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Contributor and Victim - Indonesia's Role in Global Climate Change with Special Reference to Kalimantan

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Abstract

Through rapid deforestation, forest fires, degrading peatlands, and diminishing carbon 'sinks' Indonesia is one of the main contributors to the phenomenon of Global Climate Change. On the other hand, Indonesia will also be a major victim of Climate Change. The combination of high population density on some islands and high levels of biodiversity, together with 80,000 kilometres of coastline and 17,500 islands, makes Indonesia one of the most vulnerable countries to the impacts of Climate Change. Experts expect a warming from 0.2 to 0.3°C per decade in Indonesia during this century, together with an increase in annual precipitation across the majority of the Indonesian islands. Additionally there will be a change in the seasonality of precipitation; Borneo may become 10 to 30% wetter by the 2080's during December-February. As rainfall decreases during critical times of the year this translates into higher drought risk, consequently a decrease in crop yields, economic instability and drastically more undernourished people. On the other hand, increased rainfall during already wet times of the year will lead to high flood risk. Rising sea levels and many more extreme weather events will contribute to the many problems caused by Global Climate Change. Indonesia, and Kalimantan in the first instance, has to take up the challenge of climate change in taking actions at all levels to reduce greenhouse gas emissions, including promoting sustainable use of land and water resources, and putting adaptation into the development agenda.

1. Introduction

In 2004, the industrialised countries ("Annex I countries") had 20% of the world's population, but accounted for 46% of global Greenhouse Gas (GHG) emissions, and the 80% population in the Developing World ("Non-Annex I countries") emitted only 54% of the global GHG.

Global energy use and supply – the main drivers of GHG emissions – are projected to continue to grow, especially as Developing Countries pursue industrialization. Under 'business as usual' conditions, the projected emissions of energy-related CO2 in 2030 will be 40–110% higher than in 2000, with two thirds to three quarters of this increase originating in the Developing World (Non-Annex I countries), though annual per capita emissions in industrialized countries will remain substantially higher, that is 9.6 t CO2/cap to 15.1 t CO2/cap in Annex I regions versus 2.8 t CO2/cap to 5.1 tCO2/cap in Non- Annex I regions (IPCC 2007).

The World Development Report 2010 (World Bank 2009) entitled "Development and Climate Change" emphasizes that developing countries are the most vulnerable to the negative impacts of

climate change. In fact, they face 75 to 80 percent of the potential damage from climate change. The latest and best scientific evidence tells us that at global warming of more than 2°C above pre-industrial temperatures—an increase that will be extremely difficult to avoid—

- more than a billion people could face water scarcity,
- 15 to 30 percent of species worldwide could be doomed to extinction,
- hunger will rise, particularly in tropical countries,
- sea-level rise is contributing to losses of coastal wetlands and mangroves,
- more weather extremes than ever (incl. floods and droughts) will affect negatively the life of millions and the economy of nations (IPCC 2007).

So it's overwhelmingly clear that developing countries are the major victims of Global Climate Change and that they assistance to cope with these potential impacts.

2. The role of forests and peatlands in Global Climate Change

Forest ecosystems account for as much as 80% of the total above-ground terrestrial carbon while peatland ecosystems, which only cover 3% of the world's terrestrial surface, store 30% of all global soil carbon or the equivalent of 75% of all atmospheric carbon (Dioghlaf 2008). As such, healthy forests and peatland systems have the potential to capture a significant portion of projected emissions. Inversely, unsustainable land use, deforestation and soil degradation, can contribute significantly to greenhouse gas emissions. Between 1990 and 2005, nearly 45,000 square kilometers of forest were lost in low income countries (an annual deforestation rate of 0.5 percent) and 38,000 square kilometers in lower middle income countries (including Indonesia, annual deforestation rate: 0.16 percent) (World Bank 2007).

Additionally, forests host at least half of all life forms on earth, and as deforestation continues, the biodiversity of the planet is being seriously affected (World Bank 2009a). According to Wetlands International,

- 2000 million tons of CO_2 are released annually from forests,
- 600 million tons are caused by decomposition of dry peat and
- 1400 million tons are emitted through annual fires.

While most emissions in industrialized countries result from fossil fuel combustion, the largest contributors to greenhouse gas emissions in the Developing World are deforestation and land use change. On average, land use change, forestry, and agriculture account for more than half of the

emissions of greenhouse gases in Developing Countries, compared to 10 percent in industrialized countries (World Bank 2009a).

3. Indonesias contribution to greenhouse gas emissions

Indonesia releases about 3000 million t CO_2e annually, which is about half the US emission volume (Fig. 1). Deforestation, rapid degradation of peatlands and forest fires together account for 85 per cent of the country's annual greenhouse gas emissions (Fig. 2). These emissions make up 34% of the global emissions caused by land use, land use change and forestry (LULUCF) (PEACE 2007).

Indonesia is host to very large forest areas. About 24 billion tons of carbon are stored in vegetation and soil, and 80% of this, i.e. around 19 Bt C, are stored in standing forest (status 2003). Out of the 108 million ha of forest area (in 2005) of Indonesia almost half is in poor and degraded condition.

