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INTERNATIONAL GERMAN ALUMNI SUMMER SCHOOL INDONESIA

IMPACT OF CLIMATE CHANGE ON BIODIVERSITY: DOES NATURE CONSERVATION NEED NEW STRATEGIES?

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IMPACT OF CLIMATE CHANGE ON BIODIVERSITY: DOES NATURE CONSERVATION NEED NEW STRATEGIES?

Edited by

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INTRODUCTION:

The German Alumni Summer School 2009 on 'Impacts of Climate Change on Biodiversity : Does Nature Conservation need New Strategies?'was jointly organized by the Centre for Nature Conservation (CNC), Georg-August University, Göttingen (Germany), South-East Asian German Alumni Network (SEAG) and Biodiversity Conservation and Sustainable Use Network, Indonesia (BIODICS-Alnet). This summer school was funded by the German Academic Exchange Service (DAAD) and targeted the German Alumni from Southeast Asia as well as scientists and experts from various discipline.

The German Alumni Summer School encompassed significant contributions from participants from Germany, Australia, Indonesia, Malaysia, India and Philippines with the main concern on ***climate change and biodiversity***. In addition, several key lectures and expertise were incorporated into the summer school program.

Climate change and its impact on biodiversity has become the main issue in recent times. Climate is changing rapidly due to human activities especially burning of fossil fuels and enormous CO_2 output. Several studies indicated the correlation between deforestation, species loss and climate change. One of the serious efforts to minimize or mitigate the emission of CO_2 is to generate and use bioenergy. As the demand for this alternative energy is rapidly increasing, large areas of rainforest are being opened and altered to palm oil plantations and other types of plantation to supply the raw materials for biofuel. This can adversely accelerate climate change and biodiversity loss. Moreover a paradox concerning bioenergy and carbon stocks is emerging specifically in tropical countries, and this should be pointed out.

With the objective of discussing the impact of climate change on biodiversity and seeking solutions for sustainable development, the following main areas were covered :

- Global climate change as the challenge for the future.
- How climate change is affecting biodiversity.
- Social equilibrium in consumption of bioenergy.
- Food crisis and renewable energy resources

- Climate change, renewable energy and biodiversity: Implication for nature conservation.
- Climate change and tropical rainforest.
- Climate change and forest fire
- The impacts of climate change on marine biodiversity
- Effects of climate change on agriculture and food supply.
- Biodiversity management as important means to reduce climate change.

In addition to the lectures and presentations, there were discussions during the group activities and field trips. Alumni networking activities and future programs of SEAG-BIODICS-Alnet were also discussed after the plenary sessions.

As part of the field excursion program, a field trip to the Bunaken National Park was conducted. During this trip, there were presentations and discussions addressing the following issues:

- Climate change, coral bleaching and coral mortality.
- The assessment of coral reefs alteration.
- Climate change and coastal human communities.
- Assessing and predicting the influence of climate change on seashore species.
- Climate change: threats to mangrove forest and its biodiversity.
- Managing mangrove for resilience to climate change.

TARGET GROUPS:

The focus is given on German Alumni from South-East Asia. Experts and advanced students working on the science and management related to climate change and biodiversity conservation are invited to participate. Institutional affiliations include research and education, NGOs, government agencies, and civil society organizations. The selected participants are given an opportunity to present climate change and biodiversity related issues based on their capacities.

FOREWORD:

Excellencies,
Distinguished guests,
Ladies and Gentlemen,

Welcome to Manado. I am very pleased to be here this morning to attend the opening ceremony of the German Alumni Summer School in Manado – Indonesia. I want to thank the organizing committee, particularly to Dr. Jolanta Slowik, for choosing Sam Ratulangi University to host this summer school. I believe this summer school will strengthen the relationship not only among the German Alumni but also between Göttingen University as the organizer and Sam Ratulangi University as the host.

Let me give a brief introduction about Sam Ratulangi University. This university consists of ten faculties including Medicine, Engineering, Agriculture, Animal Science, Fisheries and Marine Science, Economics, Law, Social and Political Sciences, Letters, and Mathematics and Natural Sciences. Soon we will also start a new faculty, namely the Faculty of Public Health. We run various academic programs from undergraduate to Doctoral level. We also have several research centers. One of them is the research center for environment.

In order to increase the quality, we setup several programs which is one of them is to increase cooperation and collaborations with international universities and other related institutions. Currently, we only have a very few collaborations with German Institutions.

Therefore, I am looking forward to having more intense cooperation and collaborations with German Institutions, particularly DAAD and Gottingen University. I believe such cooperation will not only benefit the parties involved but also can strengthen the relationship between the two countries.

We all are experiencing the climate change including the global warming phenomenon. I agree that this is one of the greatest environmental challenges ever facing by this planet. Therefore, I fully support the chosen topic for this summer school which is ***"Impact of Climate Change on Biodiversity: does nature conservation need new strategies?"***

Finally, while you are here please enjoy your stay by visiting some interesting sites including the excursion program setup by the local committee. You may also be interested to bring home some of our traditional souvenirs and try some of our traditional food.

I wish you all a successful summer school and an enjoyable stay.

Professor Donald A. Rumokoy

Rector of Sam Satulangi University,

Manado, North Sulawesi, Indonesia

FOREWORD:

Each day we are confronted with news on various global crises like financial crisis, energy supply crisis, biodiversity crisis, food supply crisis, demographic crises, climate crisis and many more. By definition crisis is a critical, turning point or state of affair. Every crisis is unique, and can be managed and mitigated through the systematic development and application of a comprehensive plan.

'The Impact of Climate Change on Biodiversity'- It is well known for science that mankind is totally dependant on biodiversity from the gene level through the species, populations, ecosystems, landscape level and on its functiones and services.

Why didn't we till yet learn how to use in a sustainable way this basis of our existence? There are many answers depending on the various disciplines we are representing or our personal opinion. It is sure that the species *Homo sapiens recens* is responsible for two of the present day crisis- biodiversity loss and climate change. Human activities during historical times were mostly unsustainable but we had the possibility to leave destroyed lands and look for new existence elsewhere but now our Earth has become too small for our big population and there are many borders and hurdles to overcome.

Climate change influences biodiversity and the species can either adapt, escape or become extinct. Many species are unable to adapt within a short time period to climate change or to escape and migrate to other places because of the barriers we have created in the landscape or habitats and therefore have no chance to survive.

What can we do as scientists to stop or mitigate biodiversity loss and climate change ? We are not politicians, decision makers or even bankers with huge amount of money lost on speculations.

Our power is knowledge and to have more influence on the society we should concentrate this knowledge from different disciplines - it means to work together and not against each other. Field Biology, Ecology, Technical Sciences, Genetics, Social Science, Philosophy, Ethnology and other sciences should coordinate in working out the ways to overcome many crises that we are facing.

The interdisciplinary research and proper, modern education can pave the way for a better understanding and to overcome the barriers we have built between the different disciplines.

Our Summer School was an excellent example of interdisciplinarity and internationality. In spite of all the crises we are confronted with, I hope that science will play an important role in searching for the practical solutions and not create the new ones like genetically modified crops. After Prof. K G Saxena from the School of Environmental Scineces, Jawaharlal Nehru University, New Delhi, India, I would like to point out three steps to mitigate the climate change and biodiversity crisis :

1. Changing in Policy and economy roles
2. Changing in our behavior
3. Increasing of our knowledge

Polish philosopher Kolakowski had written that 'unlimited glutony is the main problem of humanity'.

We are responsible in each country for the biodiversity and we have to care about it. Until now, escape to other planets to destroy them and the adaptation to climate change that we have talking about has many limitations. As scientists we should be modest and teach the students the conscience and sensibility towards the variety of life on our Earth.

Our Summer School has specifically dealt with biodiversity crisis and climate change.

The UNO 7 Millennium goals for development are looking forward to

- Integrate the principles of sustainable development into country policies and programmes to reverse loss of environmental resources
- Reduction of rate of biodiversity loss by 2010,

The future of next generations is depending on the fulfilment of these presumptions. In spite of these expectations the loss of biodiversity is still going on and the main causes are globalisation, human population growth, increasing demand for resources and overexploitation of natural resources, fragmentation of natural habitats, introduction of alien species and human induced climate change.

