds. However, these concerns are likely to be overstated. Indonesia is currently in a position of market dominance in the palm oil sector internationally, so an additional tax levied by the Indonesian government is likely to be reflected in a higher international price for palm oil, generating more revenue for Indonesian exporters in spite of the tax. Global market demand for the oil is expected to remain strong, as it is a staple good with multiple uses ranging from processed foods to cosmetics to biodiesel. As for the pulp and timber market, although Indonesia doesn't have the same dominance, it is unlikely that a small additional tax will make Indonesian wood less competitive, as supply of these commodities is tight, investments in these plantations are made for the long term, and shifts in production to other countries are not easily undertaken in a short time frame in response to increased production costs.

Finally, an environmental tax may be criticized in terms of equity. The export environmental surcharge would affect all producers, from smallholders to large plantations, but smallholders of palm oil would be put in relative disadvantage and their earnings would suffer, plus it would be difficult for them to claim deductions as the relative costs of FSC or RSPO certification would be high. These problems can be mitigated in two ways: If the tax rate is small enough, the impact on individual small producers should be marginal. Furthermore, if Rewards for Ecosystem Services are instituted to reward smallholders for good management practices, fire prevention and suppression, the impact on earnings could be reversed.

Lastly, the complete success of the tax of encouraging the certification of most of palm oil and forest production would diminish the revenue obtained from the tax. If this occurs, the incidence of fire and haze should have diminished anyway by the shift to sustainable practices, so the overall objective would still be accomplished

2. Investment in fire management capacity at a national level and through the ASEAN Transboundary Haze Pollution Control Fund

The vast fires that have come with increasing frequency in the past 30 years have increased the vulnerability of Indonesian forests and lands to fire. The land use pressures on forests and peatlands have not abated, and although there is a stricter regulation banning open fires for land clearing, enforcement of this blanket ban is patchy and difficult. Fire response should not be a matter of responding to one-time disasters, but begin before fires start and address entire fire

regimes that have developed in Indonesia over the last decades (Hoffman et al., 2003; Myers, 2006). The Global Fire Assessment by the FAO pointed out the need for institutional strengthening of fire management in many countries, as the big costs of suppression take up all the small budgets and leave limited resources for fire prevention (FAO, 2007).

Thus, Indonesia needs to increase its fire management capacity substantially to deal with the problem and be prepared for El Niño events that are likely to result in large-scale peatland and forest fires. The country should consider large investments in all the aspects of integrated fire management: prevention and education, fire use, preparedness and response, restoration and recovery, and adaptive management (Hoffman et al., 2003; Shlisky et al., 2007, Applegate et al., 2002). These activities need dedicated sources of revenue, which could come from the proposed Forest Conservation and Haze Prevention Tax, and to a minor extent from an enlarged ASEAN Transboundary Haze Pollution Control Fund. The required investment in fire management capacity is significant, but when evaluated against the cost incurred by Indonesians due to haze events there is enormous potential to avoid damages.

Investments in Fire Management Capacity

Prevention and information

Education and awareness are necessary to combat fire. The ASEAN THA can fund region wide awareness campaigns, but the Indonesian and provincial governments should tailor campaigns to their local audiences. Capacity building of local communities, particularly migrants, about integrated fire and peatland management is necessary, as well as regular information about fire hazard levels informing people about the dangers of fire in particular times. Prevention activities also include law enforcement, prosecuting those responsible for initiating and propagating fires in order to create disincentives for future offenders. Prevention is the expense most often omitted as it seems the least urgent, but substantial efforts need to be devoted to it (FAO, 2007).

Detection and monitoring

The THA is a logical umbrella for funding shared detection and monitoring capabilities for use by all ASEAN nations. Currently, the Indonesian Ministry of Forestry and Ministry of the Environment use fire event data from NOAA. Hotspots can be detected in real time by satellite within a range of 1 km^2. Nonetheless, on-the-ground monitoring, for instance with fire lookouts, is important as well, recruiting community members as fire monitors and requiring fire monitoring by plantations. Fast detection enables fast response, and fast response has more likelihood of controlling fires and costing less. Another option is to incorporate this to REDD monitoring schemes.

Preparedness

If provided with basic training in fire management, many small fires could be controlled by farmers and plantation workers. Having said that, Indonesia would benefit by increasing its professional firefighting capacity to suppress large fires and escaped fires (Applegate et al., 2002). The country could recruit and train more firefighters and have a reserve force that can be deployed at short notice. It is also ideal to have equipment, vehicles and fuel available at short notice and in sufficient quantities to attack fires on many fronts.