The forest area in Indonesia has decreased in 10 years (1995 to 2005) from 50.2 % to 48.8% of the total land area (World Bank 2008). Forest fires count for 57% of total deforestation and land conversion. In Indonesia these fires may cover millions of hectares and can last for weeks, sometimes even months, often burning thick layers of peat over large areas.

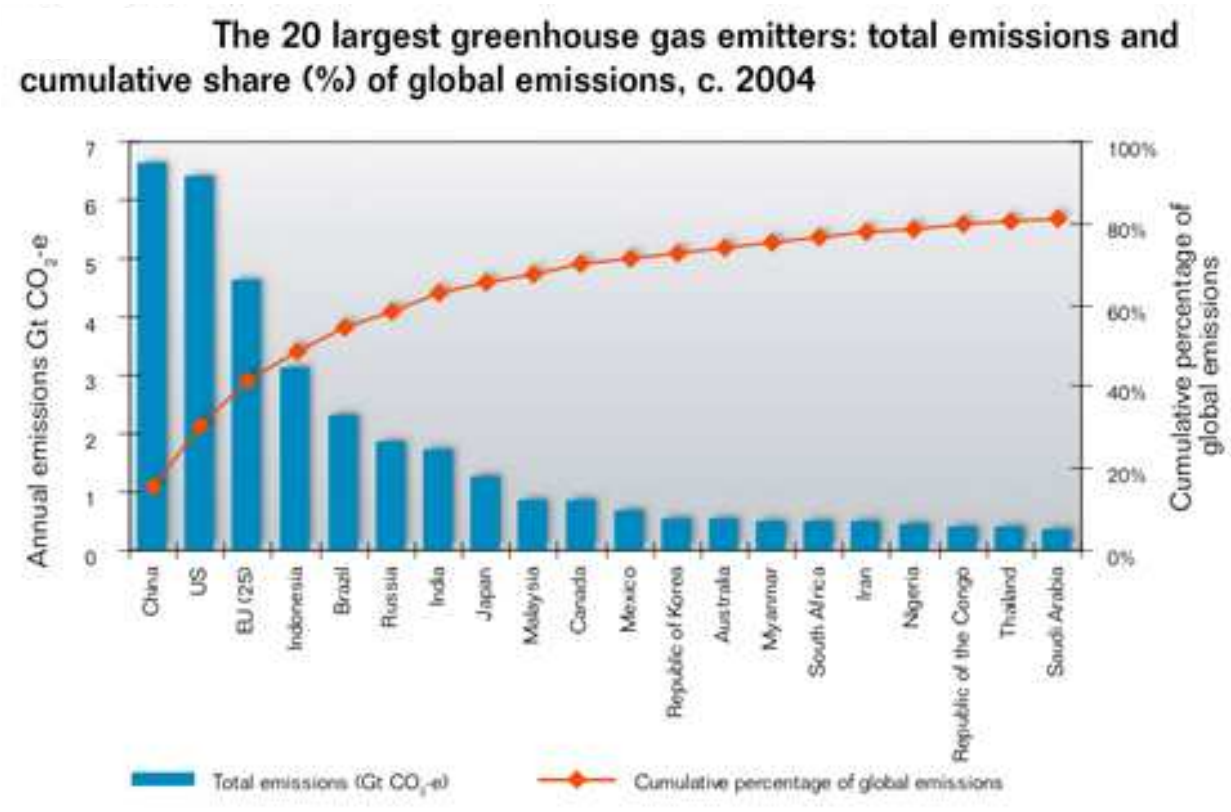

Figure 1. The 20 largest greenhouse gas emitters: total emissions and cumulative share (%) of global emissions; Year 2004 (Source: Garnaut (2008))

Indonesia holds about 60% of the world's peatlands (about 20 million hectares) and these peatlands are a rich potential source of carbon dioxide (Vasander et al. 2007). 3.7 millions of hectares of peatland had been completely destroyed until 2005 and the process continues (BiofuelWatch 2006). In Indonesia, larger tracts of peatswamps are found on Sumatra and Kalimantan, Sulawesi and Irian Jaya. In Central Kalimantan alone the size of wetland areas (2000-2002) was 2.25 million hectares; its carbon content was estimated to amount to 6.3 million tons (WI-IP, 2004).

Ongoing disturbances like land conversion and logging decrease the peat coverage (CKPP 2006). The large-scale use of peatlands is associated to drainage. Through drainage, the peat dries, starts decomposing, and emitting carbon dioxide. In the tropics this process takes place very rapidly and is often accelerated by fires (Rieley et al. 2007, Prinz 2008).

