Ecosystem Services of Southeast Asia: Major Threats and Opportunities

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Executive Summary

- There are major external pressures driving the degradation of the forest resources of Southeast Asia, namely: **rapid population and economic growth**. This has been accomplished through exploitation of the region's **rich mineral, petroleum and forest resources and a favourable climate for agricultural commodity production, such as oil palm, rubber and coffee.**

- There is still uncertainty as to what fraction of **global emissions from land use change** can be attributed to Southeast Asia, but estimates range from **25-31 percent**.

- **Modelling of business as usual deforestation** between 1980 and 2050 in Southeast Asia (including all ASEAN countries) **predicts total conversion of natural forest** to agricultural land, forest plantation and other non-forested uses **before 2050**.

- In Indonesia, nationally endorsed development plans drove deforestation rates to increase from **0.6 mha/year to 1.6 mha/year in just two decades.**

- Illegal logging remains a major challenge for the Indonesian government, with an estimate of the economic loss being **US$4 billion** annually. This activity is occurring in all manner of forest areas, even national parks

- Some illegal timber is smuggled from Indonesia across the Malaysian border as well. The scale of this can be estimated by Malaysia's annual processing capacity of **40 million m^3/year compared to an annual timber production of 22 million m^3/year.**

- Forest governance in Malaysia appears to be among the most robust of the region; however there are still cases of logging concessions provided as political favours.

- PNG's economy is **dominated by its mining sector** with the financial returns of logging seemingly unsustainable, with an average log price of US$60 per cubic meter (US$23 below production costs) in 2005. **Although the PNG government still realises annual revenues of US$30 million from the sector from a direct tax on log exports.**

- One example of an integrated conservation and development project in the region is an effort by the Grand Perfect timber consortium, called the Planted Forests Project. This project will combine several types of land use in one **490,000 ha** area, including: **conservation, timber plantation and community subsistence**.

- In terms of ecosystem services for the region, little is understood of the contribution of the region's forest to the global hydrologic cycle due to its maritime environment and influence by a series of monsoons. Significant research has been performed on its carbon emissions from land use (including peat drainage) and air pollution from out of control forest fires. Finally, the richness of

biodiversity in this region is recognised though not known fully, although the question remains how to begin to quantify its value.

- Carbon emissions from, Malaysia and Indonesia were estimated to have released **309.9 Tg C**[1] from land cover change, compared to 465.1 Tg C for all ASEAN countries. In addition, carbon densities in Indonesia have been shown to be decreasing due to increasing rates of degradation severely impacting its forests' ability to store carbon in the future.

- Southeast Asia is home to the majority of global peatland, though across the tropics, **70 Pg C** in total is estimated to be stored in these soils. This constitutes **two percent** of carbon stored in soils globally and **20 percent** of carbon found in peat soils worldwide.

- In a study by Hirano et al (2007) of gas exchange over a **drained peatland**, these areas were found to be a significant net source of carbon to the atmosphere; on the order of **0.6 kg C/m^2/year** to **0.31 kg C/m^2/year**. The high end in the range of values was due to an ENSO event.

- The Global Fire Partnership estimates that **1,400 Mt C** are released each year by forest fires in Indonesia, which are becoming more frequent as degraded forests are increasingly susceptible to ENSO drought events.

- During the 1997-98 El Nino season, large-scale forest fires in Indonesia burned **11.6 mha** and released **1.45 Gt C**, valued at **US$3.6 billion** on the current carbon market. The costs of this fire for regional economic activity were initially estimated to be **US$4.5 billion**, though revised estimates put the number closer to **US$2.3 billion**.

- Southeast Asia houses four of the world's 25 biodiversity hotspots, due to its high incidence of endemism, as well as being the home of the endangered orang utan, Sumatran tiger, elephant and rhinoceros.

- In an ecosystem service valuation exercise for Leuser National Park, Indonesia, calculations for total economic valuation were made for three scenarios: deforestation (business as usual), conservation and selective use. The relative values found to be in the deforestation scenario were **US$7.0 billion,** in the conservation scenario **US$9.5 billion** and the selective use scenario **US$9.1 billion** over a 30-year time frame.

Conclusions: There is scope for determining ecosystem services for this region; although the most obvious issue to address is carbon emission from land use change and peatland drainage. More research is needed regarding the contribution of the region's forests to local and global precipitation and the importance of its biodiversity for its forests' functional integrity.

[1] Estimated from an assumed average carbon stock of 200 MgC/ha for Asian moist tropical forest taken from Houghton and Hackler (1999).

Figure 1 Political map of Southeast Asia showing Malaysia, Indonesia and Papua New Guinea

Introduction: Natural Resources and Land Use Change in Southeast Asia

There are major external pressures driving the degradation of the forest resources of Southeast Asia. Rapid population and economic growth, estimated at 2.3 percent/year and 4-7 percent/year respectively, are cited as drivers of deforestation in ASEAN[2] countries ((WB) 2002). The region is rich in mineral, petroleum and forest resources as well as having a favourable climate for agricultural commodity production (e.g. oil palm, rubber, coffee etc.)

Indonesia is a nation of 17,508 islands (only 6,000 inhabited) with a total land area of 1.9 million km^2. It is home to ten percent of the world's tropical rainforest. Four thousand tree species have been identified of which only 120 are commercially viable. Oil, gas and agricultural commodities, including forestry, are the country's major exports contributing the most to GDP.

Malaysia consists of eleven states situated on Peninsular Malaysia and two on the island of Borneo (Sabah and Sarawak). The economy of Malaysia is most dependent

[2] Associate of Southeast Asian Nations (ASEAN) is comprised of Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. Note: Papua New Guinea is not included in these statistics.

on industrial exports; although agricultural commodities constitute about 8 percent of GDP (e.g. palm oil, rubber, timber etc). About 80 percent of their forest is Dipterocarp with Sarawak being the major forest producing state. In addition to commercial logging, Malaysia's forests also suffer pressure due to fuelwood needs (Hammonds 1997).

Papua New Guinea shares its landmass with Indonesia's eastern most state, Papua and is located 150 km north of Australia. Mineral extraction, including oil and gas, constitute 70 percent of national exports, 30 percent of government tax revenue and 25 percent of GDP. For 2004, the mineral sector was responsible for 53 percent of total exports (Tologo 2006). Hence, forestry is not the most significant export revenue, being the third agricultural export after oil palm and coffee ((FT) 2006). In contrast to Indonesia and Malaysia described above, PNG's forests are extremely diverse with few commercially profitable tree species[3]; nevertheless it is one of the four main suppliers of tropical timber in the region.