Response

In firefighting, the speed at which crews get on the ground and start combating a fire is one of the most important factors to prevent it from becoming unmanageable. In remote areas, aircraft, boats or helicopters are necessary to bring the initial fire crews to contain the fire until further ground support arrives, so guaranteeing access to some form of transportation is key. Aircraft and helicopters are also useful to pour water or fire retardants with fire buckets. Helicopters are more versatile and have been successful in the region (FAO, 2007), but are riskier to operate and more expensive. These investments are expensive: Eaton (2001) reports that Brunei rented a helicopter to combat forest fires in 1997-98 at the cost of $32,000 a day.

Underground peatland fires can only be extinguished by flooding, rain, or trenches beyond the full depth of the peat layer, the latter of which are impractical in some areas with thick deposits (Roderick et al., 2001). Thus, it is imperative to have engineering expertise to carry out the necessary works to extinguish those fires, like flooding burning peat areas by damming existing canals and diverting water flows.

Restoration

Active restoration of fire-affected areas is difficult. Myers (2006) states that the best restoration activity is to prevent new fires from occurring in a given location, rather than engage in expensive replanting efforts. In peatlands, however, restoring the hydrology and vegetative cover is very important to reduce the fire hazard.

Making the case for fire management investments

The ASEAN THA has advanced in promoting regional cooperation for capacity building for fire management, fire monitoring, peatland management and regional emergency coordination and sharing of expertise. At present, however, the Transboundary Haze Pollution Control Fund has received only small contributions from ASEAN countries with seed funding of $500,000. To increase and maintain the level of cooperation, the fund needs more resources from ASEAN governments.

The main hurdle for increased funding of the Haze Fund is the lack of ratification of the THA by Indonesia. On the other hand, there are few incentives in ratifying the treaty if there is not substantial funding available for Indonesia to combat haze. Indonesia has somewhat behaved like the United States did when it rejected the ratification of the Kyoto Protocol: it will not commit to a treaty that acknowledges that the country has the highest degree of responsibility for resolving a problem.

Nevertheless, conditions may be ripe for ratification with the renewed mandate obtained by the reelection of President Yudhoyono in July 2009, statements from parliamentary leaders in Jakarta, and the return of the haze in Riau, Peninsular Malaysia and Singapore in June 2009, which have given new impetus to the issue and fresh pressure on Indonesia.

Even if Indonesia ratifies the THA and it is expanded, it would not be able to cover all the investments needed for fire protection, as they fall on the shoulders of individual governments: aircraft, vehicles, fuel, salaries for firefighters and other operational expenses. How can Indonesia, a developing country, justify making these very expensive investments? Indonesia

could look at these as national defense investments, securing the precious natural assets of the country. With the expectations of REDD financing coming along in the near future, Indonesia needs to protect its forest carbon stock. As an example of what could be done, the Indonesian military might consider retrofitting some of its aircraft to combat fires, and devote some helicopters for the same purpose. Through persistent negotiations, it could even procure these as components of aid from countries like the United States.

The literature mentions that fire management should not focus on technological solutions to fire but work on reducing the actual causes of fire (Myers, 2006). At this stage, however, both approaches are needed. During El Niño of 1997-1998, the drought was so pervasive and the fires spread so easily that it was clear that a robust fire response capacity with sufficient numbers of trained and professional firefighters, modern equipment, aircraft, helicopters, vehicles and boats would have helped to put out the fires. With another El Niño looming in late 2009, plus larger areas of degraded forest and drained peatlands, the fire hazards are very high.

Glover and Jessup (1999) reported that Indonesia spent US$11.67 million in firefighting in 1997 whereas the damages for the country reached $4,085 million. Although comparisons are very coarse to be indicative of an appropriate level of investment, the cost figures pale in comparison to what is spent in other countries. The U.S. Forest Service spent more than US$10 million in each of 27 large fires occurring in 2007, and had a total fire suppression budget of US$1.8 billion in 2007 (ILWCP, 2008). Without knowing the marginal benefit of increased firefighting capacity, it is difficult to establish an appropriate level of investment, although certainly it needs to be much larger than it was in 1997. The lack of reliable estimates of cost effectiveness should not preclude investments in fire management, although certainly research is needed in this area for the Indonesian context.