The habitat change and alteration together with climate change are declared by most of the scientists as the main reasons for biodiversity alteration. Climate is changing rapidly due to human activities especially due to burning of fossil fuels with increasing CO_2 output. Several studies have documented the correlation between deforestation, species loss and climate change. The primary goals of this Summer School were:

- To bring the German alumni and experts together for exchange of scientific ideas and knowledge with an interdisciplinary approach

- Establishment of close cooperation between International Biodiversity Network (INBINET) and Indonesia Network for Biodiversity Conservation and Sustainable Use (BIODICS)

- Preparation of proposal for our next Alumni Summer School in Indonesia in 2010: with venue, theme and topics.

An International Seminar on Genetic and Climate Change had also been incoroporated into our program so as to be able to widen our knowledge on the new aspects of Molecular Biology, Genetics and Climatology.

I would finally like to thank all the participants, guests and key note speakers for their excellent contributions, the authorities of Sam Satulangi University, Manado and DAAD Germany for supporting this Summer School and would like to appreciate the organising Committee members Jane Onibala, Margaretha Pangau-Adam and Kamini Barua for giving their extensive support and assistance in the management of the groundwork and preparation of the Summer School.

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BIODIVERSITY, ECOSYSTEMS AND CLIMATE CHANGE

The Potential Impacts of Climate Change on the Birds of Indonesia

RICHARD A. NOSKE

Abstract

Indonesia has more endemic bird species than anywhere else in the world, but also the highest number of threatened bird species for any nation. The major causes of this avian diversity crisis are high rates of deforestation, with conversion of logged forest to plantations, and a thriving wildlife trade. However, anthropogenic climate change represents a further threat, the impacts of which are unknown. In this paper I review the evidence for the effects of climate change on birds in neighbouring Australia, and discuss its implications for Indonesian birds. Of greatest relevance is the finding that the geographical ranges of several high-altitude cool-adapted specialists in the Wet Tropics region of northeast Australia are contracting due to increasing temperatures. Bioclimatic and population modelling studies predict that many such species will become endangered, if not extinct, with only a 1°C increase in temperature. This has serious consequences for Indonesian birds, as most of the endemic species of Sumatra and Kalimantan, and a large number of species in Papua, are montane specialists, which will be forced to shift their ranges upwards into increasingly smaller areas of suitable habitat.

Long-distance migrants are another group of birds that is likely to be affected by climate change. The East Asian-Australian Flyway is the least known of the three migratory flyways of birds breeding in the high latitudes of the Northern Hemisphere, and wintering in the Southern Hemisphere. With the earlier arrival of spring temperatures, many migratory species on the other two flyways are now arriving earlier on their breeding grounds than they did a few decades ago, causing changes in their migration schedules, which are not necessarily matched with resource availability. Australian intra-continental migratory birds are showing similar phonological trends. It seems likely that the many (100+) Palearctic migrants over-wintering in Sumatra and Kalimantan will also be similarly affected, but the data required to determine trends are lacking for all but a few raptor species. A nationally coordinated Atlas of Indonesian birds is an essential first step in collecting the sorts of data that are required to detect changes in population sizes, range contractions, and migration schedules of species affected by climate change. However this project

should not distract attention and resources awayfrom conservation initiatives aimed at combating deforestation and the conversion of logged forests to biologically sterile oil palm plantations

Key words: global warming, endemic species, montane specialists, high elevation, range contraction, Palearctic migrants, Bird Atlas

Introduction

The evidence is now overwhelming for human-mediated climate change. Over the last century the planet has warmed by 0.8°C, although most of this occurred over the last 30 years. Within the next century, the average global temperature is expected to rise another 3°C. Although the end of the last ice age saw a 5°C rise in temperature, this took about 7,000 years. What does this mean for biodiversity? Although one species (*Homo sapiens*) has evolved the ability to change the natural environment to suit its own needs, and as a consequence has successfully colonised most corners of the globe, the vast majority of the remaining millions of organisms on earth are constrained to varying degrees in their capacity to colonise new habitats. There is a growing body of evidence suggesting that the world's climate is changing faster than most species can adapt to it via natural selection (Thomas *et al.* 2004). Moreover, so many landscapes are already so heavily modified by humans that the ability of animals and plants to adapt is now severely compromised. The likely impacts of climate change on birds are changes in (1) the geographical range of species, (2) the timing of their movements and breeding seasons, (3) their population size and life history traits (such as clutch size), and (4) their physiology, morphology and behaviour (see reviews in Chambers 2005, Williams & Hilbert 2006, Olsen 2007). Avian community composition may also be affected as a consequence of any of the above working on its own, or in concert (Lemoine *et al.* 2007; La Sorte *et al.* 2009). Compared to the Northern Hemisphere, very little is known about the effects of climate change on the biota of the Southern Hemisphere (Hughes 2003; Williams & Hilbert 2006). There is also a general perception that climate change impacts will be more severe in temperate regions than in the tropics, but many studies are now showing that tropical biotas are highly vulnerable (Corlett & Lafrankie 1998; Pounds *et al.* 1999), especially those in the mountains.

In this paper I attempt to identify some of the potential impacts of climate change on birds in Indonesia, by reviewing the evidence for such impacts in neighbouring Australia, and assessing its implications for Indonesia. There is a growing body of evidence that several tropical or sub-tropical Australian birds are expanding their range southwards, just as those of the Northern Hemisphere have shifted their ranges northwards, in response to increased temperatures towards the poles.

Similarly, several Australian species are now known to have decreased in body size over the last few decades (Gardner *et al.* 2009). However Indonesia lies completely within the tropics, and as most of its islands are elongated along an east-west axis, latitudinal changes in distribution or body size are impractical to investigate and unlikely to be any significance. Thus I have focused on potential altitudinal, rather than latitudinal, shifts in distribution.

Trouble in paradise

New Guinea is considered one of the world's three great lowland tropical rainforest Wildernesses Areas, and home to most of the famous birds of paradise. In the opening paragraphs of his insightful book on climate change, *The Weather Makers*, Tim Flannery recalls climbing Mount Albert Edward, one of the highest peaks in eastern New Guinea, in 1981 (Flannery 2005). Above 3,000-3,500 m the montane vegetation on the highest island on earth changes abruptly from moss-shrouded subalpine forest to open tussock grasslands studded with tree ferns. However on the floor of the forest, Flannery noticed dead tree ferns, which he knew grew only in the grasslands. The forest, he deduced, was expanding upwards, and further speculated that this was due to increasing temperatures in the recent past.

Judging from the distribution of the tree fern trunks, [the forest] had swallowed at least 30 m of grassland in less time than it takes for a tree fern to rot on the damp forest floor – a decade or two at most. [Flannery 2005]

Clearcut evidence of climate change affecting the tops of New Guinea's mountains comes from the retreat of its glaciers. In the western half of the island (Irian Jaya or Papua), the Carstensz Glaciers on Mount Jaya (Puncak Jaya; 4884 m above sea level) in the Snow Mountains, have been shrinking since they were first photographed in 1907 and 1936 (Prentice & Hope 2007). The glaciers retreated from c.11 km^2 in 1942 to 2.4 km^2 by 2000, an 80% decrease in ice area. Using high-resolution satellite images from 2000 and 2002 and comparing these with previous photographic studies, Klein & Kincaid (2006) predicted that the remaining ice masses on Puncak Jaya – one of only three equatorial glacier complexes on the globe - will melt within 50 years.

Are high altitude species affected by climate change?

One of the first places to demonstrate the effect of climate change on the fauna of tropical mountains was the cloud forest of Costa Rica. Here the decline and disappearance of no fewer than 20 out of 50 frog and toad species, as well as changes in the bird and lizard communities, were associated with a decrease in dry season mist frequency since the 1970s (Pounds *et al.* 1999). According to the "lifting-cloud-base" hypothesis, atmospheric warming has raised the average basal altitude of the cloud layer over land. On their 30 km^2 plot at 1,540 m in the tropical highlands

of Monteverde, Pounds *et al.* (1999) found that the number of sub-montane (<1,470 m) or cloud-intolerant bird species in 1979-81 had increased by 1998, while the number of lower montane species (>1,470 m) remained stable. This upslope colonisation was not caused by habitat alteration at lower latitudes as it involved both open-country and forest-dependent species. Moreover, 15 colonising species established breeding populations and became more abundant on the plot.