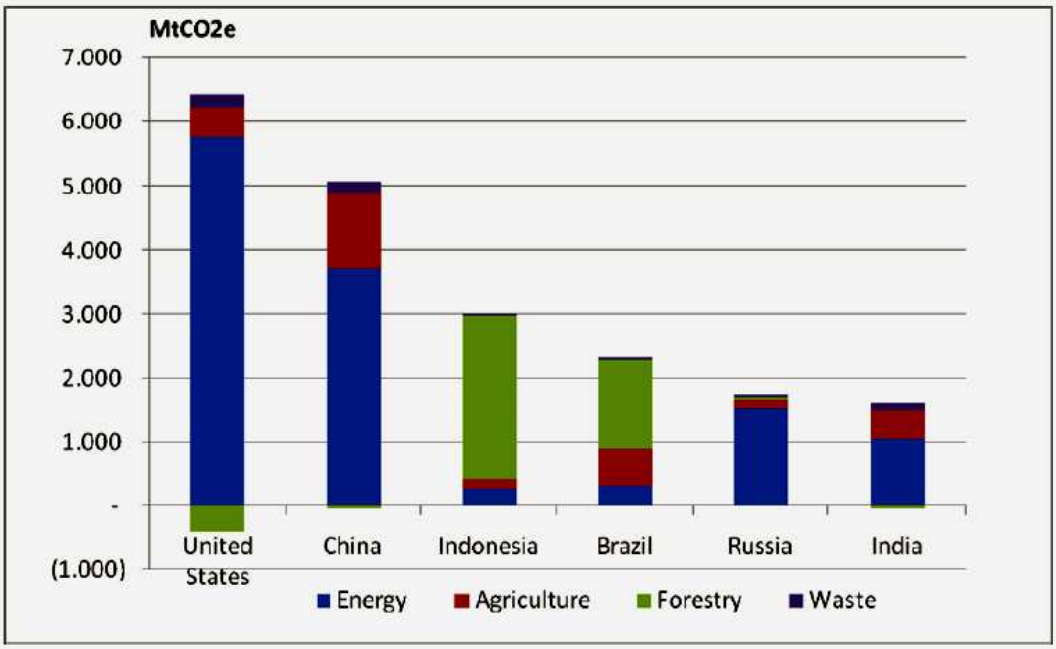

Figure 2. The 6 largest emitters of greenhouse gases (taking EU not as a block) and the origin of emissions (Source: *PEACE (2007)*

Fires from peatlands are the largest contributor to haze, which is a major source of carbon emission. In the 1997/1998, peatland has contributed 60% to 90% of emissions from forest fires. It was estimated that the fires released 7% of the total global greenhouse gas emission that year and affected the health of 75 million people (BAPPENAS-ADB 1999).

Deforestation and land-use change are estimated to cover 2 million hectares per year (Fig. 3). Studies estimate that illegal logging comprises about two thirds of the country's total CO_2 emissions, or between 140 and 250 MtC annually (PEACE 2007).

These developments have major impacts on the global carbon cycle, on local and global climate regulation, on biodiversity, soil, water, and coastal marine productivity. Indonesia is also a serious crude oil, natural gas and coal producer and user in the region.