3. Haze Disaster Emergency Fund

Transboundary haze episodes are disasters that affect the health of human populations over great areas far beyond the main sources of fire. In that regard, there should be a risk management approach to the problem that addresses the specific impacts of haze, incorporating air quality monitoring, early warning systems, determination of vulnerable areas and populations, education and public awareness, emergency response planning, among others. Some of these expenditures are for prevention and preparedness, but other costs arise only when a haze episode occurs.

To help countries cope with the emergency expenditures needed when haze episodes occur, ASEAN could establish a Haze Disaster Emergency Fund under the Transboundary Haze Agreement. This fund would pool the risk of haze among all ASEAN countries much like an insurance policy for natural disasters, and would take the spirit of regional cooperation further, giving emergency funds to affected countries regardless of where the haze originated. Such a fund would be appealing for Malaysia, Singapore and Brunei, countries regularly affected by transboundary haze.

The fund could be established by the ASEAN THA and managed by agreement by the Asian Development Bank, which can function as a trustee and manager. It could even be pegged to the newly established *Asia Pacific Disaster Response Fund* (APDRF), managed by the ADB as well as a special funding section for haze events with specific criteria for disbursement (ADB, 2009).

The APDRF was set up in April 2009 to provide quick grants of up to US$ 3 million for immediate assistance to developing countries in the region following a disaster declaration.

Design of the Fund

The proposed Haze Disaster Emergency Fund could cover emergency medical attention and response measures of affected areas anywhere in the region. The fund could only be tapped if the haze levels rise above a dangerous threshold for a certain period of time, using existing indices like the Air Pollution Index or the Pollutant Standards Index used by Malaysia, Singapore and Brunei, or developing a regionally appropriate haze-specific index. These standards provide a guarantee that the fund would be used only in severe emergencies.

Such a fund would help cover expenses such as the additional costs of emergency medical attention, distribution of masks, provision of shelters with good air conditioning and purification systems, subsidies for air purifiers, public broadcasting of alerts, transportation and evacuation of vulnerable populations and other humanitarian assistance expenses (Ostermann and Brauer, 2001). The funds could be made available to government agencies and to humanitarian NGOs on a very rapid basis. Each ASEAN country would contribute to the fund as a function of its responsibility for the problem and level of wealth. In the case of Indonesia, the country could devote revenue from the proposed Forest Conservation and Haze Tax for this purpose.

Although there are many costs incurred by countries affected by transboundary haze, such as economic damages from lost productivity and decreased tourism activity, it is unlikely that a fund could be set up to mitigate all these collateral damages. However, private insurers could potentially create haze insurance to mitigate these risks for the private sector. By limiting the possible expenditures for use with the fund it is more feasible that that level of expenditure could be met and that the revenue would be used appropriately.

Promotion of the fund

There are various hurdles for the adoption of this Haze Disaster Emergency fund. First, it is contingent on the ratification of the ASEAN THA by Indonesia. Secondly, it would seem unnecessary given the existence of the APDRF. Thirdly, Indonesia will be reticent to contribute to the fund in proportion commensurate with its responsibility for producing haze. Indonesia might also be concerned about setting a precedent for compensation for other costs beyond the health costs.

Fortunately, there are arguments that address these concerns. The establishment of a Haze Disaster Emergency Fund can be an incentive for Indonesia to ratify the THA, as Indonesia would be able to tap into the fund when haze effects are strongest inside the country. Although effectively the APDRF could attend haze disasters, having specific contributions for haze disasters by ASEAN countries would allow non-developing countries like Singapore and Brunei to be eligible for funds. The risk of setting a precedent could also be viewed differently. For Indonesia, contributing to this fund would mean making a good-will gesture of acceptance of responsibility for the haze vis-à-vis neighboring countries, and mitigate possible future harsh legal compensation claims from them. In addition, it could stimulate good-will gestures from Singapore, Brunei and Malaysia, like investment in REDD and combating of illegal logging.

4. Rewards for ecosystem services to local communities in priority areas

Payments for ecosystem services (PES) are promising as a policy option for encouraging landholders to adopt practices that are unprofitable to them but that provide positive externalities (Engel et al., 2008). PES compensate land holders for their opportunity costs (the most profitable land-use foregone and are most appropriate when these externalities are likely to persist in time so compensation is required on the long term (Wunder et al., 2008).