Much closer to Indonesia is the World Heritage Area of the Wet Tropics bioregion of northeastern Australia. This relatively small area (c. 10,000 km^2) is home to 65 species of regionally endemic vertebrates, most of which are restricted to the cool, wet rainforests above 300 m (Shoo *et al.* 2005a,b). Using bioclimatic models of spatial distribution to predict the effects of climate warming on these cool-adapted species, Williams *et al.* (2003) found that with an increase of 3.5°C, 30 vertebrate species would completely lose their core habitat, resulting in their extinction, while the surviving 35 species would retain only 11% of their current distribution. Of the 12 species of birds endemic to this region, five are restricted to these upland rainforests, and some are thought to have global ranges of less than 2,000 km^2 (Stattersfield *et al.* 1998). One such species is the Golden Bowerbird *Prionodura newtonia* whose estimated total habitat currently comprises 1,564 km^2 spread over many separate rainforest patches. Using a generalised linear model based on climatic variables, Hilbert *et al.* (2004) predicted that the habitat of this species will shrink to 582 km^2 with future warming of 1°C, and with a 3°C warming, to just 37 km^2, clearly compromising its chances of survival.

Such estimates of extinction risk following predicted changes in the size of species distributions under future climate change scenarios are largely derived from models of 'climatic envelopes'. These models represent the full spectrum of climates within a species' range and are usually based on simple presence/absence survey data. Yet most species can be expected to vary in abundance because of spatial variation in climate, topography, community composition and disturbance within their range. Shoo *et al.* (2005a,b) argued that accurate predictions about climate change impacts require quantitative data on the abundance of each species across the environmental gradients within their range, as such data are fundamental to estimating changes to total population size. The latter is also a key criterion in determining IUCN conservation status.

Shoo *et al.* (2005a) used abundance data and expected upslope shifts across altitudinal gradients to predict the changes in total population size of 55 species of Australian tropical rainforests birds (including the 12 regional endemics) under a range of projected future climates. According to their most conservative model scenario, 41 species (74%) were predicted to become threatened (including 26 critically endangered species) as a result of projected mid-range warming (i.e. +3.6°C) expected within the next 100 years. Upland birds were most affected and were likely to be

immediately threatened by even small increases in temperature (Shoo *et al.* 2005a). Moreover, predicted declines in population size occurred at a much faster rate than that suggested by distribution area alone (Shoo *et al.* 2005b). Indeed, nine of the 12 endemic bird species were expected to suffer disproportionately large losses in population size following an initial reduction in distribution area.

One such species is the Grey-headed Robin *Heteromyias albispecularis*, one of the endemic upland rainforest species, which has many close relatives in Papua. Using abundance data for this species to develop a generalised linear model, Li *et al.* (2009) predicted that when temperature increases, the robins became more abundant at high elevation, but less abundant at low elevation. Consistent with the predictions of Shoo *et al.* (2005b), population size declined more than the habitat area under all climate change scenarios, implying that the species might become extinct long before the complete loss of its habitat.

However, climate change is predicted to result not only in increased temperatures but also in increased rainfall seasonality, which may lead to increases in the average length and severity of dry seasons. Indeed, increasing climatic seasonality may be more critical than increasing temperatures for many tropical birds, which experience little or no seasonal changes in temperature and photoperiod. Williams & Middleton (2008) showed that the most significant variable explaining spatial patterns of bird abundance in the Australian Wet Tropics was within-year climatic variability, particularly rainfall seasonality. They surmised that this pattern was due to a bottleneck of resources, particularly insects, during the dry season, which limits breeding success, and hence, the population size of many birds. Thus, increases in seasonality due to climate change could produce significant declines in bird abundance, exacerbating the impacts of increasing temperature (Williams & Middleton 2008).

High altitude specialists in Indonesia

There have been no studies to date investigating actual or potential changes in the altitudinal distribution of birds in Indonesia. However, one study examined such changes in birds of mainland South-east Asia, including Peninsular Malaysia, which shares so many species with Sumatra, that the two are combined into a single Endemic Bird Area (EBA158; Stattersfield *et al.* 1998). Peh (2007) compared data on the altitudinal limits for birds given in two well-known field guides (King *et al.* 1975; Robson 2000), which were published 25 years apart. Of 306 common resident species, 94 (31%) were found to shift their altitudinal range upwards over that period. Of these 94 species, 84 (28%) extended their upper altitudinal limit only, by an average of c. 400 m (range 105-1525 m), while seven species shifted only their lower limit upwards, and the remaining three species shifted both their upper and lower limits. Peh (2007) ascribed the upward shifts in distribution to

climatic warming over the same period, although he did not explain why 32 species were found to shift both upper and lower limits downwards. A major weakness of this study is that the differences between information sources in altitudinal minima and maxima for each species may simply reflect the improved state of knowledge by the 1990s (Peh 2007). Given the potential problem of different sampling methodologies and sample sizes used in the two guides, it would be risky to extrapolate the results of this study to Indonesia.

As noted earlier, Sumatra shares many of its resident species with Peninsular Malaysia, as does Borneo (87% and 83% of their resident species, respectively; MacKinnon & Phillipps 1993). It is now well-known that during the Pleistocene ice ages, when sea-levels were much lower than those of today, Borneo, Sumatra, Java and Bali (the Greater Sunda Islands) were repeatedly joined to each other and to the mainland, while those of Wallacea, comprising Sulawesi, the Lesser Sundas and the Moluccas, remained isolated due to deep seas.

Despite being considerably smaller in size than Borneo, Sumatra has more resident bird species (Table 1) because it is closer to the mainland and hence, remained connected to it for longer periods. For the same reason, however, Sumatra has fewer endemic species than Borneo (Table 1). Significantly, the majority of endemic birds of the Greater Sundas, indeed all of those of Sumatra, are montane, while those of Wallacea are mainly lowland forms (Table 1). A simple explanation for the low proportion of lowland endemics in the Greater Sundas is that any progress towards speciation of isolated lowland-specialised taxa during the interglacial periods (when sea-levels were similar to those today) would have been nullified by gene flow between sibling taxa during the glacial periods, when these islands were joined to the mainland. In contrast, the mountains would have remained as evergreen refuges for wet-adapted taxa within a matrix of drier vegetation during the glacial periods (MacKinnon & Phillipps 1993).

Table 1. Numbers of endemic land bird species on selected islands of Indonesia, and the proportion that are montane. Sources of information listed below*.

	No. resident land bird species	% residents land birds that are endemic (n)	% endemic land birds that are montane (n)	Highest mountain in metres asl
Greater Sundas				
Sumatra	397	5.5 (22)	100 (22)	3,805
Borneo	358	10.1 (36)	72 (26)	4,101
Java	289	10.4 (30)	53 (16)	3,676
Wallacea				
Sulawesi & satellites	224	39.3 (88)	27 (24)	3,455
Sumbawa	168	0	0	2,851
Timor	137	16.1 (23)	5 (1)	2,963
New Guinea				
Papua (Irian Jaya)	577	56 (323)	28 (90)	4,884

* Values for Sumatra, Borneo and Java, based on MacKinnon & Phillipps (1993), in which waterbirds, waders and wide-ranging raptors are excluded; Sulawesi, Coates & Bishop (1997); Papua, Mack & Dumbacher (2007); Sumbawa, Trainor (2002) and Stattersfield et al. (1998).

For similar reasons, the islands of Wallacea have never been joined to mainland Asia, nor, in many cases, to neighbouring islands, since their emergence. Here avian endemism is much higher than in the Greater Sundas. Indeed the Northern Maluku Endemic Bird Area (EBA 171) ranks tenth globally in terms of restricted-range species richness, including 26 species that are endemic to this EBA (Sattersfield *et al.* 1998). All but two of these endemics occur on the large island of Halmahera, and four are endemic to this island alone (Coates & Bishop 1997; Stattersfield *et al.*

1998). Despite having mountains reaching 1635 m, all bird species on Halmahera have been recorded down to sea-level.

However, the mountainous islands of Buru and Seram in South Maluku (EBAs 169 and 170), with their highest points at 2429 m and 3027 m, respectively, are exceptions to this pattern. Of the ten species endemic to Buru, five (50%) are confined to hill and montane forests above c. 500 m; and of the eight endemics on Seram, three are found only above c. 800 m (Stattersfield *et al.* 1998). Poulsen & Lambert (2000) attributed the distinct montane bird community on Buru to its large continuous area of forest at high altitude. Northern Nusa Tenggara (EBA 162) has 17 endemic species, of which only three species are confined to montane forest above c. 1000 m on Sumbawa and Flores (Stattersfield *et al.* 1998). Nevertheless, on Mount Tambora, Sumbawa, Trainor (2002) found that all 11 RR species present occurred at 1200-1600 m, and ten were found above 1600 m, highlighting the conservation significance of hill and montane forests on the island.