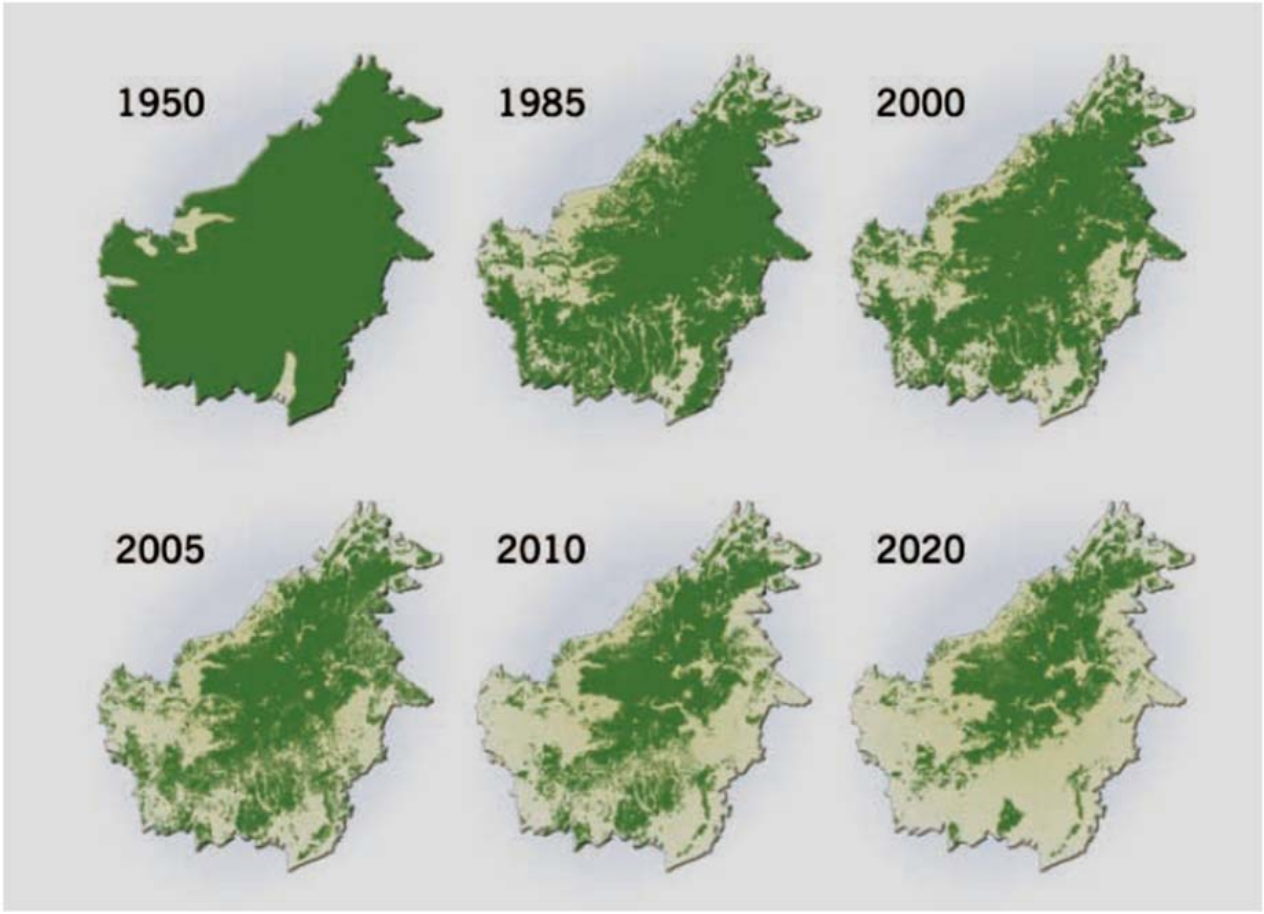

Figure. 3. Extent of deforestation in Borneo 1950 – 2005, and Projection Towards 2020 Source: *PEACE (2007). Indonesia and Climate Change: Current Status and Policies, (based on UNEP/GRID-Arendal, 2007)*

Indonesia ranks only as the world's 22nd largest economy, but has the fourth highest level of greenhouse gas emissions after China, the United States and the European Union (25 countries). It ranks third when counting the EU countries separately (PEACE 2007, World Bank 2009). Greenhouse gas emissions from the agriculture and waste sectors are very small, coming mainly from rice production. Agriculture is the main contributor of methane (CH_4) and nitrous oxide (N_2O) emissions. Emissions from energy and transport sectors are small, but are growing very rapidly (PEACE 2007).

4. Indonesia as a victim of Global Climate Change

On the other hand, Indonesia will also be a major victim of Global Climate Change. The combination of high population density on some islands and high levels of biodiversity, together

with 80,000 kilometres of coastline and 17,500 islands, makes Indonesia one of the most vulnerable countries to the impacts of Climate Change. Here are some of the issues Indonesia is confronted with or has to cope with in future:

Temperature

Experts expect a warming of about 0.3°C per decade in Indonesia during this century. This modest increase will nevertheless result in

(1) changes in the hydrological cycle, i.e. it will alter evaporation, transpiration, run-off, soil moisture, and in turn, precipitation,
(2) a higher water demand by vegetation, crops, animals and human beings,
(3) higher losses of water to atmosphere by evaporation from reservoirs,
(4) higher electricity needs for cooling, ventilation etc.,
(5) more stress to all living beings and the out-migration or extinction of species,
(6) more problems with pests and diseases, including malaria, Dengue fever etc.,
(7) ocean warming, affecting fishery as well as marine biodiversity,
(8) sea level rise (thermal expansion of the ocean's water body in combination with melting of glaciers and polar ice caps).

Precipitation, Droughts and Floods

The models predict an increase in rainfall across the Indonesian islands, with the largest change being in the Moluccas. Borneo may become 10 to 30% wetter by the 2080's. Increased rainfall during already wet times of the year will lead to higher flood risk (Hulme and Sheard 1999).

There will be a change in the seasonality of precipitation: Most probably the rains will come later, the rain intensity will be higher once the monsoon begins and then it will be drier during the summer months. This means a much shorter rainy season, with an almost rainless dry season in some areas. As rainfall decreases during critical times of the year this translates into higher drought risk, consequently a decrease in crop yields, economic instability and drastically more undernourished people.

In Jakarta area higher rain intensities might be expected during monsoon season. Jakarta has already a much higher risk of flood disasters because more than 40 percent of the city is situated below sea level. Another source of flood hazard is due to the 13 rivers that pass through the area. Different low-lying parts of the city experience flooding on an annual basis resulting in disruption of local

economic and social activities. The flooding is due to the accumulation of rainwater as well as to incursion of seawater.

Jakarta area ('Jabotabek') is growing very rapidly. Several parts of the coastal plains are experiencing subsidence of around two to three centimeters every year. (World Bank 2009b).

Rain Intensities

Heavy rainstorms will become more common and more intense in future due to the increased moisture available for condensation, which again is caused by higher temperatures (University of Miami 2008). More intense rain events increase the risk of soil erosion, sedimentation of river beds and reservoirs, of flooding and can have substantial societal and economic impacts.

Scientists expect for the humid tropics that precipitation in extreme events will go up by about 6 percent for every one degree Celsius increase in temperature (MIT 2009).

Groundwater Recharge

Increased precipitation variability/intensity may decrease groundwater recharge in humid areas because more frequent heavy precipitation events may result in the infiltration capacity of the soil being exceeded more often (Bates et al. 2008).

Impact on Agriculture and Food Security

The anticipated changes in the hydrologic cycle together with reduced soil fertility and higher incidence of pests and diseases will affect negatively the agricultural production. Climate change will likely reduce soil fertility by 2 to 8 percent, resulting in projected decreases of rice yield. There is a very high risk of decreased food security as well as reduced income from non-food commodities (coffee, cacao, tea, rubber etc.) in future decades.

Sea Level Rise

The climate change induced changes of the ocean make Indonesia particularly vulnerable:

- Indonesia is the world's largest archipelago;
- its 17,500 islands stretch over 5000 thousand kilometres East to West, or an eighth of the world's circumference;

- its total sea area is four times bigger than the land area.