There are a growing number of PES experiences worldwide, with widely known national government programs in Mexico and Costa Rica paying landowners for conserving forest cover to sustain water, carbon and other services (Engel et al., 2008). In Indonesia, the experience with PES is scant, one of the main hurdles being the nature and uncertainty of *adat* land tenure, which complicates payment distribution. Nevertheless, the need to steer the incentives faced by forest dwellers and farmers to favor sustainable forest management and conservation over deforestation and fires is paramount (Shlisky et al., 2007; Myers, 2006; Suyanto et al., 2004; Wunder, 2004; Tacconi, 2003, Glover and Jessup, 1999).

In order to be successful, PES schemes must fit within the governance schemes of Southeast Asia (Tomich et al., 2004). Thus, the concept of *Rewards for Ecosystem Services* (RES) is useful to deal with *adat* but still preserve the essence of PES. Rewards include monetary payments as in PES but do not preclude non-monetary rewards such as securing legal rights to the land, support for infrastructure and social capital, conditional on delivery of environmental services (Tomich et al, 2004). In that spirit, the Indonesian government could support Rewards for Ecosystem Services to local communities for forest conservation and integrated fire management activities (Myers, 2006), with money from the Forest Conservation and Haze Prevention Tax and REDD financing, as a strategy to preserve the ecosystem services of Indonesia's forests.

Design and implementation of the rewards

The goal of the rewards would be to provide incentives to communities to protect the forests, use fire in a judicious way, and comply with fire use restrictions when there is a high risk of fires and haze. Without incentives, behavior is very hard to change (Myers, 2006). Rewards could take many forms, but should be conditional upon compliance with the activities of the program. To maximize the cost-effectiveness of the program, it can be targeted to areas at great risk of deforestation and fire. These include forested and non-forested peatland areas; as well as buffer zones of protected areas, where prevention of fire episodes is crucial as in drought years the risk of fire expansion into parks is serious. Targeting is one of the flexibilities of PES, where the policy seeks to impact those communities that provide the most environmental services, the places where they are most at risk, or the areas where it can make a difference for poverty alleviation. Targeting also helps manage the overall costs of a PES program (Engel et al., 2008).

What activities could be credited with rewards? In addition to the conservation of forests in community land, credited by area preserved and carbon stocks, other activities carried out by local farming communities could be credited: alternative livelihoods like agroforestry and forest gardens (Brodbeck et al., 2004) in lieu of annual crops requiring burning; the establishment of community fire brigades and fire monitoring activities (Myers, 2006); creation of fire barriers

between agricultural and forested land[4]; prescribed burns[5] early during the dry season (Myers, 2006); the adoption of longer fallow cycles in swidden agriculture, to allow better regeneration of forest ecosystems after burning; and management of water tables in peat areas. Direct household payments can be made to compensate farmers for not being able to use fire at all in peat areas and during El Niño years, when absolute restrictions on fire use should be in place.

The rewards instituted could be direct payments to households, payments to the community as a whole under a cooperative, government investment in the community (school construction, sanitation, electrification), employment (such as participation in a fire brigade), and concessions over land rights granted to entire villages in recognition of *adat*, just as concessions are issued to private companies for logging and plantations.

In the Indonesian context, securing rights to land can be an excellent incentive for communities to follow integrated fire management practices and conserve the forests, because it gives them the assurance that they will not be uprooted from their land and can continue to derive a livelihood from it, albeit with some restrictions. Land tenure security is also effective at reducing land conflict and the use of fire as arson (Suyanto et al., 2004). The scheme was tested successfully in Indonesia by the RUPES program (Rewarding Upland Poor for Environmental Services), coordinated by the World Agroforestry Center, by granting farmers concession rights to their communal land for 5 years upon compliance with the program, to be extended to 25 years after (Kerr et al., 2008). The figure of *community forestry licenses*, existent in legislation since 2007, was employed by the RUPES program to grant communities rights to degraded forest conditional on sustainable forest management, agroforestry and conservation of remaining forest. The program maintains the Indonesian policy of preserving state ownership of forest lands (Leimona and Lee, 2008). The Indonesian Forest and Climate Alliance (2007) suggests using approaches similar to RUPES.