At the eastern end of Indonesia is New Guinea, the highest island on Earth where, as previously mentioned, there is evidence of retracting alpine grasslands and melting glaciers. A total of 657 bird species are known to occur in the Indonesian provinces of Papua and West Papua that cover the western half of the island (Mack & Dumbacher 2007). Although most species in these provinces are shared with Papua-New Guinea (PNG) and/or Australia, 38 are endemic (Mack & Dumbacher 2007). Many endemic species are montane. The West Papuan Highlands (EBA173, including the Vogelkop Mountains) have nine endemic montane (>1000 m) species, and the North Papuan Mountains (EBA175) five endemic species (including two recently described from Foja Mountains), while the extensive Central Papuan Mountains (EBA178) have no fewer than 39 endemics, of which six are found only in the Snow Mountains of Papua. Including the six endemics of the Adelbert and Huon Ranges in northeast PNG, therefore, gives a total of 90 species that are endemic to the mountains of New Guinea (mostly >1500 m), representing an estimated 28% of the island's endemics (Table 1). These include five species confined to alpine grasslands and shrublands above the tree-line (> 3900 m), and another five species associated with both grasslands and high conifer-dominated mountain forest (>2500). Given Flannery's (2005) observations, the latter species may already be at risk from global warming.

In summary, if the effect of global warming on the montane avifauna of Indonesia is similar to that predicted for birds of the Wet Tropics of Australia, over 150 species that are endemic to the mountains of Papua, Sumatra, Borneo, Java and Sulawesi must be considered at risk of extinction due to range contractions and population declines within the next 100 years. Moreover if the birds of these wetter regions of Indonesia are as sensitive to increasing rainfall seasonality as those of the Australian Wet Tropics (Williams & Middleton 2008), declines in bird species abundance may be

more rapid than that predicted by increasing temperatures alone. Clearly, however, bioclimatic modelling studies are required to assess the true level of threat imposed by climate change on Indonesia's montane avifauna.

Changes in phenology

Temperature is the most important cue for avian phenological events, including the timing of migration, territory formation and laying dates (Gordo 2007). For migratory birds, the timing of arrival on breeding territories and over-wintering grounds is a key determinant of reproductive success and survivorship, and hence, fitness. There is now substantial evidence that the arrival of a large percentage of migratory birds at their breeding grounds over the last few decades has advanced by as much as 6 days per decade, and that this shift is associated with climatic warming (Parmesan & Yohe 2003; Root *et al*. 2003). To date, however, almost all studies of this kind have focused on the responses of Northern hemisphere birds. However, recently, Beaumont *et al.* (2006) analysed data on the first arrival dates and last departure dates of migratory birds in southeast Australia since 1960. The results shocked many Australian ornithologists.

Consistent with findings in the Northern Hemisphere, 12 (50%) of the 24 species analysed showed a significant trend towards earlier arrival, whereas only one species arrived significantly later. Yet Australia, spanning tropical to warm temperate latitudes, has a much milder climate than Europe or North America, and as a consequence of this and its long history of geographic isolation, none of its breeding landbirds migrates across the equator. Indeed, except for a few species that migrate to New Guinea and the Lesser Sundas, Australian-breeding migratory birds move within the continent, travelling less than 1000 km from their breeding to non-breeding grounds (Chan 2001). Since 1960 to present day, however, these short-distance migrants have been arriving at their breeding grounds 3.1 days per decade earlier, and delaying departure by 8.1 days per decade, thus extending the time spent on their breeding grounds by about 11 days per decade (Beaumont *et al.* 2006).

The overwhelming majority of migrants visiting Australia are Palearctic shorebirds (37 species), most of which breed in eastern Siberia and China, and migrate up and down the East Asian-Australasian Flyway through Korea or Japan to Indonesia or Australia and New Zealand (Bamford *et al.* 2008). Beaumont *et al.* (2006) showed that some of these long-distance migrants have advanced both their arrival and departure dates by an average of 6.8 and 6.9 days per decade, respectively, suggesting that the length of stay has not changed, but that the timing of events had simply advanced. However, their analysis is based on few species, and more pertinently, depends on the dates when observers first saw one or more birds arriving or departing, data which may not accurately reflect the arrival and departure times of most of the population. If the population size or

sampling effort decreases over time, but the population's mean arrival time does not change, the likelihood of observing the earliest migrants declines, giving the impression that the first bird is arriving later over time (Miller-Rushing *et al.* 2008).

In the Northern Hemisphere many species are now breeding earlier due to the earlier arrival of spring temperatures (Crick et al. 1997, Coppack & Both 2002, Visser *et al.* 2004). Although this might seem advantageous to birds by providing a longer breeding season, and hence an increased opportunity for multiple broods, it can lead to disadvantages if food resources are not affected in the same way. Such mismatching of egg laying and peak food availability has already affected the reproductive success of some species (Coppack & Both 2002). Migratory birds are particularly vulnerable to such mismatches as climate change does not act equally over the globe, so migration may be mistimed with resource availability at any number of staging and/or breeding areas (Jones & Cresswell 2010).

The "phenology mismatch" hypothesis predicts that migratory birds, which experience a slower rate of warming in their wintering grounds than in their breeding grounds, are more likely to be in decline because they will arrive after the optimum timing of spring resources (Jones & Cresswell 2010). Indeed, in general, migrants have been found to be declining more than non-migrants, with long-distance migrants declining the most because the chances of a phenology mismatch during migration increase with the number of staging sites (Sanderson *et al.* 2006). Jones & Cresswell (2010) analysed temperature trends and population trends for migratory species breeding in the Northern Hemisphere, and found that "phenology mismatches" were correlated with population declines in North America, but not in Europe, where migration distance was a more important of declines. They suggested that differences in geography, average migration distance, migrant species composition and anthropogenic change may account for this disparity between the two continents.

Migratory birds in Indonesia

As with patterns of species richness and endemism, the proportion of migrants in the Indonesian avifauna varies markedly across the archipelago. Like Australia, Wallacea and Papua are visited by relatively few long-distance migratory landbirds (Beehler *et al.* 1986; Coates & Bishop 1997). However, this contrasts strongly with the Greater Sundas, where an estimated 25% of the entire avifauna of 820 species is said to be comprised of North Temperate migrants (MacKinnon & Phillipps 1993), although about 60 of these are Palearctic shorebirds (including gulls and terns), most of which are shared with Australia. The remainder is comprised mainly of raptors, flycatchers, thrushes, and warblers, with smaller numbers of swallows, wagtails and pipits. Apart from a few species of migratory raptors that have been studied in some detail (Ash 1993, Nijman

2004, Nijman *et al.* 2006, Germi *et al.* 2009), very little information is available on the arrival and departure schedules, and migration routes, of the large number of Palearctic migrants that over-winter in Indonesia.

Although the East Asian - Australasian Flyway is the least known of the world's three major flyways for migratory birds, Bamford *et al.* (2008) estimated that it is used by a minimum of 8 million shorebirds of 54 species, 42 of which visit Indonesia during the austral summer. Indonesia supports a significant proportion (>5%) of the population of more shorebird species (14) in the Flyway than any country other than Australia. Over three-quarters of the global population of the Asian Dowitcher ***Limnodromus semipalmatus*** is present in Indonesia during the non-breeding period, and one important site was identified for the Endangered Spotted (Nordmann's) Greenshank ***Tringa guttifer*** (Bamford *et al.* 2008). Of the eight internationally important sites in Indonesia, most are in Sumatra. Banyuasin Delta and the Kualatungul to Tanjung Jabung coast in the south-east of Sumatra are used mainly during southward migration, whereas records from Bagan Percut on the west coast of Sumatra are from the non-breeding and northward migration periods (Bamford *et al.* 2008).

Whilst the direct loss of habitat due to land reclamation is the major threat to migratory shorebirds in Asia (Birdlife International 2003), predicted rises in sea level due to climate change could result in further loss of large areas of tidal flats, especially where the coastline is developed and therefore the tidal habitat cannot move inland (Bamford *et al.* 2008). Currently, apart from a few species of concern, there is little evidence of declines among the shorebirds using the East Asian-Australasian Flyway. However population trends are difficult to assess due to inadequacies of the available data (Bamford *et al.* 2008). For migratory landbirds breeding in China and Korea and over-wintering in Indonesia, population data are likely to be even sparser. Therefore an assessment of population trends and evaluation of the role of phenology mismatches on the majority of species using the East Asian-Australasian Flyway are unachievable at this stage.