Land use change over the last few centuries has resulted in significant carbon emissions with 33 percent of global CO_2 emissions from 1850-1998 being from forested land. Southeast Asia has undergone dramatic shifts in land use over the last three centuries, with total agricultural land increasing by 1,275 percent between 1700-1980 (Meyer 1996). Even more rapid change has occurred since 1980. In fact, historic and current land use changes in Southeast Asia appear to dominate its impact as a net source of a carbon. The process-based Terrestrial Ecosystem Model (TEM) estimated that between 1860 and 1990, Southeast Asia released **18.1 Pg C**, about 60 percent of carbon emission for the whole region (29.0 PgC) during that era (Tian et al. 2003). There is still uncertainty as to what fraction of global emissions from land use change can be attributed to Southeast Asia with estimates of **25-31 percent** (Esser 1995, Houghton and Hackler 1999). Also, the influence of CO_2 fertilisation and climate variability appear to be a significant factor in the region's carbon emissions, with net carbon exchange (NCE) oscillating considerably from year to year (Tian et al. 2003). Modelling of business as usual deforestation between 1980 and 2050 in Southeast Asia (including all ASEAN countries) predicts total conversion of natural forest to agricultural land, forest plantation and other non-forested uses before 2050, which would have serious implications for regional carbon emissions (Phat et al. 2004).

Forest Governance and Major Threats

Indonesia

All natural forests in Indonesia's territories are owned by the national government, which has the power to issue either temporary (20-25 year) concessions or permanent rights to companies. Generally local communities, otherwise dependent on these areas, have been allowed little input in this process. Before the end of President Suharto's 30-year reign, Indonesia established a National Forest Action Plan (NFAP) that provided a number of targets for a more sustainable forestry sector. One such

[3] It is estimated to house " 5 percent of the world's biodiversity on only 1 percent of its land area" (Sekhran 1996).

target was to increase the forestry sector's use of timber harvested from industrial tree estates (HTI) instead of natural forest, with a goal of fifty percent of timber extraction to be from natural forests by 2020 (Hammonds 1997). This target is far from being met; with land use change decisions appearing to be more influenced by a Ministerial decree from 1981. This policy designated 20-30 mha of forestland to be "Conversion Forests", which effectively encouraged several decades of rapid land use change starting in the mid-1980s. The policy was supportive of the establishment of large-scale timber and oil palm plantations as well as transmigration settlements. In this period, deforestation rates increased from **0.6 mha/year to 1.6 mha/year** in just two decades (MoFEC 1997). The one mha 'Mega Rice Project' began in 1995 and entailed draining a huge swath of peatland for rice cultivation. This project was later abandoned following its large-scale burning during the 1997-98 fires (Murdiyarso and Adiningsih 2007).

In general, since the shift from President Suharto's New Order policies the country's governance has shifted to a system of decentralisation. This transition saw an increase in forestry related conflicts most often to do with land rights and compensation payments. While the total number of violent conflicts appear to have subsided since the years 2000-2003, recommendations from a study done by the Centre for International Forestry Research (CIFOR) and the Forest Watch Institute (FWI) suggest that an improved means of mediation between forest users and a more reliable compensation system should be put in place (Wulan et al. 2004). With land not always being acquired transparently, setting fires has been used as a means of voicing displeasure over land disputes (Murdiyarso and Adiningsih 2007).

There continues to be great debate concerning who are the major agents of deforestation in Indonesia. Blame has been placed heavily on smallholder slash and burn agriculturalists or on large-scale government development projects, timber companies and *forest frontier farming*[4]. Basically, there is no consensus as to who is responsible because there has yet to be a formal survey made of agricultural practices and the relative number of actors in each category (Sunderlin 1997). Even the term *smallholder conversion* is problematic, as Dick (1991) noted it was being used interchangeably for small-scale *traditional shifting cultivation* (considered less destructive) and resettling migrants, characterised by larger-scale and shorter fallow rotations.

Illegal logging is rampant in Indonesia. The government estimates the economic loss due to illegal logging at **US$4 billion** annually (EIA and Telapak 2007). This logging is occurring in all manner of forest areas, even national parks. For instance, lowland forest in Protected Areas of Kalimantan (Indonesian Borneo) have undergone severe deforestation between 1985 and 2002, estimated at 56 percent (Curran et al. 2004). Also, a recent report commissioned by the United Nations Environment Programme stated that 37 out of 41 national parks in Indonesia were victim to illegal logging (Nellemann et al. 2007). While the Indonesian government struggles with curbing this problem, some illegal timber is smuggled across the Malaysian border as well. The scale of this can be estimated by Malaysia's annual processing capacity of 40 million m^3/year compared to an annual timber production of 22 million m^3/year (Valentinus and Doherty 2005).

[4] This can also be described as industrial agriculture and large-scale timber production.

Papua is home to the remaining frontier forest of Indonesia and Southeast Asia; however its forests are being plundered illegally as well. President Yudhoyono has responded with military action and issued a Presidential Instruction on the Eradication of Illegal Logging (Inpres) for coordination between 18 government agencies to address this problem. The initial results of these efforts have showed some slowing down of wood processing in states of Indonesia, Malaysia and China, which are having greater difficulty sourcing cheap logs; although neither endeavour has targeted the high-level perpetrators of this logging via criminal trials (EIA and Telapak 2007).

Malaysia

Malaysian forest governance must be considered within its National Vision 2020, a strategy for attaining greater industrialisation, which includes improved economic development of the indigenous. In 1991, Malaysia released a New Development Policy, under which successive Industrial Master Plans (IMPs) have been published every ten years. In terms of agriculture, previous IMPs have outlined the necessity to increase value-added processing for the export of wood-based products in addition to providing raw timber materials at a competitive price. The dominant policy on forests is called the National Forestry Policy (NFP); though mainly the states of Peninsular Malaysia are within its remit. Sabah and Sarawak have their own forest policies, modelled after the NFP (Traffic 2004).

Under the Federal Constitution each state has authority over its own territorial forest. The Federal Government only has the power to provide technical assistance, research and advice. Its administrative authority extends to trade policies, including regulation of imports and exports (JOANGOHutan 2006). Permanent Forest Estates (PFE) are designated by each state and can be classified as Permanent Reserved Forests (PRF). These are further assigned a degree of protection including: national and state parks or wildlife sanctuaries where commercial logging is strictly forbidden (Traffic 2004).

The Forestry Department of Peninsular Malaysia, the Forest Research Institute Malaysia (FRIM) (both under the Ministry of Natural Resources and Environment (MNRE)) and the Malaysian Timber Industry Board (MTIB) (under the Ministry of Plantation Industries and Commodities (MPIC)) administer the NFP in Peninsular Malaysia. The Sabah Forestry Department manages its state's forestry and performs its own forestry research, while the MTIB still has jurisdiction over Sabah's downstream timber industry. Sarawak's forests are managed by the Sarawak Forestry Corporation (SFC), including its conservation, within which research is undertaken by the Applied Forest Science Unit. In addition, there are national policies on biodiversity (1998), environment, conservation and agriculture. Most of these policies are more concerned with land use planning than forest management, except for the Environmental Quality Act of 1974 (Traffic 2004).

The definition of illegal logging for state governments relates to the granting of official permission and rent payment. The forest resources are treated as the property of each state, therefore permits require extraction companies to develop plans for long-term forest management units (FMUs)[5], reduced impact logging (RIL), cutting limits, log tracking from harvesting to the mill and locally beneficial road building.