It is projected, that

- the mean sea level in Indonesia will increase as high as 0.9 cm per year during this century,
- vast stretches of coastal plains will be inundated by the end of the century,
- the country could lose 2000 islands by 2030,
- the capital Jakarta will suffer most from sea level rise as large parts of Jakarta bay are also sinking by 0.8 cm per year due to groundwater over-pumping
- aquaculture of fish and prawns in coastal areas will be affected (PEACE 2007).

For instance, in West Java province's Karawang region, a huge reduction in local rice supply is estimated as a result of inundation and loss in fish and prawn production could go over 7,000 tons. In the lower Citarum Basin it was calculated that, sea-level rise could result in the inundation of about 26,000 ha of aquaculture ponds and 10,000 ha of crop land. This could result in the loss of 15,000 tons of fish, shrimps and prawns output, and about 940,000 tons of rice production (PEACE 2007). As a consequence, thousands of labourers might loose their jobs and many farmers will have to look for other sources of income.

Marine Environment

Due to climate change Indonesia's ocean water will become warmer by 0.2 to 2.5 ^{0}C during this century and will be more acid. Together with land-based water pollution, destruction of mangrove forests along the coast and over-fishing, the marine environment does suffer significantly. More than 50% of the coral reefs around Java and Bali were found bleached (PEACE 2007, WOC 2009).

There are a number of direct and indirect implications of climate change for fisheries in Indonesia.

5. Vulnerability Mapping

A survey on the vulnerability of the various regions of SE Asia to the impacts of Global Climate Change (Fig. 4), revealed, that the districts of Jakarta come out as the top most vulnerable regions in Southeast Asia (Yusuf and Francisco 2009). This is because this district is the intersection of all the climate-related hazards, except tropical cyclones. It is frequently exposed to regular flooding but most importantly, it is highly sensitive because it is among the most densely-populated regions in Southeast Asia. Areas in western Java are also highly vulnerable due to exposure to multiple hazards (namely, floods and landslides) as well as having high population densities. This

assessment was carried out by overlaying various maps following the vulnerability assessment framework of the United Nations' Inter-governmental Panel on Climate Change (IPCC).

The vulnerability mapping included:

- five different climate hazards: the frequency of droughts, floods, and cyclones, for about 20 years (1980-2000/1/3), physical exposure to landslides, and inundation zones of a five-meter sea level rise,
- human and ecological sensitivity to climate change, which included the population density,
- adaptive capacity, consisting of socio-economic factors, technology and infrastructure.

6. Mitigation and Adaptation

The impacst of Climate Change such as more extreme weather events and rising sea levels, will aggravate the many problems which already exist in the country. To avoid a further deterioration of conditions, Indonesia, and Kalimantan in the first instance, has to take up the challenge of climate change in taking actions at all levels to reduce greenhouse gas emissions, including promoting sustainable use of land and water resources, and putting adaptation into the development agenda (Mani et al. 2008).