Concluding remarks

Studies in Australia have revealed that climate change is causing shifts in the geographic range of many resident species, and changes in the arrival and departure times of several migratory species. There is also evidence that, consistent with trends in the Northern Hemisphere, the body size of several temperate Australian species has decreased over the last 100 years (Gardner *et al.* 2009). The consistency of these

biological impacts of climate change in different parts of the globe (notwithstanding intercontinental differences in the role of phenology mismatches) make it is highly likely that Indonesian birds are also being affected by climate change.

Much research in Australia has focused on the potentially catastrophic impact of increasing temperatures and rainfall seasonality on the fauna of the Wet Tropics, which includes five bird species that are endemic to the uplands. Within Indonesia, however, some 64 species of birds are endemic to the mountains of the Greater Sundas alone, and another 90 species are confined to the New Guinea highlands (Table 1). Whilst climate change researchers in Australia repeatedly lament the lack of long-term monitoring data to permit robust analyses of changes in population sizes and phenology of Australian birds, such data are virtually non-existent in Indonesia!

An inescapable conclusion from this review is that there is an urgent need for precise distributional and phenological data for Indonesian birds, especially for montane resident species, and migratory species, most of which occur in the lowlands. In Australia, much of the distributional data used in early trend analyses and bioclimatic modelling studies were derived from the Atlas of Australian Birds, a scheme initiated by Birds Australia (formerly Royal Australasian Ornithologists Union) in the 1970s, in which thousands of amateur ornithologists have participated. Sadly our knowledge of Indonesia's birds lags well behind that of birds in most other parts of the world, and to date ornithological studies have been dominated by westerners. The first guides to the birds of all of the Greater Sundas (Sumatra, Borneo, Java and Bali) and Wallacea (Sulawesi, NT and Maluku) were published in 1993 and 1997, respectively, but the lack of Bahasa Indonesia versions of these books until 1998 and 1999, has hampered amateur participation in ornithology by Indonesian nationals. Since the establishment of Burung Indonesia, and the subsequent formation of the Indonesian Ornithological Union (IdOU) in 2004, numerous local bird clubs have emerged, signaling a growing interest in birds. The stage is now set for an Atlas of Indonesian Birds, which will begin the vital work of collecting distributional and phenological data that are needed to assess the impact of climate change on the birds of this mega-diverse nation.

Whilst data collection is essential for determining the impact of climate change and other environmental threats, it should not distract attention away from the urgent need to halt deforestation in Indonesia (Sodhi *et al.* 2004, 2009). Although forestry exports are a vital source of income to developing countries such as Indonesia, the economic benefits from forestry are now declining, because most forests outside protected areas have already been logged (Berry *et al.* 2010). Consequently, logged forests are coming under increasing pressure for conversion to other more profitable land uses, such as oil palm plantations. One proposed mechanism to counter these economic incentives is to compensate developing countries for preserving carbon stores, through

payments for Reduced Emissions from Deforestation and Degradation (REDD; Gullison *et al.* 2007; Canadell & Raupach 2008). Edwards *et al.* (2009) have shown that logged forests, if managed for rehabilitation, have considerable biodiversity value. Meijaard & Sheil (2007) also argue that a logged forest in Borneo is much better than no forest at all. Preventing the conversion of logged forests to oil palm or other crops, and protecting unlogged forests, should remain the priorities for policy makers and conservationists in Indonesia.

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Climate change, Biodiversity and Livelihoods in the Indian Himalaya

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Abstract

Conservation of biodiversity and avoidance of negative impacts of climate change are the perhaps most critical challenges faced by all sections of the society. The patterns and processes related to climate change and biodiversity are so complex that corrective measures are often taken with an imperfect scientific knowledge base. This article draws on the scope of indigenous knowledge in mitigation and adaptation to climate change, with special reference to central region of Indian Himalaya.

1. Introduction

With adoption of Convention on Biological Diversity and United Nations Framework Convention on Climate Change, global warming and biodiversity depletion figure as the most critical challenges for sustainable development worldwide. As the current phase of climate change has been progressing parallel to a whole range of ecological-socio-economic-cultural-technological changes, with significant interactions between them, it is difficult to precisely segregate the effects of climate change on ecosystem structure and function and livelihoods. This article deals with some dimensions of climate change-biodiversity-livelihoods relationships in the central region of Indian Himalaya, a region distinguished globally for its rich biodiversity and far-reaching climatic and hydrological environmental services.

2. Climate change -trends and perceptions

2.1. Scientific perceptions

While unprecedented rate of global warming in recent times is conclusively established, scientific capacity to predict future climate scenarios is limited, with projected warming rates reported in the range of 1.0 to 5.8 ^{0}C on a global scale (IPCC, 2001) and 0.4 to 2.0 ^{0}C in India (Hingane et al., 1985; Parish and Funnell, 1999) largely because of an upward trend in maximum temperature (Rupa Kumar et al., 1994). Kavi Kumar and Parikh (2001) considered warming by 2 ^{0}C together with a 7% increase

in precipitation as the 'best guess'. Climate change projections may vary depending on the analytical tools used for making predictions. A trend of warming in the 20th century in Himalaya unraveled by mathematical modeling and trend analysis of long-term climate data is not supported by the tree ring width data (Yadav et al., 1997). Future climate scenarios in higher Himalayas constructed by the Oregon State University model radically differ from those by Goddard Institute Space Studies model (Brazel and Marcus, 1991). Nesting of high resolution local/regional models within the low resolution global models can improve precision of predictions. While monsoon rainfall has been considered trendless over a long period of time by many workers, Rupa Kumar et al. (1992) concluded a decline in rainfall by 6-8% per hundred years over the north-eastern but an increase by 10-12% per per hundred years over the western part of the country. Prediction of sporadic extreme climate events is much more difficult compared to changes in climate on annual or seasonal scale. An uncertainty in the projected rates of climate change implies an uncertainty of the predictions about its consequences or the outcomes of the mitigation or adaptation measures identified based on an imperfect knowledge. Enhancement of scientific knowledge must be an integral component of all climate change programmes (Steffen et al., 2002). Farmers' perceptions about climate change can provide useful insights for adaptation and vulnerability to climate change.

2.2. Farmers' perceptions

Farmers are concerned more with the impacts of and adaptation to rather than the nature and degree of climate change. Reconstruction of the past by farmers will always be limited to variables which are traditionally quantified, and to a time scale within the range of human memory (Showers, 1996). Farmers can hide or provide inaccurate information (Omiti et al., 1999) and hence a careful cross-checking of responses is required. One can ask farmer to identify climate change or to list changes in their surroundings first and then to identify the causal factors. Majority of Himalayan farmers accept climate change but are unable to measure its rate. They conclude warming based on a trend of a decline: (i) in area and duration of snow around snow peaks and (ii) in time and energy put in to clear pathways during snowfall period.

By 'good climate year' farmers mean sporadic low rainfall events during March-May, peak monsoon rainfall during July-August, moderate rainfall/heavy snowfall during December-January and absence of cloud burst events, with highest degree of uncertainty attached to the onset of monsoon and time of abnormally high rainfall events. Thus, farmers attach more importance to precipitation than temperature. Farmers feel a trend of decrease in frequency of occurrence of good climate years, with increasing frequency of abnormally high precipitation events at elevations > 1500 m, low precipitation events in 500-1500 m zone and of both kinds of abnormalities in the foot hill zone. People believe drought, excessive rainfall/flood, hail storm and cloud burst events as

unpredictable and unavoidable events in the hands of supernatural powers. Prayers and rituals devoted for favorable climates, though undoubtedly superstitious, seem to have fostered evolution of ecosystem management practices and institutions enabling minimal possible damage due to and fast recovery following catastrophic events. Farmers consider climate change a factor not as crucial as other factors in determining spatio-temporal dynamics of ecosystems and livelihoods, suggesting the need of integrating climate change issues with the livelihood issues (Table 1).