[5] Under SFM guidelines, FMUs are expected to set aside some portion of their land for community use.

Apparently, only Sabah includes all of these under Sustainable Forest Management Licence Agreements (SFMLA), which can be revoked if not followed (Traffic 2004). Despite a federal policy to improve the economic livelihood of the indigenous (a.k.a. Orang Asli) and the recognition of their right to access forests for their subsistence, these groups are rarely approached or informed of awarded logging permits in their lands; sometimes with violent consequences. (JOANGOHutan 2006).

Malaysia has also been active in certification of sustainable forest management, by developing criteria and indicators based on the guidelines endorsed by the ITTO for the Malaysian Timber Certification Council (MTCC) (Traffic 2004). This scheme has had some difficulty getting off the ground as its proponents struggle with indigenous groups recalcitrance to cooperate due to lack of trust. Also, it has yet to be recognised internationally to the same degree as the Forestry Stewardship Council (FSC) certification scheme. Nevertheless, it is evidence of the domestic industry's attempt to spearhead environmentally sustainable reforms of the sector (Shahwahid 2004).

Forest governance in Malaysia appears to be among the most robust of the region; however through researching logging permits in Sabah and Sarawak, Ross came across the practice of selling discounted logging concessions by politicians to family members (Ross 2001). Further he found in Sabah that logging concessions were awarded in exchange for political support during elections (JOANGOHutan 2006). Malaysia has also come under fire for the alleged smuggling of Indonesian timber across its borders, in spite of an Indonesian government ban of log exports (Traffic 2004).

Papua New Guinea

The forestry sector in PNG has little to no forest plantation with most activity involving harvesting of natural forest resources. The main timber extraction companies are Malaysian, with un-processed logs shipped to Japan, Korea and China. There is little to no timber processing in PNG itself ((FT) 2006). The financial returns of logging in PNG do not appear to be sustainable, with an average log price of US$60 per cubic meter (US$23 below production costs) in 2005. Although somehow the PNG government is realising annual revenues of US$30 million from the sector through a tax directly on log exports, none of which appears to be reinvested in the affected communities ((FT) 2006).

Almost all of the forested land in PNG is recognised by customary rights and are not implicitly government property; therefore companies interested in attaining concessions to log must negotiate with local communities directly (Hammonds 1997). While ministers within the government claim that there is no illegal logging in the country, a recent thorough review of the sector, commissioned by the government, shows little compliance with national forestry regulations. In fact, in a subsequent report published by Forest Trends, almost all logging activities were found to be illegal because they did not: adequately benefit land-owners, positively impact local living standards, generate revenue for the government to improve public services, have a system of permits or licenses regulated by the government, exhibit any intention to maintain sustainable timber yields and have transparent profit reporting (according to official figures the logging sector posted a financial loss of US$25 million in 2005) ((FT) 2006). Even though the PNG government was supportive of this extensive legal review of the sector, it has not exhibited political will to address

the problem.

Types and Values of Different Land Uses by Country

Table 1 below outlines the extent and per hectare returns of various forest types in Indonesia, Malaysia and Papua New Guinea. However the distribution of these economic returns is not equal. In the case of Malaysia, the poorest in the country are those dependent on forests, indicating the profits of this sector are remaining in the hands of elites (JOANGOHutan 2006).

Table 2 presents a brief look at the major exports contributing to each country's GDP, where possible their respective land extent is presented in terms of percent of total land area. As these numbers were derived from several different sources, there are some obvious discrepancies. You can see from these tables what a difference in contribution timber, palm oil, rubber and mining make. Papua New Guinea is clearly more dependent on its precious metals than its forestry, whereas figures reported for Indonesia indicate a much smaller contribution to GDP from timber than would be expected.

Table 1 Percent land cover (%ha) of different forest types, 2000-2005. Unless indicated, source is FAO's Forest Resource Assessment (2005).

Land Use	Indonesia**	Malaysia	PNG
	%ha	%ha	%ha
Forest (% of total land area)	**48.8% (88.5 mha, 4% primary)**	**63.6% (20.8 mha)**	**65.0% (29.4 mha)**
Protected/Conservation Forest (% of total forest area)	**46.1% (40.8 mha)**	**23.6% (4.9 mha)**	**4.6% (1.35 mha)**
Forestry Stewardship Council Certified Forest (% of total forest area)†	**0.4% (0.739 mha, 5 projects)**	**0.22% (0.072 mha, 3 projects)**	**0.04% (0.019 mha, 1 project)**
Logging Concessions (% of total forest area)	**53% US$24/ha**	**56.6% (11.8 mha) US$103/ha**	**24.8% (7.3 mha) US$22/ha***
Total Growing Stock in forest and other wooded land (m^3/ha)	**59**	**251**	**35**
Annual rate of change in growing stock 2000-2005 (m^3/ha/yr)	**-4.6**	**1.94**	**-0.01**
Total Above Ground Biomass in Forest (tonnes) 50%= carbon stock	**8,867**	**5,661**	**No information**
Rate of Deforestation (2000-2005) (mha/yr) (%loss)	**-1.87 -2%**	**-0.14 -0.7%**	**-0.139 -0.5%**

*Extremely speculative, due to lack of reliable information. No data from FRA (2005).
**Noted by FRA (2005) as having poor reporting reliability of logging economic returns.
† FSC 2007

Table 2 Contributions of Major National Exports to GDP. Unless indicated, from FAO Country Commodity Profiles

Land Use	Indonesia		Malaysia		PNG	
	%GDP	Land cover	%GDP	Land cover	%GDP	Land cover
Agricultural Commodity Production‡: (For domestic consumption and export)	**13.4% (2005)** (GDP US$287.2 billion, 5.6% growth)	**26.4% (2005)**	**8.7% (2005)** (GDP US$130.3 billion, 5.2% growth)	**~24% (2000)**	**38% GDP** (GDP US$4.94 billion, 3.7% growth) (2005) [o]	**7%**
Rubber	**0.77%** (US$2.2 billion)		**1%** (US$1.3 billion)		**0.09%** (US$4.3 million)	
Palm oil	**1.2%** (US$3.94 billion)	**1.9%*** 3.5 mha	**4.6%** (US$5.95 billion)	**10.3%*** 3.37 mha	**3.1%** (US$152.2 million)	**1.6%*** 0.73 mha
Coffee	**0.1%** (US$283 million)		**0.05%** (US$69 million)		**1.8%** (US$88.1 million)	
Cocoa	**0.1%** (US$369 million)		**0.3%** (US$333 million)		(US$67 million)	
Timber	**0.7%** (US$2.2 billion)	**53%**	**6%** (US$8.1 billion)[+]	**56.6%** (11.8 mha)	**2%** (US$106.2 million)[++]	**24.8%** (7.3 mha)
Mineral and Petroleum‡: (Industry)	**45.8% (2005)** (Oil and gas exports US$19.2 billion) [1.4% of global daily production]		**51.8% (2005)**		**25% of GDP (2005)**	

‡ World Bank Country Statistics 2007
[o] US State Dept
[+]JOANGOHutan 2006
[++]Forest Trends 2006
*FOE (2005)

Key Agents and Activities in the Region

There are several NGOs, IGOs as well as national and international aid agencies working in the region. An attempt at a comprehensive list is provided by country in the **Appendix**, though the bias would be to groups that either have a website or have collaborated on electronically produced reports.