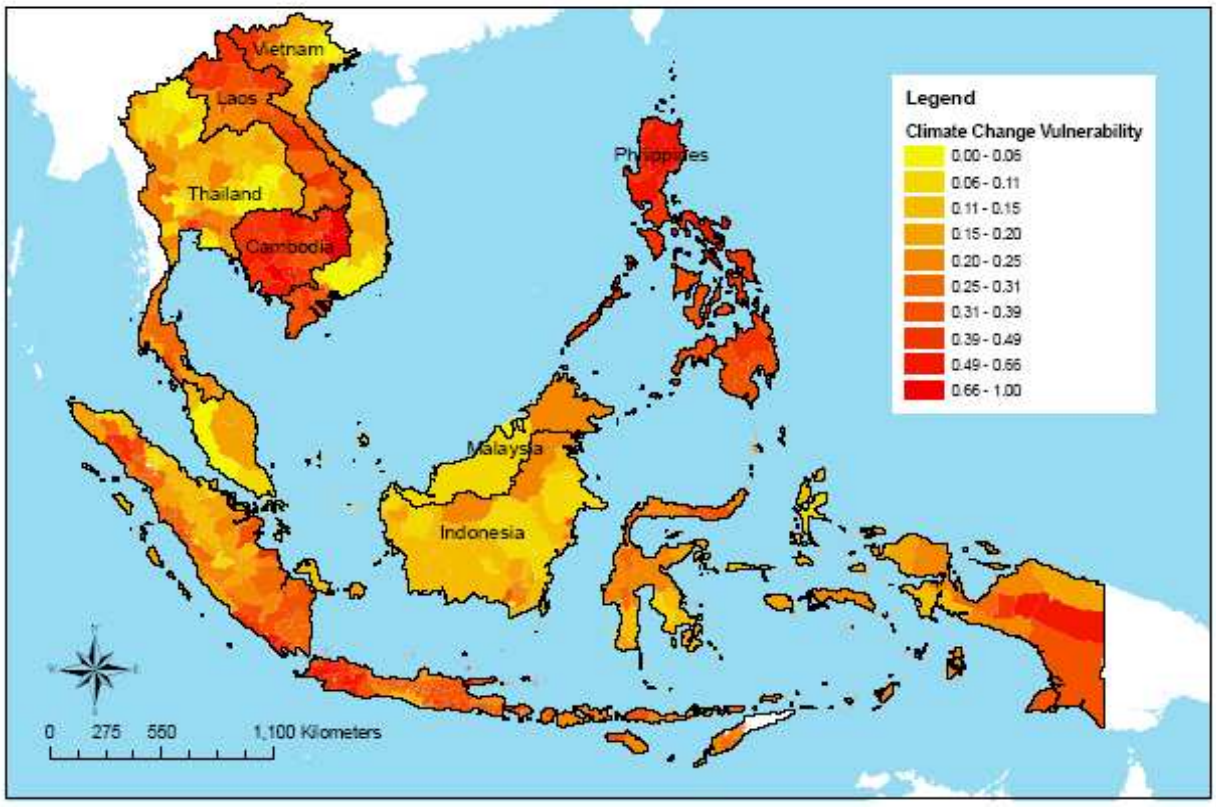

Figure 4. Climate change vulnerability map of Southeast Asia
(Source: Yusuf, A. A. & Francisco, H., 2009)

What is needed, is

- the implementation of mitigation projects to promote low carbon societies; including
  - reduced deforestation, prosecution of illegal logging,
  - more sustainable forest management,
  - introduction of agroforestry systems (CGIAR 2008 a),
  - stopping by legal action and law enforcement further drainage of peatsoils,
  - production of biofuels from waste material, not from palm-oil,
  - new energy strategies based on renewable energies (e.g. geothermal energy, wind energy, microhydropower etc.)
- communication and public awareness;
- capacity building at schools, colleges and universities, and
- enhancement of scientific understanding of climate change.

There are many binational and international programmes offering support to national governments. UNEP e.g. is offering assistance through the Regional Seas Programme and the Global Plan of Action for the Protection of the Marine Environment from Land-Based Activities (WOC 2009).

In regard to **adaptation** a wide range of fields have to be covered, such as

- Avoiding a further sinking of Jakarta area by lowering water abstraction and promoting groundwater recharge,
- Introducing a soil conservation strategy to avoid land slides, soil erosion from agricultural lands and sedimentation of rivers and reservoirs,
- Implementing a water conservation strategy in agriculture, i.e. to produce the same crop yield with smaller quantities of water,
- Storing more water above or below ground,
- Promoting water harvesting, i.e. to collect rainwater from house roofs for use in the dry period,
- Changing agricultural crops to fit to the new conditions,
- Constructing more dykes along the coast against sea level rise etc.

But conventional interventions might be not sufficient. Adapting to climate change both needs to build on conventional interventions and requires a major shift in thinking in planning and designing cities, in managing land, water and energy resources and in protecting the environment (incl. biodiversity).

It needs the development of flexible or "smart" systems that can anticipate and react to changing circumstances, particularly in light of uncertainties in projected impacts. New design standards and

criteria will also need to be developed for a changed environment, including the hydrologic system. Adaptive capacity—both social and physical—will need to be enhanced to protect the poorest and most vulnerable populations and ecosystems from the impacts of climate change.

According to OXFAM in six years time the number of people affected by climatic crises is projected to rise by 54 per cent to 375 million people, threatening to overwhelm the humanitarian aid system. The projected rise is due to a combination of entrenched poverty and people migrating to densely populated slums which are prone to the increasing number of climatic events. This is compounded by the political failure to address these risks and a humanitarian system which is not fit for purpose (OXFAM 2009).

The Indonesian government and all sectors of the society have to take into account the issue of climate change and have to translate it into policy making and in daily life decisions.

7. Climate change developments in Indonesia

Indonesia has signed the Kyoto Protocol in 1998 and ratified it in 2004. Since then, a lot has happened, notably in the field of clean development mechanism (CDM), although less so in the other fields (PEACE 2007). According to international experts, forestry policies in Indonesia are good, but implementation and enforcement are weak (PEACE 2007). Additionally there are conflicting targets, e.g. between replacing fossil fuels such as diesel, by biofuels on one hand and protecting forest area on the other hand:

Historically, oil-palm production in Indonesia has been a major driver of deforestation. As the national and international demand for biofuels is steadily rising, and the oil from oil-palms is well suitable for this purpose, more and more plantations are established. In 2009, biodiesel from oil-palm in Indonesia is estimated to be in the range of 700 million liters, or 2% of diesel consumption, requiring about 200,000 ha of oil-palm plantations. To reach the target of covering 5% of the diesel demand in 2025 by biodiesel, an oil-palm area of 1.4 million hectares will be needed (PEACE 2007).

While this year's parliamentary and presidential elections have been dominating political life in Indonesia in recent months, the issue of climate change took a low priority on the competing parties' manifestos. Meanwhile, the government's much-criticised regulation on Reducing Emissions from Deforestation and Forest Degradation (REDD) has been issued. Twenty projects are now underway in the country (DTE 2009). Indonesia's REDD arrangements have come under fire from many

NGOs and the UN, too. A March 2009 statement by the Committee on the Elimination of Racial Discrimination (CERD) criticised the draft REDD regulation for being incompatible with indigenous peoples' rights. The Committee recommended that the draft regulation, as well as other laws, be reviewed and amended to ensure their consistency with the rights of indigenous peoples to own and control their traditionally owned territories and to consent to activities, such as REDD, that may affect them (DTE 2009).