Table 1. Climate change attributes s drawn from analysis of people's perceptions in Indian central Himalayan region

Kind of change	Evidence	Response
Decline in snowfall/rainfall	• Decline in snow-covered area around clearly visible peaks • Decrease in depth and persistence of snow around settlements in higher altitudes • Decline in apple yield as it needs proper chilling during winters for proper fruit yield	• Decline in transhumant practices as poor winter precipitation is believed to follow poor fodder quality as well as quantity • Replacement of apple by annual cash crops like pea, tomato, cauliflower, chilly and cabbage under rainfed conditions in higher altitudes and irrigated conditions in lower altitude
Decline in rainfall during March-May	• Adverse impacts in terms of decline in yield of Kharif crops due to large scale mortality and/or poor growth in the initial stage of crop growth	• Abandonment of crops e.g., *Panicum miliaceum* which used to be sown in March. This crop matures over a period of 3 months. The crop is badly affected if rainfall is delayed. • Casual management of traditional staple food crops grown during rainy season • Replacement of *Amaranthus paniculatus* by cauliflower, cabbage and potato, search of off-farm employment opportunities • innovation of new agricultural practices characterised by high labour productivity and stress tolerant cash crops, e.g., bush fallow agriculture
High rainfall during August/September instead of the normal peak in July/August	• Damage to rainy season crops when they are close to maturity • Huge landslides blocking roads during August-September	• Search for off-farm employment opportunities
Winter precipitation in January/February instead of December/January and decline in intensity of snow fall	• Delayed ploughing/sowing of wheat, barley, naked barley and mustard – earlier it used to be done in November but now in December • high yielding variety of wheat and green pea which did not perform well earlier, can perform well at higher altitudes • Decline in barley and wheat yields but in black pea (black does not need as much soil moisture as wheat and barley)	• Replacement of traditional cultivars of wheat by high yielding varieties • replacement of barley by green pea
Increase in instances of cloud burst	Heavy losses of life and property due heavy downpour over a short period of time	Re-establishment of dwellings

3. Climate and agrobiodiversity

Cropping patterns in the Himalaya are built around two seasons: the monsoon/rainy season and the winter season. With a belief of occurrence of absolute crop failure due to bad climate only in one cropping season in a year, farmers tend to stock staple food required for a period of 6 months. Over the last 50 years, farmers could recall complete failure of both crops only in 1966-67 in a few high elevation villages. People coped such a situation by consuming wild staple food like dried fruits of *Pyrus pashia* and *Aesculus indica* and by selling non-timber forest products and earning wages in far off places. However, policy of supplying a quota of staple food at subsidized price since 1970s has drawn farmers' attention away from local production based food security system (Semwal et al., 2004; Singh et al., 2008). Even though sowing of winter crops has been delayed by about a month due to late winter precipitation in recent years, harvesting time seems to be unchanged possibly because of warming.

Farmers view two major risks to crops: the risks arising from (a) uncertainty of monsoon rainfall and (b) cultivating distant fields that demand huge labor and time spent in travel/transport. Maintenance of a heterogeneous village landscape is a reflection of indigenous ways of risk management: the rainfed crop agroecosystem is characterized by both climatic and distance related risks, rainfed agroforestry systems by only climatic risks, the irrigated crop system by only distance related risk and the homegarden system by neither of the two risks (Singh et al., 2008). Within an agroecosystem type, farmers cope climatic risks by growing crops/cultivars based on indigenous knowledge on their responses to different ecological conditions ((Bardsley, 2003). After the first monsoon showers in April/May, Muatha and Bhagan cultivars of barnyard millet and Jhalarya and Chauras cultivars of fingermillet are sown in a few fields. If monsoon commences by mid-June, maize is sown in about 50% of the remaining fields. If maize growth is normal till 20-25 days after sowing, soybean is intercropped between maize rows and Mungerikuad cultivar of fingermillet is sown in the remaining vacant fields. If the crop growth is poor during first month after sowing, maize fields are ploughed afresh and sown with Mungerikuad cultivar of fingermillet. If monsoon does not commence by mid-June, all cultivars of barnyard millet and fingermillet are sown, covering almost equal areas (Figure 1). Jhaidu and Khimanand ki Ghodi are local rice cultivars able to withstand hail storms while Rekher or Syal Satti varieties of rice and Misri and Thangya varities of wheat can survive heavy snow fall during early stages of crop growth.

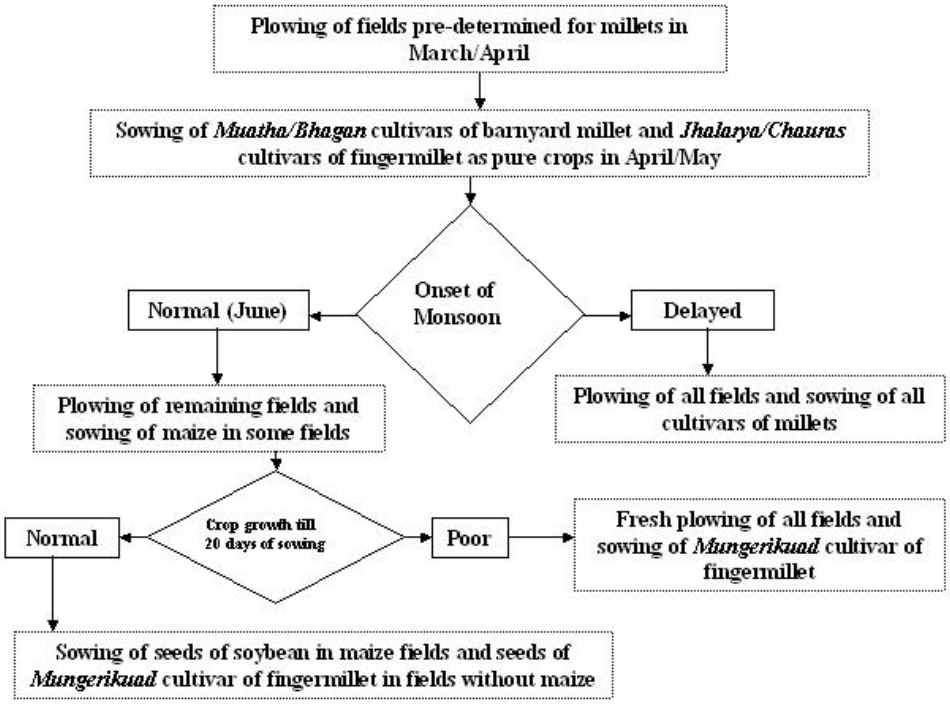

Figure 1. Farmers' decision making on cropping pattern during rainy season in rainfed agro forestry system (based on Singh et al., 2008).

Farmers classify crops in three groups based on their responses to various stresses/risks together with their economic values : (a) economically more-valuable crops with poor performance under extreme rainfall regimes, low soil fertility levels and weed abundance: maize, soybean, paddy, wheat, lentil, potato, buckwheat, amaranths and green vegetable, (b) economically less-valuable crops with ability to perform under unfavorable climatic conditions, low soil fertility levels and weed abundance: fingermillet, barnyard millet and barley, and (c) economically more-valuable crops with ability to perform under unfavorable climatic conditions, soil stresses and weed abundance: sesame, cowpea, black pea (*Pisum arvense*), horsegram and pigeon pea. Though many farmers' perceptions about crop-environment relations are substantiated by scientific evidences (Maikhuri et al., 1996; Singh et al., 1997; Sherchan et al., 1999; Pilbeam et al., 2000; Singh et al., 2008), there is a need of developing long term comprehensive programs for validation and enhancement of local knowledge system. A traditional crop like *Panicum miliaceum* is unique in that it's maturity time is as short as two months but is not viewed as a delicious food by local people. Increasing the area under this crop following bad climate seasons is a common way of achieving food sufficiency. Farmers apply higher levels of inputs available in limited quantities to

the perceived low risk agroecosystems as compared to the more risky ones (Carter and Murwira, 1995).

Conversion of rainfed to irrigated farming reduces the risks of climatic uncertainty and improves productivity (Bhatnagar et al., 1996; Maikhuri et al., 1997) but has not progressed much for two reasons. First, farmers face a shortage of manure (due to scarcity of forest resources) required for performance of irrigated crops and are unable to afford chemical fertilizers. Second, labor productivity from the irrigated crop system is lower than other traditional land uses like homegardens. Highly productive indigenous irrigated farming systems do exist in situations where rainfed crops fail to survive (e.g., cold desert) or when population pressure exceeds the carrying capacity of rainfed agriculture or when farmers do not have any source of income other than irrigated crops (Rao and Saxena, 1994; Chandrasekhar et al., 2007).