In Bogor, Indonesia, the Center for International Forest Research (CIFOR) is part of the CGIAR family and performs significant research in the region with programmes on payment for environmental services (PES), carbon forestry (CarboFor) and forests that benefit the poor. They have produced numerous reports themselves and provide access to valuable research on Southeast Asian forests on their website. The Forest Research Institute of Malaysia (FRIM), administered by the Ministry of Natural Resources and the Environment, provides invaluable research on biodiversity, climate, forests and forest governance. Telapak and the Environmental Investigation Agency (EIA) have collaborated on several revealing reports regarding illegal logging and forest governance in the region, as has the EU based NGO FERN. WALHI is Indonesia's largest environmental NGO, which is affiliated with Friends of the Earth, dealing with a range of campaigns including water use, improved natural resource use and energy use. Several groups are involved with endorsing sustainable forest management across the region, including: the Tropical Forest Foundation (TFF), the Tropical Forest Trust (TFT) and the Conservation Training and Resource Center (CTRC)[6].

As will be discussed further later, there is a great deal of concern regarding forest fires in the region, particularly in Indonesia. As a result, collaborative projects like the Global Fire Partnership have emerged, which includes the Nature Conservancy, UC Berkeley's Center for Fire Research and Outreach, IUCN and WWF. Their efforts are following significant investment by the World Bank, USAID, the International Timber Trade Organisation (ITTO) and the Asian Development Bank (ADB) to help develop more sustainable use of fire for land management. Some of the groups concerned with addressing indigenous rights include Greenpeace's program on 'Paradise Forests', Sawit Watch (who follow oil palm expansion), Down to Earth (DTE), Indigenous Peoples Development Centre (IPDC), Partners of Community Organisations (PACOS), Foundation for People and Community Development (FPCD), Borneo Resources Institute of Malaysia (BRIMAS) and Village Development Trust (VDT) based in PNG.

Recent innovative efforts for multiple land use include one by Grand Perfect timber consortium. This endeavour, called the Planted Forests Project, will combine several types of land use in one 490,000 ha area. Roughly one half of this will be a dedicated *Acacia mangium* plantation, one third will remain a conservation area and the remainder will be left for indigenous use (Cyranoski 2007). This model has been attempted in the Amazon, but with little success; however it could be a new approach for Integrated Conservation Development Projects (ICADPs) as suggested by Sekhran

[6] The CTRC was formed under the auspices of Conservation International (CI), the Institut Pertanian Bogor (Agricultural University), The Nature Conservancy and the World Wildlife Fund for Nature (WWF).

(1996) for PNG. In his view, ICADPs can be divided into the following categories: timber extraction, ecotourism, crop production and payments for ecosystem services (PES). ICADPs would be a means of attempting to more equitably divide the economic benefits of resource exploitation with the local community while beginning to consider the long-term *sustainability* implications of these industries. This may include a method of zoning whereby ecologically fragile or valuable ecosystems can remain intact while neighbouring areas can be designated for multiple uses. By coordinating this effort with the local communities, one would hope, more equitable land use decisions would be made as well as guaranteeing certain areas will remain under protection; ideally under the auspices of the partner timber company.

Discussion: Ecosystem Services

According to the Millennium Ecosystem Assessment (MA), ecosystem services are defined as the "benefits people obtain from ecosystems." The MA divides these services into four categories: provisioning, regulating, supporting and cultural ((MA) 2003). Provisioning services ensure availability of freshwater and food; regulating services involve flood, drought, erosion and disease control; supporting services include nutrient cycling and soil generation; and finally cultural services enhance aesthetic and spiritual uses of nature. Land use change, particularly due to resource extraction, in Southeast Asia has been attributed the detrimental impacts on the region's ecosystems services. In general, activities significantly changing local land-cover affect biogeochemical and biophysical factors (references from (Feddema et al. 2005). This report will attempt to quantify some of the larger-scale provisioning, regulating and supporting services provided by the region. This will include the *intrinsic* value of an intact ecosystem, e.g. forest, focusing on their importance for global temperature and precipitation regulation: both of which have serious ramifications for the global economy.

Degradation of these services is mainly attributed to humans' increasing demand on ecosystems and climate change: the major drivers of which in Southeast Asia have been described in the sections above. With projected population and global economic growth, demand is expected to increase on these resources; hence the importance of attributing some economic value to intact resources in order to provide incentives for their protection. Many of the region's ecosystem services remain poorly understood, especially regarding their influence on global biogeochemical cycles; therefore some discussion of them will be provided as well as the scope for further research. The highlighted ecosystem services to be described include examples of provisioning services (contributions to the global hydrologic cycle), regulating services (carbon storage of the region's forest and peatlands, as well as benefits from avoided haze from forest fires) and supporting services (regional biodiversity).

Global Hydrologic Cycle (e.g. the Asian Monsoon)

Natural forest contributions to the hydrological cycle are a popular biogeochemical feedback for scientific research, although they are largely complex and poorly understood (Balmford and Bond 2005). In the case of Southeast Asia, this research is seriously complicated by the marine climate and monsoon influenced precipitation patterns. The tropical lowland rainforests of Borneo (Indonesia and Malaysia) exhibit larger rates of evapotranspiration rates of any other tropical forest, due to its aseasonal climate punctuated only by irregular dry spells. The maritime climate of the Southeast Asian archipelago is influenced by the monsoons in the summer over the Indian Ocean, the winter over the Pacific Ocean and South China Sea, the Madden and Julian Oscillation (MJO)[7] and intermittent ENSO events. Significantly more research has been performed on gas exchange over the Amazon Basin than Southeast Asian rainforests; hence not as much is understood of their role in the global hydrologic cycle (Kumagai et al. 2005).

In order to look at the extreme case of land cover change for the region, i.e. all tropical forest being converted to grassland and shrubland, Werth and Avissar (2005) used the NASA-GISS Model II global circulation model (GCM). Under such extreme conditions, local precipitation is reduced only slightly, which is less severe than the same simulation performed over the Amazon and Congo Basins. Atmospheric "teleconnections" become evident once 66-100 percent of Southeast Asia's forests are "removed" linking this region to the precipitation and atmospheric pressure values in Hawaii, the Pacific Northwest of the United States and Southern Europe. There is some uncertainty in these results as assumptions are that modes of deforestation are distributed evenly throughout the region. The idea of atmospheric teleconnections in this case are difficult to understand without first discussing some of the aspects of the Asian Monsoon dominating weather patterns in this region.