The Indonesian policy to rapidly expand the use of coal, including the expansion of coal-fired power generation, will increase emissions further.

On the other hand, renewable energy sources are underdeveloped and only few incentives given. According to PEACE (2007), the development of renewable energy in Indonesia has slowed if not halted.

In August 2008 the National Council on Climate Change (DNPI) was established; its functions are to coordinate climate change policy, negotiations, and implementation across all levels and portfolios of government in Indonesia’s decentralized system (Ashton 2009). This Council has only rarely made it into the headlines during the past election season 2009. DNPI's profile remains rather low given the prominence of United Nations Climate Change Conference in December 2007 on Bali and Indonesia's importance as a key carbon store, as well as a big emitter (DTE 2009).

In partnership with other countries and NGOs, Indonesia is building systems to collect and analyze satellite and ground data, and undertaking large-scale demonstration activities. It is working with Australia to develop a national Forest Resource Information System and National Carbon Accounting System.

8. Conclusions

There are no doubts that global warming will increase temperatures, shorten the rainy season and intensify rainfall all over Indonesia, with minor differences between groups of islands. These conditions will lead to other changes e.g. in water demand, reduced groundwater recharge, more soil erosion etc, which have effects on agriculture and thus food security. A simulation has projected a significant decrease in crop harvest in West and East Java due to climate change.

Global warming will also make sea levels rise, inundating productive coastal zones and reducing farming in such communities. If such predictions come true, thousands of farmers in that area alone would have to look for other sources of income.

The rise in the number of dengue fever cases during the rainy seasons in Indonesia, especially in Java, could have been partially caused by warmer temperatures. Research has confirmed that warmer temperature has led to mutation of the dengue virus, making it difficult to handle, leading to an increase in fatalities.

It is now evident, that deforestation, peat land degradation and forest fires have placed Indonesia among the top emitters of greenhouse gases in the world, among industrial giants United States, China and Japan. About 75 percent of the largest carbon dioxide emissions in the Indonesian forestry sector come from deforestation and land conversion which are caused mainly by forest fire. Global warming will likely cause a vicious cycle by drying up the rainforest and peat swamps, thus increasing the risks of even more intense fires.

All these facts call for immediate action. But experts argue that forest sustainability programs are challenged by the local reality that the forests are worth more dead than alive. Timber and palm oil profits are much greater and easier to grasp than vague notions of sustainability.

Professor Emil Salim, the father of Indonesia's environmental movement and a senior adviser to Indonesia's President Susilo Bambang Yudhoyono, said in an interview, that with Indonesia's current population of 230 million expected to grow by another 100 million in the next 30 years, Indonesia needs very good reasons not to clear land. And local people, he said, need good economic reasons to keep the forests standing. (ABC 2007)

Ironically demand for energy crops from rich countries may now be worsening the situation, with hundreds of thousands of hectares of forest in Southeast Asia being converting annually for biofuels production.

In a recent World Bank paper (World Bank 2009b) it was proclaimed “Lets act now, act together, and act differently. Act now, because what we do today shapes the climate of tomorrow and the options available to future generations. The cost of delay or inaction is too high. Act together, with rich countries taking the lead to reduce their carbon footprints and to help developing countries with the funding and technology they need both for adaptation to climate change as well as for low-carbon growth in future. Act differently, by transforming energy systems, managing land and water sustainably, protecting forests and biodiversity, and designing policies that take into account new information about climate change” (World Bank 2009b).

In order for a post-Kyoto climate change agreement to work, industrialized and developing nations should work together to avoid deforestation and create the necessary financial mechanisms to transfer resources to countries that effectively protect their natural resources.

Bibliography

ABC 2007. Indonesia says more money needed to stop deforestation. *ABC News*, 07.Sept. 2007. http://www.abc.net.au/reslib/200708/r172483 (retr. 30.09.2009)

Ashton, R. (2009). *World Leaders Can Take Their Cue From Indonesia*. Go Now to Indonesia. 30 September 2009, http://gonowtoindonesia.com/&usg

Bappenas-ADB. (1999). *Causes, Extent, Impact and Cost of 1997 -1998 Fires and Drought*. Planning for Fire Prevention and Drought Management Project, ADB TA 2999-INO, Jakarta.

BiofuelWatch. (2006). Factsheet 1: South-East Asia's Peat Fires and Global Warming, see http://www.biofuelwatch.org.uk/peatfiresbackground.pdf (22.07.2008)

CGIAR. (2008a). Adapting Agricultural Systems to Climate Change. *Consultive Group on International Agricultural Research*, Washington DC. http://www.cgiar.org/impact/global/cc_adaptingagrsystems.html

CGIAR. (2008b). Managing Tropical Lands to Mitigate Climate Change. *Consultive Group on International Agricultural Research*, Washington DC. http://www.cgiar.org/pdf/cc_managing_tropical_lands.pdf

CKPP. (2006). *Central Kalimantan Peatlands Project*, see http://www.wetlands.org/ckpp/gallery.aspx

DTE. (2009). Climate Change Developments in Indonesia. Down to Earth No.80-81, June 2009. *International Campaign for Ecological Justice in Indonesia - Kampanye Internasional untuk Lingkungan Hidup Yang Berkeadilan di Indonesia*. http://dte.gn.apc.org/index.htm

Djoghlaf, A. (2008). Biodiversity and Climate Change. *Convention on Biological Diversity*. IISD News.