How can such a rewards program be scaled up and administered in the context of Indonesia? The PNPM Generasi Program is a promising example[6] (World Bank, 2008). The central government, with contributing funds from the World Bank and foreign donors, gave block grants to villages to achieve progress towards the Millennium Development Goals with a set of clear and measurable health and education indicators. Villages agreed through participatory mechanisms on how the money should be spent in the community. The PNPM scheme actually followed the model of the Kecamatan Development Program (KDP), which provided grants to subdistrict governments. In the context of forest conservation and fire management, a similar scheme might be useful to administer the rewards, and could actually be a good complement to poverty reduction programs. Block grants to initiate the scheme could be distributed to targeted districts, and these in turn agree with forest communities how to comply with the requirements of the program and what kind of rewards would be most useful. After a period of time, monitoring activities take place and rewards would be given anew if there is compliance. A PNPM-type scheme would actively involve district and village governments, which would increase buy-in for the program but may elevate transaction costs.

[4] In Borneo and Sumatra, these barriers would most likely be trenches on the ground or strips of grass and scrub adjacent to forests.

[5] Burning of the fire barriers so when there is a higher risk of fire later during a drought, fires from grassland and agricultural areas will stop at the burnt strips and will not enter the forest.

[6] PNPM Generasi is part of the Government's poverty alleviation program, Program Nasional Pemberdayaan Masyarakat (PNPM) - Mandiri or the National Program for Community Empowerment.

If RES schemes are set up without going through local governments as an intermediary, they can be established also with communities organized in cooperatives or similar entities to facilitate the signing of a contract and the channeling of payments to a community as a whole, given that individual household payments would be impractical without private property rights. Although this approach would reduce transaction costs and be useful where local governments are uncooperative, it would lack the buy-in from local authorities.

Any RES program should be coupled with efforts at capacity building and education and awareness about sustainable practices and the rationale for preserving environmental services, to promote a culture of preservation of ecosystem services beyond the economic justification for it. Capacity building needs to occur across the board, from migrant communities who lack traditional land management practices, to local authorities. If the education component is lacking, there is fear that the environmental services will be held hostage to any payment (Kelsey et al., 2008).

RES also requires careful monitoring, so that in case of non-compliance the rewards are not issued. Determining the appropriate size of the rewards is tricky. Although the literature states that farmers should be paid at least the opportunity cost of their preferred land use, it has been shown from the experience in Costa Rica that farmers can respond positively to much smaller incentives because it is the right thing to do (Engel et al., 2008). On the other hand, when non-monetary rewards are used, the assessment of their value compared to opportunity costs is difficult. In the case of land tenure rights, their value is likely to be substantial. Intensive environmental education efforts may lower the threshold of necessary level of payments to deter unsustainable practices.

Promotion of the program

The Indonesian government is well-positioned to act as a central buyer of forest ecosystem services and issuer of rewards to communities, while procuring additional investment from global and regional beneficiaries through REDD, donor climate funds and the ASEAN THA. However, the country cannot rely solely on external funding. The use of the forest conservation and haze prevention tax to finance these payments and rewards would guarantee a sustainable revenue stream. Donor-funded PES programs are often unsustainable if no committed buyers are found for the long-term. Furthermore, some donors may be uncomfortable with issuing aid conditionally, as is the principle of PES (Wunder et al., 2008).

The concept of PES enjoys widespread acceptance among academic policy circles, NGOs, development banks and donor countries. It has a lot of momentum at present as a mechanism for forest conservation and to some extent for poverty alleviation. Indeed, mechanisms like PES are much more likely to be accepted in Indonesia than environmental taxes, although guaranteeing money for a PES scheme is harder without any steady revenue stream. Although the RES program suggested here diverges from PES in that cash payments are only one possible form of reward, it maintains the principle of remunerating landholders for providing ecosystem services.

An additional benefit of the RES program in Indonesia is its usefulness for the enforcement of fire bans. The current blanket ban is unenforceable in small farming communities. However, it is

crucial to enforce the ban of burning on peatlands and during El Niño years. By issuing compensation payments for farmers who are restricted from burning in these areas and during these periods, the compliance with these restrictions should increase substantially.

One possible danger with the RES scheme is that it may attract more colonists to the forested areas, procuring monetary payments (Wunder, 2004). The fact that some of the rewards are non-monetary might help mitigate this risk.