First, there is a much larger area affected by these weather patterns termed *monsoon Asia*. This land mass is affected by seasonal changes in wind patterns, which dominate the regional climate. The total land area comprises roughly 16 percent of the earth's surface, including China, the Indian subcontinent and Southeast Asia and is home to more than 50 percent of the global population. The area covers a range of ecosystems from tropical forests to deserts and tundra in Northern Asia (Tian et al. 2003). These ecosystems are responsible for approximately 20 percent of global terrestrial net primary productivity and global carbon storage (Melillo et al. 1993, McGuire et al. 2001). The Asian summer monsoon has been classified into three separate monsoon cycles, which have some influence over each other, namely: the Indian Summer Monsoon, the western North Pacific summer monsoon (WNPSM) and the East Asian summer monsoon (EASM). The formation of these appears to originate over the South China Sea (SCS), close to Sumatra; however their propagation are quite complex to describe and may be more dependent on activity in the mid-latitudes, see (Yihui and Chan 2005) for a review.

[7] The Madden-Julian Oscillation refers to a 30-60 day *intra*-seasonal monsoon fluctuation, which in some years is capable of initiating the Asian summer monsoon (Yihui and Chan 2005).

Fundamentally, the summer monsoon cycle is driven by a land and ocean temperature gradient, often decided by the temperature over the Tibetan Plateau; though the SCS has an area known as the *Warm Pool* (a body of water near the Philippines) whose temperature has an indirect effect on summer monsoon precipitation. Findings by Li and Zhang (1999) and Lau and Weng (2002) suggest that the influence of this Warm Pool may actually extend from China to Korea, Japan and possibly North America. Concerns are being raised as the temperature of the oceans continue to rise, which could further enhance the existing interdecadal variation in the East Asian Monsoon (Yihui and Chan 2005). The occurrence of ENSO events and their intensities are also important to consider for precipitation patterns in this region. Juneng and Tanang (2005) provide an empirical review of the Southeast Asia rainfall (SEAR) anomalies and how they may be impacted by sea surface temperature (SST) anomalies.

Feddema et al (2005) ran a number of region-specific simulations to assess the feedback of biosphere-atmosphere interactions using IPCC atmospheric scenarios B1 and A2. While conversion from rainforest to agriculture exhibited the greatest climatic impact in the Amazon, Indonesia showed little change in its diurnal temperature range (DTR). Instead the Asian Monsoon appeared to be influenced more by land-cover changes in East Africa, Australia and southern and eastern Asia (Feddema et al. 2005). Finally, the Asian Monsoon is shown actually to compensate for land cover forcings in Indonesia by maintaining precipitation levels in spite of local deforestation. The B1 scenario (with greater global reforestation) shows a warmer and dryer climate for India, Africa and northern Australia as well as potentially impacting the North Atlantic Oscillation (NAO). For the A2 scenario, tropical deforestation will enfeeble the Hadley circulation, increase the temperature and cloud cover above the Indian Ocean and thereby negatively impact the Asian Monsoon. See Feddema et al (2005) for a more complete description.

Carbon Storage and Peatlands

Significant volumes of carbon are stored in Southeast Asia's forests, soils and peatlands, which are being rapidly released through unchecked land use changes and resource extraction. For example between 1990 and 2000, Malaysia and Indonesia were estimated to have released **309.9 Tg C**[8] from land cover change, compared to 465.1 Tg C for all ASEAN countries (Phat et al. 2004). A survey of land cover types in Sumatra found a range of above ground carbon densities to be between **39 Mg/ha** (degraded grassland) and **254 Mg C/ha** (primary forest) (Mudiyarso et al. 2002). These measurements could change in the future as carbon densities in Indonesia have been shown to be decreasing due to degradation ((FAO) 2005). Also, carbon stock capacity of forests has been cited as a climate change mitigation strategy; although it is not yet clear how impacted forests in Southeast Asia will be in a changing climate regime.

Tropical peatlands are highly acidified soils, which store immense amounts of carbon and organic matter under anaerobic conditions. Drainage of peatland (i.e. for agriculture) exposes this organic matter to oxygen, thereby accelerating decomposition and carbon emissions. Southeast Asia is home to the majority of this

[8] Estimated from an assumed average carbon stock of 200 MgC/ha for Asian moist tropical forest taken from Houghton and Hackler (1999).

soil type, though across the tropics **70 Pg C** in total is estimated to be stored. This constitutes 2 percent of carbon stored in soils globally (Sabine et al. 2004) and 20 percent of carbon found in peat soils worldwide (Hooijer et al. 2006) In a study by Hirano et al (2007) of gas exchange over a drained peatland in Kalimantan during the years 2002-2004, these areas were found to be a significant net source of carbon to the atmosphere; on the order of **0.6 kg C/m^2/year** to **0.31 kg C/m^2/year**. The high value in that range was due to an ENSO event in 2002, which was characterised by low precipitation and reduced solar radiation available for photosynthesis. This result implies a **net peat loss of 4.4-8.4 mm/year**, calculated from a peat carbon density of 71.5 kg C/m^3 (Shimada et al. 2003). The driving factor of this net loss of carbon was falling groundwater level, usually exacerbated by an ENSO drought event (Hirano et al. 2007).

Air Quality: Impacts of Haze from Forest Fires

It is difficult to discuss Southeast Asia and not consider the role of fire in land management. It is used for most methods of land clearance, large- and small-scale, and as mentioned earlier in land disputes. Some would argue the region's biota is well adapted to fire; however several decades of degradation are taking their toll making these ecosystems ever more vulnerable to out of control forest fires. In the case of Indonesia, large, uncontrolled fires have struck repeatedly over the last several decades, usually coinciding with an ENSO event. The Global Fire Partnership[i] estimates that **1,400 Mt C** are released each year by forest fires in Indonesia. Rainforests of Indonesian Borneo in the past have regenerated under ENSO events, with the intermittent droughts encouraging fruiting of the dominant lowland family *Dipterocarpaceae*. These fruiting events are important for both invertebrates and local indigenous communities. Subsequent to severe lowland forest degradation, ENSO events are quickly becoming destructive phenomena leading to drought and rampant wildfires (Curran et al. 2004).

After the destructive fires of the 1982-83 ENSO event, several intergovernmental bodies like the World Bank, the Asian Development Bank, USAID and the International Tropical Timber Organisation (ITTO), poured money into feasibility studies to address how the conditions for these fires could be avoided in future. In a report for the Overseas Development Institute (ODI), Byron and Shephard (1998) found these recommendations largely to be unheeded. So again over several months during the 1997-98 El Nino season, large-scale forest fires in Indonesia burned 11.6 mha (Tacconi 2003) and released **1.45 Gt C**, valued at **US$3.6 billion** on the current carbon market (Murdiyarso and Adiningsih 2007). The cost of this fire for regional economic activity was estimated to be US$4.5 billion, though revised estimates put the number closer to **US$2.3 billion** (Tacconi 2003). This included timber and non-timber products losses, public health costs, reduced agricultural productivity, industrial losses, and reduced revenues from tourism in addition to significant CO_2 emissions. Approximately 70 million people were affected with 12 million receiving medical attention (Schweithelm and Glover 1999).