IPCC. (2007). Fourth Assessment Report of the Intergovernmental Panel on Climate Change, IPCC Working Group 3, Technical Report. *Intergovernmental Panel on Climate Change*. Geneva, CH.

Bates, B.C., Kundzewicz, Z.W., Wu, S. and Palutikof, J.P. (Eds.). (2008). Climate Change and Water. *Technical Paper of the Intergovernmental Panel on Climate Change*, IPCC Secretariat, Geneva.

Garnaut, R. (2008). *Indonesia's Energy Potential*. http://www.desertec-australia.org/content/indonesia.html

Hulme, M. and Sheard, N. (1999). *Climate Change Scenarios for Indonesia Climatic Research Unit*, Norwich, UK. http://www.panda.org/climate

Mani, M. Markandya, A. Ipe, V. (2008). *Climate Change - Adaptation and Mitigation in Development Programs. A Practical Guide*. The World Bank, Environment Department, Sustainable Development Network, Washington DC.

Marland, G., Boden, T.A. and Andres, R. J. (2006). *Global, Regional, and National Fossil Fuel CO2 Emissions. In Trends: A Compendium of Data on Global Change*. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A.

MIT. (2009). Heavier Rainstorms Ahead Due To Global Climate Change. Study by Massachusetts Institute of Technology. *ScienceDaily*. Retrieved September 28, 2009, from http://www.sciencedaily.com /releases/2009/08/090817190638.htm

OXFAM. (2009). *The Right to Survive*. OXFAM International, April 2009. http://www.oxfam.org/sites/www.oxfam.org/files/right-to-survive-eng.pdf

PEACE. (2007). *Indonesia and Climate Change: Current Status and Policies*, Pelangi Energi Abadi Citra Enviro (PEACE), World Bank and DIFID, June 2007

Prinz, D. (2008). Land Use Options for Indonesia's Peatlands. Proceedings, In: Siaahan, U. (Ed.). Management of Water and Land Resources in Central Kalimantan, Indonesia. *Proceedings, International GAWN-SURED* Seminar 24-27 August 2008 in Jakarta., Christian University of Indonesia, Jakarta.

Resurreccion, B.P, Sajor, E.E. and Fajber, E. (2008). *Climate Adaptation in Asia: Knowledge Gaps and Research Issues in South East Asia*. Climate Change Adaptation in Se Asia, http://www.i-s-e-.org/Climate%20Adaptation%20SEA%20Sept08.pdf

Rieley, J. O., Limin, S. H. and Jaya, A. (Ed.) (2007). Restoration and Wise Use of Tropical Peatland: Problems of Biodiversity, Fire, Poverty and Water Management. *Proceedings of the International Symposium and Workshop on Tropical Peatland*. Palangka Raya, Central Kalimanatan, Indonesia, 20–24 September 2005. EU RESTOREPEAT Partnership, University of Palanga Raya, Indonesia and Wageningen University and Research Institute, The Netherlands. CIMTROP (downloadable from internet: www.alterra.restorpeat.wur.nl)

UW. (2007). *Climate change a threat to Indonesian agriculture*. University of Washington News 10 May, 2007. http://uwnews.org/images/newsreleases/2007/May/20070510_pid32856_aid32855_indonesia

Vasander, H., Limin, S. and Jauhiainen, J. (2007). Carbon stored in tropical peatland and losses resulting from fire and land use change. In: Rieley, J. O., Limin, S. H. and Jaya, A. (Ed.). Restoration and Wise Use of Tropical Peatland: Problems of Biodiversity, Fire, Poverty and Water Management. *Proceedings of the International Symposium and Workshop on Tropical Peatland*. Palangka Raya, Central Kalimanatan, Indonesia, 20 – 24 September 2005, pp.41 - 51. EU RESTOREPEAT Partnership, University of Palanga Raya, Indonesia and Wageningen University and Research Institute, The Netherlands.

WI-IP. (2004). *Wetlands for Water and Life*. Wetlands International. http://global.wetlands.org/

WOC. (2009). *Proceedings, World Ocean Conference in Manado*, Indonesia, May 2009. Bulletin Vol. 162 No. 1 - International Institute for Sustainable Development (IISD) New York, USA, http://www.iisd.ca/oceans/woc2009/html/ymbvol162num1e.html

World Bank. (2007). *The Little Green Data Book 2007*. The World Bank, Washington DC.

World Bank. (2008). *World Bank Fact Sheet Indonesia. Environment at a Glance 2008*. The World Bank, Washington DC.

World Bank. (2009a). *World Development Report 2010 - Development and Climate Change*". http://beta.worldbank.org/node/4806 (20.09.2009). The World Bank, Washington DC.

World Bank. (2009b). *Climate Resilient Cities. A Primer on Reducing Vulnerabilities to Disasters*. City Profile Jakarta, Indonesia. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2009/03/19/

Yusuf, A. A. & Francisco, H. (2009). Climate Change Vulnerability Mapping for Southeast Asia. *Economy and Environment Program for Southeast Asia (EEPSEA) in cooperation with IDRC, Sida and CIDA*, Singapore, http://www.idrc.ca/uploads/user-S/12324196651Mapping_Report.pdf