5. REDD financing and haze premiums for peat forest areas

Peat forests are of particular interest to REDD, because they have the largest carbon stock per unit of area, when considering the deep peat deposits in the soil. Preventing fires in peatlands is also the most important action to prevent transboundary haze due to the release of particulate matter from peat burning. Therefore, Indonesia should seize this opportunity for synergy and establish REDD demonstration projects in peat forests, particularly in Riau province and Kalimantan, and seek additional investment in them from Singapore, Brunei, Australia and Japan among other donors and investors. The idea is that those projects would not only generate carbon credits but would also reduce the incidence of haze by measurable amounts by preserving the biomass pollution retention services of those forests. If the projects succeed, Brunei and Singapore in particular would have the incentive to maintain those investments to prevent haze episodes that affect them.

Design of the projects

Avoided deforestation projects in peat forest would need to address land zoning and tenure, forest management, illegal logging, intentional burning, escaped fires and peat subsidence and oxidation. These projects would benefit from investments in fire management capacity and law enforcement, and could employ Rewards for Ecosystem Services as a component of their action.

In the demonstration stage of REDD, the channeling of funds would operate differently depending on the carbon fund or donor. Similarly, the guidelines for determining baselines, measuring carbon sequestration and accounting carbon credits will vary depending on the standard favored by each carbon fund. The use of multiple standards, such as the Voluntary Carbon Standard (VCS) and the Forest Carbon Standard of the Climate, Community and Biodiversity Alliance (CCBA) are appropriate at this stage, when REDD is in an experimental phase and countries are learning what works best. At this stage, the use of experimental methodologies can be tested, such as the inclusion of "haze credits" as a premium to carbon credits.

Challenges to REDD financing for peat forests

Measuring peat forest degradation and carbon stocks

There is not yet an agreed definition of forest degradation for REDD, but it is understood as the reduction of the carbon stock of a forest that still remains a forest, for instance through logging, harvesting or fires. For peat forests, the degradation definition should include the oxidation or burning of peat in units that still have forest. However, measurements of carbon stock are not

complete for Indonesia yet (IFCA, 2007). Measurement of any forest degradation is still somewhat challenging through remote sensing, although some indices in development that use proxy variables such as proximity to roads look promising.

Leakage of deforestation to protected areas

The Indonesia Forest Climate Alliance (2007) mentions the need to direct REDD funding not only to the so-called "smoking" provinces in Kalimantan and Sumatra, but also to areas where deforestation levels are low, so that there is a reward for the conservation that has taken place so far. Similarly, IFCA points out the danger of not funding protected areas because of the idea that forest conservation that is already in place is not additional and should not be entitled to REDD payments. If REDD efforts concentrate outside of protected areas, parks might suffer from encroachment, in effect, a national leakage. In terms of carbon, there might be a net benefit if the national REDD commitment is met, but in terms of biodiversity, loss in protected area forests would be very serious.

One way to address these valid concerns is to have complementary mechanisms for protected areas beyond REDD, namely investments in law enforcement, Rewards for Ecosystem Services in buffer regions and fire prevention and suppression.

Permanence of emission reductions

The emission reductions from averted deforestation must persist in time in order to make a contribution to global greenhouse gas cuts. Yet, they could be lost if deforestation begins again, or if forest fires affect the areas. The international community has to negotiate how to count forest losses due to fires within a REDD framework. The creation of carbon allowance reserves and insurance can serve as a buffer to withstand some reversals in deforestation gains. If fires are not well captured within the REDD framework it is unclear how it could be effective in Indonesia (Daviet, 2009).

Land tenure insecurity

Uncertain land tenure poses difficulties for REDD because if communities do not have recognized long-term rights to the forest, they cannot be sure that they will reap the benefits of carbon payments for forest conservation. Indonesia recently issued rules for revenue-sharing of REDD financing, which would address this concern[7]. The revenue sharing varies depending on the type of forest category. Local communities would get 20 to 70%, project developers would get 20 to 60% and the government (district, central and provincial) would get 10 to 50% (Butler, 2009c).

Making the case for REDD projects in peat areas

Peat forests in Riau and in coastal areas in Kalimantan are extremely threatened with small and industrial-scale land clearing and the threat of wildfires now that another El Niño event seems very likely in the second half of 2009. Thus, there is an urgent need to act. REDD financing should certainly expand to other forests in mineral soil, but the urgency of the problem in peatlands in Kalimantan and Sumatra merits the deployment of initial pilot projects there.

[7] Ministry of Forestry of Republic Indonesia Regulation No: P.36/Menhut-II/2009, on Procedures for issuing permit for carbon sequestration and/or stock uses at production and protected forest.