A few decades of irresponsible logging practices placed Indonesia's forests in this vulnerable fire prone state. In addition, poor fire response and management during the break out of the 1997 fires further worsened the situation. The former claim was validated by a study of climate anomalies by Murdiyarso and Adiningsih (2007)

where the degree of the ENSO events during the 1982 and 1997 fires were compared. While the conditions during 1982 were far more extreme, only one third of the forest area that burned in 1997 was affected. Clearly, the increasing scale of these fires is not solely a result of climate forcing.

Air pollution from large-scale forest fires in this region also have affected the productive efficiency of the forests as the smoke interfered with intercepted solar radiation thereby reducing total photosynthetic activity (Schimel and Baker 2002, Hooijer et al. 2006). This could have serious ramifications for future uptake of carbon in this region's vegetation. Iron fertilisation of the coastal areas from the fires' smoke caused hyper anoxic zones or red tides, killing large tracts of coral reef and affecting surrounding fisheries (Abram et al. 2003). **Estimates of the damages to the fishing industry around Malaysia in 1997 were US$ 16.2 million** ((WWF) 1998).

Draining of peatland for cultivation both allows greater access for local human populations to practice slash and burn agriculture and makes available dry, flammable detritus for fires soon to burn out of control (Shlisky et al. 2007). The dry conditions during El Nino years further exacerbate this trend (Murdiyarso and Adiningsih 2007).

Finally, little research has been done on the concentrations of Trichloroacetic acid (TCA, CCl3COOH) and C2-chlorohydrocarbons tetrachloroethene (TECE, C2Cl4) and 1,1,1-trichloroethane (TCE, CCl3CH3), which oxidise to form TCA, in Southeast Asia. Both TCA and TECE are highly volatile, organic compounds, easily transported in the atmosphere and capable of reacting into different compounds of varying phytotoxicity. The effects of these chemicals on crops and natural vegetation are not known for sure, though TCA was an accepted herbicide in the 1950s. Concerns have been raised by Weissflog et al (2003) as the Southeast Asian region continues to industrialise, practice slash and burn agriculture and develop their metal and textile industries[9]. Most effects can be observed in local and regional vegetation; however the mechanisms by which they are transported globally are not yet fully understood. More research is needed to begin quantifying the impacts of these chemicals and their emissions in this region.

Biodiversity Benefits

Southeast Asia houses four of the world's 25 biodiversity hotspots, due to its high incidence of endemism (Myers et al. 2000) created by a unique geologic history (Mittermeier et al. 1999). In *Sundaland*, which includes Malaysia and parts of Indonesia, is found 60 percent endemism for plants and reptiles and 80 percent endemism for amphibians; most likely created by the episodic rising and lowering of the sea level connecting it with the Asian mainland and then isolating it for further speciation. *Wallacea*, which consists of Indonesia and Papua New Guinea, is a most fascinating place for endemism, with greater than 80 percent of species being endemic for mammals, reptiles and amphibians; due largely to its islands' status as fragments of Gondwanaland (the ancient super-continent) combined with a relatively stable

[9] TCA is a common solvent for the metal and textile industries. This could be of considerable concern for PNG.

tropical climate throughout geologic time (Sodhi et al. 2004). The IUCN lists 20 critically endangered (CE) to 686 vulnerable (VU) vascular plant species for the region, 6-91 fish species, 0-23 amphibian species, 4-28 reptile species, 7-116 bird species and 5-147 mammal species (IUCN 2003). Examples of more universally recognised endangered species are the Sumatran orang utan, tiger, elephant and rhinoceros. All of them inhabit the secondary, lowland forest rapidly being destroyed for oil palm cultivation and timber extraction (Wakker 2005). At the current rate of deforestation their populations are predicted to plummet in the next few decades.

Unfortunately, there is still no agreed upon mechanism for beginning to value the services biodiversity provides. For one, the term biodiversity has been accused of being too focused on the variety of species present at the expense of considering their relative abundance. This is important to determine as species will become *ecologically extinct* (i.e. not contributing to ecological functions) before they become *biologically extinct* (Balmford and Bond 2005). Also, there is emerging evidence that ecosystems with a wider variety of species will be less vulnerable to future changing climate and habitat regimes (Grime 1998, Loreau et al. 2001). For instance, fires during El Nino droughts have caused a drop in the fig wasp populations due to disturbance of the fig flowering cycle, which could affect future stability of fig populations if their main pollinators have disappeared (Harrison 2001).

Another avenue suggested involves rating the *functional integrity* of an ecosystem, considering, for instance, a forest's structural integrity by way of its level of disturbance (e.g. fragmentation, years since disturbed etc) (Melillo et al. 1985). At first glance, this effort would seem an oversimplification of the problem, because it does not consider the biodiversity housed within the forest, mainly relying on the remote sensing of areas. However, there are efforts underway to begin identifying biodiversity of forests from remotely sensed images (Foody and Cutler 2006).

Local Ecosystem Services Valued for Indonesia Case Study: Leuser National Park, Sumatra

Van Buekering et al (2003) calculated the **total economic value (TEV)** of the ecosystem services provided by the Leuser National Park, Sumatra during the years 2000-2030 to the neighbouring regencies and international community. The three scenarios modelled were for "deforestation" (i.e. business as usual), "conservation" (i.e. stabilisation of the current situation) and "selective use" (i.e. a net reduction in primary forest as these areas are logged). The economic benefits evaluated consisted of: freshwater, fisheries, flood and drought mitigation, cash crops and subsistence agriculture, hydo-electricity capacity, eco-tourism, biodiversity, carbon storage, fire mitigation, logging and non-timber products. The key stakeholders/beneficiaries considered were: the local community, the local government, forest extractive industries and plantation companies, the national government and the international community. In the three scenarios significantly different TEVs were found as well as a varied distribution of benefits (with a discount rate of 4 percent). In the deforestation scenario the TEV was determined to be **US$7.0 billion**; the conservation scenario was **US$9.5 billion**; and the selective use scenario was **US$9.1 billion** over the 30-year time frame. While the short term benefits of the deforestation scenario appeared to dominate the three models, the conservation strategy overall

provided the greatest TEV. The greatest components to TEV for all three scenarios were water supply and flood mitigation, with agriculture constituting 36 percent of TEV for the deforestation scenario. The international community, on the other hand, predominantly benefited from the biodiversity and carbon storage services of the Leuser Ecosystem

Conclusion:

Knowledge Gaps

Both Malaysia and Indonesia are encouraging the large-scale development of their agricultural commodity sector, generally in their remaining undeveloped lowland forests; therefore perhaps the most obvious problem is the conversion of peatland for cultivation. As of yet, the emissions caused by their drainage is not totally understood though the suspicion is they will continue to be severe and efforts must be made soon for their conversion to be reduced if not halted. This involves curtailing large-scale commodity production on these areas; at least until the carbon dynamics of their drainage is better understood.