A trend of replacement of traditional staple food/fodder crops by cash crops is progressing fast since last couple of decades partly because of a socio-cultural transformation from subsistence to market economy often supported by development programmes enabling availability of food and modern agricultural inputs at subsidized rates and government supported marketing system (Singh et al., 1997; Semwal et al., 2004). Farmlands in the Himalaya are heavily dependent on forests for manure and livestock feed. The ongoing changes in cropping patterns are such that manure input rates have increased along with an increase in soil erosion rates but fodder production from farmland has decreased, which, in turn, has increased the threats to forest ecosystem functions as a result of higher intensities of litter removal and grazing in forests (Sen et al., 1997; Maikhuri et al., 2000). The tendency for maximisation of income has marginalised the traditional values attached to crop-environment compatibility, social integrity achieved through exchange of complementary crop products and farmers' selection/conservation of crop genetic diversity. Over time, many local communities have gained some understanding about the market risks and uncertainties and have been found to grow cash crops to an extent that their traditional food security system is least disturbed (Maikhuri et al., 2000; Semwal et al., 2004). As biological potential of traditional crops/cultivars is poorly understood, their loss is not in the interest of the scientific and wider community too. Traditional farmers had selected and conserved a wide variety of crops and cultivars to cope up with the risks, uncertainties and extremes of monsoon and huge micro-edaphic variability in the mountains. Pests and diseases are common in warm-cold regions but not in extreme cold arid region, indicating a possibility of higher risks of damaging agents in warmer climate. Farmer selected cultivars/crops may reduce such future risks.

4. Forest biodiversity-agrobiodiversity-climate change linkages

Theoretically, plants may respond to climate change in four possible ways: (a) phenotypic plasticity enabling species survival, with alterations in eco-physiological processes, in the changed climate, (b) evolutionary adaptation to new climate, (c) emigration to favorable habitats and (d) extinction (Bawa and Dayanandan, 1998; Saxena and Purohit, 1993). Indicators of warming reported by people indicate phenotypic plasticity: shifting of flowering time of *Rhododendron arboreum* from February/March to January/February and of fruit ripening time of *Prunus cerasoides* from February to January. Farmers observed an increase in dominance of *Bauhinia vahlii* (a woody species twining around *Pinus roxburghii* trees) and attributed this change to reduction in fire frequency arising from shortening of hot-dry period. Indeed, people's observations are confined to biologically conspicuous species and the ones affecting their livelihoods.

Forests provide fodder and manure, protection of crops from wildlife and downslope processes and drinking water (through recharge of springs, the source of drinking water), the various forms of environmental services directly to local inhabitants from natural forests, apart from the services, such as regional hydrological balance, soil and biodiversity conservation and carbon sequestration, to the benefit of the global community. Climate change raises a question of uncertainty about these services in future. Forest resource use regimes, which do not pose any threat to both global and local benefits from forest ecosystems, have neither been worked out in scientific terms nor in the indigenous knowledge system. A religious belief that natural hazards/catastrophic events follow if timber trade is adopted as a means of livelihood and agricultural land use is expanded for economic development together with socio-cultural norms allowing sale of non-timber forest products only by economically weaker families and forest resource uses in groups of families, with utilization-regeneration regimes decided by the community, are the elements of social capital favoring forest conservation. People value forests most for availability of inputs required for sustaining agricultural production, health and the insurance it provides from the uncertainties of environmental extremes (Singh et al., 2008).

5. Climate change mitigation and adaptation: strategic actions

As a rich biodiversity base would provide a greater variety of adaptations to changing climatic conditions, effective ways and means of biodiversity conservation are urgently needed.

5.1. Protected area management

Protected areas will be able to achieve their stipulated goal only when conservation actions are coupled with development of local communities. A number of recent studies do not support the assumption of protected area planners that traditional resource systems (e.g., tourism, low input

crop/livestock husbandry) agriculture were not 'efficient' (Maikhuri et al., 2000; Semwal et al., 2004; Chandrasekhara et., 2007; Singh et al., 2008). Larger soil organic carbons stocks and biodiversity in traditional homegardens (Singh et al., 2008) do not support the common contention of a viewing forest land use more efficient than farming in terms of carbon sequestration. Rarity of many economic species is often attributed to over-exploitation, though it may also be related to climate change. Traditional resource uses need to be scientifically evaluated and conservation strategy should be built on indigenous knowledge completed/supplemented by scientific knowledge and institutional support.

5.2. Conservation of traditional crop diversity

As biological potential of traditional crops/cultivars is poorly understood, their loss is not in the interest of the wider community. A realization of negative consequences of high yielding varieties, viz., dependency on external agencies for seeds, fertilizers, irrigation and pesticides, drastic yield losses under unfavourable climatic conditions and low input management and lower fodder production compared to traditional varieties, in recent years has rejuvenated local efforts towards agrobiodiversity conservation in Hanval valley of Tihri Garhwal. Such efforts must be followed with scientific analysis of crop/cultivar-environment relationships.

5.3. Water management

Global warming will aggravate water stress, a factor often limiting crop yields and life quality. Traditional systems centered on minimum inputs for water purification, storage and canalization, minimal interference with natural hydrological processes, and minimal risks of damages likely from high rainfall events were, by and large, abandoned when water supply was treated as a government service to the people. With experiences of the large scale failure of the new system over the last few decades (Rao and Saxena, 1994), innovations in water technology and management sectors that can be sustained in the likely global warming scenarios are needed.

5.4. *Improvement in traditional agroforestry tree management*

Traditional farmers usually lop all branches of farm trees during winters when fodder/ fuelwood are scarce in forests. Retention of 25% of branches together with an increase in try tree density in farmland will enhance carbon sequestration in farm lands without any decline in crop yields (Semwal et al., 2002).

5.6. Improvement in traditional soil fertility management

As agriculture is dependent on forests for manure and fodder, reduction in intensity of biomass removal from forests without any threat to agroecosystem functions is crucial for forest

conservation. Application of oak residue based manure enables crop yields 15% higher compared to pine residue based manure partly because of higher rates of nitrogen mineralization coupled with better synchronization of nutrient release and crop uptake in the former (Rao et al., 2003).

5.7. Rehabilitation of degraded lands

Out of 59 million ha of land constituting the total geographical area of Indian Himalaya, 21 million ha are degraded forest lands. Coupling of local concerns with global concerns is crucial for success of any ecorestoration programme. Introduction of 'nurse species' or 'keystone species' would be the most desired treatment in degraded lands but knowledge of such species is meager. Yet, there is a scope of developing rehabilitation strategies built on indigenous knowledge supplemented/complemented with the scientific knowledge (Maikhuri et al., 1997, 2000 ; Rao et al., 1999, 2003).

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Current Issues in Climate Change and Biodiversity in the Philippines

JOSE SANTOS R CARANDANG VI

Abstract

The Philippines is recognized as one of the world's 17 mega-diversity countries and one of the 200 priority eco-regions of the world. However, centuries of deforestation, over exploitation of natural resources and the use of illegal fishing methods (e.g. dynamite and cyanide fishing) among a myriad of other factors had all contributed to habitat alteration and loss. Today the Philippines is also categorized as one of the most threatened hotspots. Never the less, recent rediscovery of long thought of extinct species and other conservation success stories have breathed fresh hope to the Philippine environment. The perils being posed by climate change unfortunately is exacerbating the biodiversity problems of the country.

Introduction

From the more than 50,000 described Philippine species, more than 65% of these are found nowhere else on Earth. Furthermore, more new species are described every year in the Philippines than in any other country in the world with sixteen new species of mammals discovered in the last ten years (see ADB, 2004 and Tables 1 & 2). The Philippines not only hosts a remarkably large number of species, but most probably supports the greatest concentration of unique biological diversity currently known in the planet (Heany, 2002). As a result, Conservation International has designated the Philippines as one of the world's 17 mega-diversity countries, which together contain approximately 80% of the world's biodiversity (when described in terms of total number of species). In addition, the Philippines is also one of the 200 priority eco-regions of the world as designated by the World Wide Fund for Nature.

Table 1. Terrestrial vertebrate fauna of the Philippines. Data from Heany (2002)

	Total Species	**Endemic Species**	**% Endemic**
Land Mammals	174	111	64
Breeding Land Birds	395	172	44
Reptiles	258	168	65
Amphibians	101	78	77
Total	**928**	**529**	**57%**

Table 2. Plant and fungal species of the Philippines. Data from [a]McNelly *et al.* (1990) & [b]Philippine Council for Sustainable Development.