Venter et al. (2008) and IFCA (2007) show that REDD payments in peat areas would be very cost effective. Venter calculated that in peat areas in Borneo, the investment needed to reduce emissions would drop to a range of US$1.63 to $4.66 per metric ton of CO_2 to compete with the net present value of palm oil over thirty years, compared to a price range of US$ 9.85 to $33.34 per metric ton of CO_2 for other areas. This is an added incentive to focus REDD financing on peat forests. Indonesia could find that by protecting its peat forests and deposits, it could achieve an impressive reduction in greenhouse gas emissions per each dollar of REDD investments.

As of mid 2009, there is a mixture of hope, enthusiasm and skepticism about REDD, and the international community and Indonesia are sending mixed signals about the feasibility of implementing the mechanism. The success or failure of REDD in Indonesia hinges on the results of international negotiations, but assuming that it goes forward, various countries should be interested in investing in peat forest projects. Japan, for instance, is an important donor country in the region and needs carbon credits. Australia is in a similar situation. Singapore is a newcomer to the Kyoto Protocol, and could gain experience participating in the carbon market by investing in these projects. Although Brunei is not a signatory to the protocol, it could be persuaded to invest in these projects as a trial participation in the carbon markets. Lastly, these projects could also attract investors from other carbon funds, project developers and buyers in the voluntary carbon market, including those from Indonesia and Malaysia. Although these countries currently have no Kyoto commitments, they have an interest in reducing haze pollution. If the projects succeed in reducing haze events, the cost avoidance of haze impacts could be quantified and resonate with governments and investors.

6. Strengthened law enforcement and oversight

The successful implementation of the policies aforementioned demands adequate monitoring, enforcement and tax collection practices, so these capabilities need to be strengthened and their costs factored into the policies. Without proper enforcement, companies and local communities could easily violate the fire restrictions, evade taxes, receive tax deductions or payments when they are not entitled to and undermine the credibility of the government. Appropriate oversight of the ASEAN Transboundary Haze Pollution Control Fund and the Haze Disaster Emergency Fund is also essential to guarantee an appropriate use of the money.

Moreover, there are crimes such as illegal logging, wildlife poaching and open-air burning that need to be combated severely as monetary incentives alone cannot prevent these activities. The report to UNEP about illegal logging, fire and palm oil in Indonesia's national parks (Nellemann et al., 2007) concluded that encroachment into protected areas will continue if police activity and prosecution are not stepped up. The report ranked increased law enforcement as the highest impact policy measure that could be established. Gouyin and Simorangkir (2002) and Tacconi (2003) indicate the need for a credible sanctions system, particularly for unlawful uses of fire by companies.

There is thus a need for an increased budget for law enforcement of environmental crime. Although some donors may give money to reinforce these activities, it is important to have a reliable internal funding source. The Forest Conservation and Haze Prevention Tax could bridge that gap by providing dedicated revenue for environmental law enforcement. In addition, law

enforcement can procure its own internal financing, by instituting and collecting fines and penalties to companies and individuals that violate the law. In Malaysia, for instance, fines for open air burning are of up to US$190,000 with up to 5 years in prison (Gouyon and Simorangkir, 2002). This level of stringency may be too severe, but both sources of funds can be used to employ and train more officers and increase their pay to diminish incentives for bribery and corruption. Indonesia requires numerous additional forest and customs inspectors, park rangers, environmental police, remote sensing and intelligence analysts, among others. Park rangers are reportedly helpless against well-armed bands of illegal loggers that encroach into protected areas, so the support of the military and police forces in controlling these activities is necessary (Nellemann, 2007). Uryu et al. (2008) show that law enforcement works: the rate of deforestation in Riau decreased sharply in 2007 after the police investigated illegal logging by the pulp and paper industry.

Following the forest fires of 1997 and 1998 and in the context of democracy after Suharto, Indonesia has issued numerous regulations and laws regarding decentralization between levels of government, forest governance, forest fire management, disaster mitigation, land use planning, and REDD. The governance picture is still in flux, so it is important to improve coordination and cooperation among levels of governments and ministries and resolve problems of overlapping jurisdictions and conflicting mandates. This can be facilitated if the central government projects an unequivocal vision for sustainability, with a strong commitment to stop forest conversions, steer palm oil and timber to sustainable practices, incentivize farmers into protecting ecosystem services and prevent forest fires and haze, with appropriate funding for each of these tasks. The possibility of receiving funding for REDD in the near future is an important opportunity to galvanize the government into adopting such a vision.