As can be gleaned from this report, much work on the impacts of forest fires in Indonesia has been performed, especially after the dramatic fires of 1997-98. While it is possible to price the unintended impacts after they have occurred, attributing benefits and their relative value is quite challenging. A whole host of agents are driving the forest degradation creating the conditions for these fires, and a dispersed population is being impacted. The blame does not lie solely with illegal logging; several officially licensed logging companies are taking advantage of lax government oversight as well (Obidzinski et al. 2007). Nevertheless, the problem of illegal logging in Indonesia continues to elude several NGOs, IGOs and the Indonesia government. Conversion of forest in this region is dominating carbon emissions; therefore any driver that cannot be managed through regulation or market incentives will remain a barrier to ameliorating this situation.

Papua New Guinea is an interesting case that is not well understood. While its territories contain among the most biodiverse rainforest in the world, little is known of neither the manner by which they are being managed nor what are the impacts of their mining operations on the surrounding environment. It is unclear what contributions are attributable to PNG's forests for global carbon emissions and the global hydrologic cycle. Perhaps it is their rich biodiversity which is the most obvious global ecosystem service. In addition, the government's recognition of indigenous rights to forests could be amenable for establishment of an ICADP as described above.

Finally, it is not yet clear what contributions the region's forests are making to the global hydrologic cycle. It is unlikely these forests have a negligible impact, considering the area is home to roughly 20 percent of global tropical forests and exhibits the most active evapo-transpiration of any other. It is more likely that they have not been adequately modelled yet. Hence, considerably more research is needed to understand the biosphere-atmosphere dynamic in this region, which would be

useful for improving the resolution of global circulation models (GCMs) for these areas as well as begin valuing the ecosystem service they are providing.

Final Comments

Markets for ecosystem services (MES) are seen increasingly as a means to protect valuable natural resources that are not otherwise valued. Especially as the non-Annex I countries consider committing to emission targets in the second phase of Kyoto (post 2012), the prospect of an additional revenue stream above carbon emissions is quite amenable (Duraiappah 2006). To date national environmental regulation has not been a sufficient deterrent when a high poverty rate dominates. Through market based instruments (MBI) around environmental services, additional financial resources can be pumped into these ailing economies. At the same time, it will be important to safeguard as much as possible *to whom* and *by whom* this money is distributed. Careful attention must be made to the institutional capacity of developing countries to monitor and regulate payments to locals. In cases where this is not reliable, alternative arrangements will be needed.

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Appendix:

I. Calculations of Land Use Cost and Sources

Indonesia

Total land area is 181.157 mha. (88 mha, 4% primary), 3% (of total area productive forest plantations) (3.4 mha).

The rate of deforestation is -1.87 mha/yr or -2%/yr

Source: ((FAO) 2005)

Malaysia

Total land area of Malaysia is 32.8 mha, with 24.8 mha (75.5% of total land) designated as forest and tree cover (incl. agricultural commodities).

Forestland is further divided into 19.5 mha for forest cover and 5.3 mha for tree cover. Sarawak has 47.45% (9.2 mha), 30.1% (5.9 mha) in Peninsular Malaysia and 22.5% (4.4 mha) in Sabah.

Logging concessions for Malaysia are estimated to be 56.6% of total forested area (20.8), for a total of 11.8 mha (FRA 2005).

In 2005, export returns from timber were 4.57 billion euros, an increase of 8.5 percent from 2004 (4.21 billion euros).

A very rough estimate of a per hectare return from the timber sector (though this is including raw and processed timber for export) is :
4.57 billion euros/ 1.8 euros to the $/ (8.8+3.59+PM)= $100-130/ha (24.8 mha or 19.5 mha).

Source: ((JOANGOHutan 2006).

Papua New Guinea

Total land area is 45.286 mha. 29,437 is forested accounting for 65.0% of total land area.

Fourteen logging projects were reviewed, for a total land coverage of 3.17 mha. In 2004, 1.3 million cubic meters were exported with a declared value of $69 million. These constituted roughly 65 percent of PNG log exports.

Estimated total contribution of logging to GDP= $69 million/0.65= **$106.2 million**

Average value/ha for logging= $69 million/(3.17-.0374) mha= **$22.0 /ha**

Source: ((FT) 2006).

II. Influential Agents (NGO, Governmental and Scientific bodies)

Table 3 Influential Agents in Indonesia

Name of Organisation	Description	Activities
Centre for International Forest Research (CIFOR)	Based in Bogor, Indonesia, CIFOR is the regional centre for forest research in Asia under CGIAR.	Funds numerous programs in payment for environmental services, carbon forestry and forests that benefit the poor, as well as providing numerous publications on forest use and health of the region.
Conservation International	An internationally recognised environmental NGO interested in the biodiversity hotspots housed within Indonesia. It operates mainly in Papua and is heavily involved with providing assistance to promote community-based conservation.	CI is involved with several networks, including the CTRC and is in partnerships with the Indonesian Foundation for the Advancement of Biological Sciences (YABSHI), ALAMI Foundation, Indonesian Ecotourism Network (Indecon) and Yayasan Cipta Citra Lestari Indonesia (YCCLI).
Conservation Training and Resource Center (CTRC)	Formed by a combination of 9 Indonesian and international organisations based in Bogor with the goal of increasing conservation capacity in Indonesia.	The CTRC provides several training courses for natural resource managers, including "how to value the region's ecosystem services."
Down to Earth (DTE)	International Campaign for Ecological Justice in Indonesia.	DTE monitors and raises awareness on social and environmental justice issues in Indonesia.
Greenpeace-Paradise Forests	Greenpeace has focused efforts in the region to raise awareness of illegal logging activities.	It has produced some reports and worked with a few forest communities; however it claims its most 'effective work' to be on international engagement of these issues.
Institut Pertanian Bogor (Agricultural University)	A well-recognised agricultural research institute in Indonesia; based in Bogor.	Involved with the CTRC.
International Tropical Timber Organisation	Intergovernmental organisation established by the United Nations in 1986, with	Sustainable Collaborative Forest Management in the Bulungan Model Forest in Indonesia;

(ITTO)	membership that represents 80-percent of global tropical forest and 90 percent of global tropical timber trade.	Phase II of the Community-based Transboundary Management Plan for the Betung Kerihun National Park in Indonesia
Sawit Watch	Indonesian network against oil palm plantations (Sawit meaning oil palm).	Their activities involve engaging with indigenous groups and advocating for their rights, campaigning against IMF/World Bank's support of industrial forest use and raising local to international awareness of the impacts of palm oil plantations.
The Nature Conservancy	An international NGO that manages programs in the region ranging from coral conservation to fighting illegal logging.	Involved with the CTRC. In addition, it is leading a Global Alliance with WWF to combat illegal logging and promote sustainably managed forests.
Telapak	Based in Bogor, Telapak believes that all of Indonesia's territory should be treated as a conservation area with integrated resource use for livelihood security of local communities.	Activities appear to be whistle-blowing mainly of timber companies' illegal activities. Has released a series of reports with the Environmental Investigation Agency.
Tropical Forest Foundation (TFF)	An international NGO inspired to encourage sustainable forest management in tropical regions around the world.	Its Asian programme, which started in 2000, focuses on training for reduced impact logging (RIL) in Indonesia.
Tropical Forest Trust (TFT)	An international NGO committed to promoting sustainable forest management. Involved with sourcing sustainable timber and linking concerned buyers as well as providing on the ground training and support to forest managers.	The largest office is located in Semarang, Indonesia. This is attributed to the fact that Indonesia is home to the greatest number of TFT forest projects.
WALHI	Indonesia's largest national environmental organisation, affiliated with Friends of the Earth.	Has several campaigns on the issues of water, disaster management, pollution, energy, globalisation and debt, forests, coasts and oceans, reforming environment and natural resource policy and mining.
World Bank	International finance institution supporting economic development and poverty reduction in developing countries.	Accused of funding several large-scale plantation and logging operations in Indonesia in the name of economic development in the region.
World Resources Institute (WRI)-Global Forest Watch	International environmental think-tank monitoring the state of forest cover change in Indonesia.	Its activities in Indonesia include 'developing a forest information system' that has been useful for several international governmental bodies, such as the World Bank.

World Wildlife Fund for Nature (WWF) – Indonesia	WWF has several programs specific to Indonesia/Borneo in order to improve the vulnerability of this region to unchecked resource extraction.	WWF programmes in this area include Forests for Life, Heart of Borneo Project and Global Forests and Trade Network (GFTN). In addition, WWF was one of the founding members of the CTRC.

Table 4 Influential agents in Malaysia

Name of Organisation	Description	Activities
Borneo Resources Institute of Malaysia (BRIMAS), Sarawak	Founded in 1993, BRIMAS was created to address the human rights abuses suffered by the indigenous Dayak communities in Sarawak.	Since its inception it has engaged with these communities by providing education, participatory research, training and campaign programmes.
FERN	Created by the World Rainforest Movement, FERN runs campaigns on forests and biodiversity, trade and investment, development aid, climate and forest peoples.	Efforts in Malaysia more focused on reports particularly on forest governance.
Forest Research Institute Malaysia (FRIM)	A governmental research body governed by the Ministry of Natural Resources and the Environment. Located northwest of Kuala Lumpur.	Tropical forest research performed by FRIM is divided into three topic areas: forestry, product development and biotechnology. With research performed in six stations around Peninsular Malaysia.
Friends of the Earth Malaysia (Sahabat Alam Malaysia)	In operation since 1977 with efforts focused on environmental impacts and economic disadvantage of indigenous groups	Activities include coordinating the Asia-Pacific People's Environment Network (APPEN), which consists of more than 300 NGOs since 1983. Not sure what its latest activities have been.
Grand Perfect	A consortium of three local timber companies in Sarawak embarking on a joint logging and conservation project.	The Planted Forests Project is to be located on 490,000 ha, with just under half dedicated to logging (acacia plantations), one third for conservation and the remainder for local indigenous use.[10]
Indigenous Peoples Development Centre (IPDC), Sarawak	ipdc@tm.net.my	
Partners of Community Organisations (PACOS)	A voluntary organisation, based in Sabah, dedicated to promoting quality of life of indigenous communities.	Activities include community organisation training and capacity building for indigenous communities to manage resources sustainably and assert land rights.
Malaysian Nature Society (MNS)	A membership organisation dating from 1940 involved with	Activities are focused on research on important habitats for

[10] (Cyranoski 2007)

	the conservation of Malaysian nature.	conservation, environmental education and management of national parks. Publications produced include books and journals (e.g. the Malaysian Naturalist and Malayan Nature Journal.)
Tropical Forest Trust (TFT)	An international NGO committed to promoting sustainable forest management. Involved with sourcing sustainable timber and linking concerned buyers as well as providing on the ground training and support to forest managers.	Based in Kuala Lumpur, focusing on forest supply chain work in Malaysia.
WWF Malaysia	Efforts appear to be focused on raising awareness in Malaysia of environmentally responsible resource use as well as disseminating information on the endangered species of Malaysia.	Activities include campaigns on forests, marine and coastal environments, wetlands and endangered species (tigers, orang utans and pygmy elephants.)

Table 5 Influential agents in Papua New Guinea

Name of Organisation	Description	Activities
AusAID Australian Agency for International Development	Australian Government's overseas aid program	Major rural development efforts include a National Agricultural Research System and support for the PNG Forestry Authority.
Centre for Environmental Law and Community Rights (CELCOR)	An NGO urging the ITTO, among other bodies, to support community awareness raising of customary land rights.	Activities include direct legal assistance, community legal education, policy research and law reform and campaigning/advocacy.
CSIRO Commonwealth Scientific and Industrial Research Organisation	Australia's national science agency developing research on energy, environment, farming and food and mining activities, among many others.	Performs petroleum research in Papua New Guinea and mineral resources available for exploitation.
Courts of PNG	The legal courts have been active in the past regarding forest governance; however greater financial support is needed for future legal cases.	In 2003 the courts ruled against illegal logging and were able to halt an infamous forestry company.
Greenpeace-Paradise Forests	International environmental NGO concerned with illegal logging in the region.	Established the Global Forest Rescue Station (Lake Murray, Western Province, PNG) to aid the Kuni, Begwa and Pari in delineating their tribal lands.
FSP Foundation of	A local NGO interested in	Projects have including building

the People of the South Pacific	sustainable development, health, good governance and community capacity building.	capacity for local community groups to improve governance, eco-forestry, reproductive health and family planning, etc.
The Forest Policy and Environment Group (FPEG) of the Overseas Development Institute (ODI)	International organisation with a focus on sustainable forest management, especially regarding institutional, policy and socio-economic issues.	Produced several reports on the state of forestry in PNG.
Foundation for People and Community Development (FPCD)	Has been operating since 1965, sometimes in partnership with FSPI on issues like ecoforestry and integrated conservation and development.	A recent project, cited at the latest ITTO meeting, highlighted a partnership between FPCD and the Madang Forest Owners and Timber Producers (sponsored by the ITTO), has realised an FSC certified project.
International Tropical Timber Organisation	Intergovernmental organisation established by the United Nations in 1986, with membership that represents 80-percent of global tropical forest and 90 percent of global tropical timber trade.	Projects include: Model forest management in PNG (awaiting financial audit).
The Ombudsmen Commission	An independent governing body that has addressed forestry issues in the past.	While the number of activities this body has engaged with our rather small, it has been offered as a first step for improving forest governance in the country and beginning to address government sponsored cronyism.
RCF The Research and Conservation Foundation of PNG	An NGO concerned with the loss of rare and endemic bird species in their local area.	Its target audience is PNG educators seen as a vector for distributing information on conservation and sustainable resource management.
Village Development Trust (VDT)	A regional NGO based in Papua New Guinea focusing on community timber and villager training in sustainable forestry.	Courses offered include: small-scale sustainable forestry courses, resource awareness workshops, integral forestry courses, managing for success-business training courses, etc.
WEI Wau Ecology Institute	It was established in 1961 and became an environmental NGO in 1973.	Houses a laboratory for visiting scientists, a herbarium and zoological collections.