6. Conclusions

The environmental and economic costs from deforestation, greenhouse gas emissions, fires and haze in Indonesia are enormous for the country, the ASEAN region and the entire world. Although the 1997 and 1998 fires and haze prompted numerous policy responses and initiatives, these have not been sufficient to respond to the problem as they have not modified, to the extent and scale needed, the economic imperatives and incentives to clear forests and use fire. On the other hand, some promising initiatives like REDD haven't been formalized yet, while others like RUPES and RSPO certification need to be scaled up. Furthermore, the government still lacks sufficient resources to combat the problems and is hampered in its environmental law enforcement capacity, which limits the effectiveness of regulatory measures. Moreover, haze and fire do not affect the main population centers of Jakarta and Java significantly, so the issue wanes in the media cycle for Indonesia, and yet it remains salient for Singapore, Malaysia and Brunei.

With the understanding of the economic drivers of deforestation, fires and haze in Indonesia, there is evidence of abundant market failures, misalignment of incentives, and a lack of internalization of the costs of forest destruction and of the benefits of the ecosystem services of rainforests. The misalignment of incentives not only occurs among palm oil and timber companies, but also among farmers, smallholders and government entities.

At the international level, a similar misalignment of incentives exists. Singapore and Brunei are mostly the victims of haze pollution generated in Indonesia and rightly demand that Indonesia attend to the problem. Malaysia is in the interesting position of being primarily a victim, but to some degree a sponsor of land clearing as many Malaysian companies operate plantations in Indonesia. For Indonesia, the costs of haze, including those of strained international relations, are somewhat offset by the benefits derived from land clearing. The global international community, preoccupied about biodiversity loss and greenhouse gas emissions from deforestation in Indonesia, has the incentive to protect the forests, but Indonesia has the incentive to convert large extents to palm oil and timber so long as it does not receive monetary benefits from leaving the forest standing for carbon storage and biodiversity habitat.

The policy framework proposed attempts to turn the links between deforestation, fires, haze and greenhouse gas emissions into a powerful set of imperatives for forest conservation and sustainable management of forests, plantations and peatlands. The tax on palm oil and timber provides a disincentive for unsustainable practices and gives deductions for RSPO certified palm Oil and FSC certified forestry operations, boosting sustainable production. The tax also generates revenue, which can be used for investments in fire management capacity, rewards for ecosystem services, a haze emergency fund and increased law enforcement. Fire management capacity needs major investments and improvements to address the increased fire hazard that Indonesian forests and peatlands are exposed to. Rewards for Ecosystem Services bring smallholders and rural communities into the equation, providing valuable incentives for conserving forests and having integrated fire management. Increased law enforcement is necessary to combat illegal logging, encroachment into protected areas, tax evasion and violation of fire regulations, and without it the incentive policies may not work.

With respect to transboundary haze pollution, there is a need for improved reciprocal incentives within the ASEAN THA, where the demands for haze prevention and compensation of the damages incurred are recognized, but where Indonesia does not carry the full burden of preventing haze. The establishment of the Haze Emergency Fund and the investments in REDD projects in peat areas serve that purpose. The fund provides some level of damage compensation for haze-affected countries whereas REDD projects present investment opportunities for Singapore, Brunei, Malaysia and other countries, with expected returns of avoided economic and health damages, in addition to GHG emission reductions. The funding that Indonesia could obtain with these mechanisms could prompt Jakarta to reexamine its non-ratification of the ASEAN THA.

REDD investments in peat areas and RES for communities for sustainable forest management are the most appealing and non-controversial of the proposed instruments in terms of political feasibility and effectiveness. However, REDD funding is not yet guaranteed, so Indonesia should keep other options open to finance economic incentives. Thus, an environmental tax on oil palm and timber should not be dismissed, as it is a transparent alternative to raise sufficient dedicated revenue and it can be designed in a way that does not have negative competitiveness effects for the industries. If there is enough political will to overcome the obstacles to establish a tax, there is enough justification for investment its revenue in enhanced fire management, emergency funds for haze events and law enforcement. These investments, although necessary, do not seem plausible unless there is additional dedicated revenue for them.

In anticipation of the decision on REDD in Copenhagen in December 2009, Indonesia needs to align its policies to make best use of the scheme and sharply reverse the trends in forest loss and reduce forest fires and haze. It is hoped that some of the ideas presented here will be taken forward and improved for this purpose.

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