Group	**Number of Described (?) Species**	
	World[a]	Philippines[b]
Lichens	-	789
Fungi	46,983	3,000
Algae (green, brown & red)	26,900	865
Bryophytes (mosses + liverworts, hornworts)	17,000	1,396
Pterydophytes	13,015	1,031
Gymnosperms	750	33
Angiosperms	250,000	8,120
Total	**354,648**	**15,234**

However, due to its population density - the highest in Southeast Asia except for Singapore, the Philippines is currently one of the most threatened hotspots in the world. Hundreds of years ago, most of the Philippine islands were covered in rain forest. Historically logged for timber products,

today, the forests are also being cleared for farming needs and for developments to accommodate the nations growing population (Conservation International, 2009). The marine biodiversity of the Philippines is likewise incomparable. The Philippines has more than 2,000 species of marine fish, more than 40 species of mangrove, and 16 species of seagrass. Furthermore, more than 500 of the 800 known coral reef species are also found in the Philippines.

Biodiversity Issues in the Philippines

According to Conservation International (2008), the primary threat to biological diversity in the Philippines is habitat alteration and loss. This had been especially rapid since 1980 and is caused by human population pressure (including development-related activities) and destructive resource use. These factors are further aggravated by: 1) resource extraction processes (i.e. in mining and logging); 2) land conversion for infrastructure; and 3) industrial, agricultural, and urban development.

The root causes of these threats to biodiversity in the Philippines include: 1) the lack of understanding and appreciation for the value of biodiversity; 2) a weak resource management and governance mechanisms; 3) an insignificant financial commitment to formal mechanisms; 4) the lack of political will for conservation of biodiversity; 5) an insufficient enforcement of environmental laws; 6) the inappropriate and conflicting conservation policies; 7) the lack of ecological expertise in decision-making institutions and processes; 8) not to mention the lack of conservation knowledge and expertise among key stakeholders; as well as 9) the lack of sustainable livelihood for local stakeholders.

Biodiversity Initiatives

Fortunately, there seem to be a hope for sustaining the great biodiversity in the Philippines despite the seemingly insurmountable threats listed above. On December 7, 2007, the 22nd Philippine eagle (*Pithecophaga jefferyi*) bred in captivity was hatched. Last year, April 26, 2008, the dwarf cloud rat (*Carpomys melanurus*) a species last seen 112 years ago was rediscovered in the Cordilleras. More recently, February 17, 2009, the button quail (*Turnix worcesteri*) previously believed to be extinct was caught in Nueva Viscaya (see Figure 1).

It has become clear that landscape and seascape-scale conservation will be necessary to allow the Philippines' extraordinary biodiversity to persist (McGinley, 2008). Listed in Table 3 are some policy and legal initiatives being undertaken to sustain the biodiversity of the Philippines.

Carpomys melanurus	*Turnix worcesteri*
	
Photo courtesy The Field Museum, Larry Heaney.	**Image credit**, Arnel B. Telesforo.

Figure 1. Two Philippine species believed to be already extinct but had been collected recently, the dwarf cloud rat (*Carpomys melanurus*) and the buttonquail (*Turnix worcesteri*).

At least five new protected areas in the Philippines were declared in 2002. In October 2003, the Peablanca Protected Landscape and Seascape was significantly extended, from 4,136 hectares to 118,108 hectares. Of late, the Quirino Protected Landscape, which covers 206,875 hectares in northeastern Luzon, was created through a presidential proclamation. Non-government organizations (NGOs) and international partners are also conducting a wide range of nature preservation activities throughout the Philippines. For instance, Conservation International-Philippines in collaboration with the Field Museum in Chicago, Haribon Foundation and other local partners are in the process of identifying and delineating Key Biodiversity Areas (KBAs) throughout the Philippines.

Likewise the Philippine Cockatoo Conservation Program in Palawan has made great progress in reducing the theft of this species' eggs. In Cebu, the recent rediscovery of several of the islands' presumed-extinct species (most famously the Cebu flowerpecker), has focused community conservation activities by the Cebu Biodiversity Conservation Foundation on protecting the island's last few hectares of forest. The Haribon Foundation and Critical Ecosystem Partnership Fund have organized a Threatened Species Program to support such initiatives through the provision of small grants.

Table 3. Summary table of policy and legal initiatives taken by the Philippines to respond to biodiversity issues.

POLICY AND LEGAL INITIATIVES	SUMMARY
National Policy on Biological Diversity (2006)	On November 10, 2006, President Gloria Macapagal Arroyo signed an executive order establishing the national policy on biological diversity.
Philippine Agenda 21	Formulation of the Philippine Agenda 21 and issuance of Memorandum Order No. 399 from the President, putting PA 21 into effect and monitoring its implementation (1996).
Executive Order Nr 299 (1995)	Issuance by the President of Executive Order No. 299 directing the integration of the PSBDC into the sectoral plans of government.
Philippine Strategy for Biological Diversity and Conservation (PSBDC)	Formulation of the Philippine Strategy for Biological Diversity and Conservation in 1994.
Convention on Biological Diversity and Conservation	Ratification by the Philippines of the Convention on Biological Diversity and Conservation in 1993.
Executive Order Nr 15 (1993)	Creation of the Philippine Council for Sustainable Development (PCSD).
National Integrated Protected Areas System (NIPAS) Law (1992)	The NIPAS Law Philippine enables the development of an extended, effective protected areas system for the country and thereby help to prevent the extinctions of unique species.
Philippine Strategy for Sustainable Development (PSSD)	Drafting and approval of the Philippine Strategy for Sustainable Development (PSSD) in 1989.
Executive Order Nr 192 (1987)	Reorganization of the Department of Environment and Natural Resources and the creation of the Protected Areas and Wildlife Bureau.

Climate Change Issues in the Philippines

The expected impacts of climate change will come as a result of climate variability due to changes in precipitation, increase in temperature and sea level rise. Over the years, temperatures have been steadily rising over the Philippines and in the surrounding coastal waters. The 90s has been the warmest decade of the 20th century and, as with a number of countries around the world, 1998 was the warmest year in the Philippines (Hulme and Sheard. 1999). At the same time as the country has become warmer, the Philippines has also become drier. Annual rainfall has declined by about 6 per cent during the course of the 20th century, most of this drying having occurred in the December-February season.

Conversely, relative sea level is monitored routinely in several hundred locations around the world as part of the Global Sea Level Observing System (GLOSS). According to the Philippines's Initial National Communication on Climate Change, five sites in the Philippines had shown a small rise in relative sea-level (Table 4). Although part of these more recent trends may be related to excessive land reclamation and possible subsidence, there remains a residual rise in sea level around the Philippine coast, the likely causes of which are warmer ocean waters and melting glaciers in the world's mountain areas.

Table 4. Trend in Annual Mean Sea Level (in meters) in Five Philippines Stations.

STATION	CHANGE			
	1950-1959	**1960-1969**	**1970-1979**	**1980-1989**
Manila	- 0.7	+ 0.083	+ 0.183	+ 0.142
Legaspi	+ 0.044	- 0.071	+ 0.074	+ 0.165
Davao	- 0.099	- 0.024	+ 0.069	+ 0.165
Cebu	- 0.09	- 0.085	+ 0.027	+ 0.009
Jolo	- 0.8	- 0.078	- 0.020	+ 0.069

Source: The Philippines's Initial National Communication on Climate Change

Climate change impacts have been manifested in the Philippines by extreme weather occurrence such as floods, droughts, forest fires, and an increase in tropical cyclones.

These extreme weather events associated with climate change, and the disasters these have wrought, have caused losses amounting to billions of pesos. Costly mitigation measures for

climate-related risks in the Medium Term Development Plan (MTDP) 2004-2010 of the Philippines are shown in Table 5.

In terms of sector impacts of climate change, some of these include changes in agricultural yields for crops such as rice and maize. Changes in land use as a consequence of the changes in rainfall pattern will push people to migrate to higher elevations where soil is less fertile causing the rate of conversion of forest to agricultural lands to increase, thereby increasing greenhouse emissions (Rincon and Virtucio, 2008). Currently, the Philippines is still a minor emitter of greenhouse gases yet it is highly vulnerable to the impacts of climate change especially by natural disasters. Nonetheless, emissions have been on the rise from both energy-use and land-use changes, with the latter as the major green house gas (GHG) contributor.

Table 5. Mitigation measures for climate-related risks in the MTDP 2004-2010 of the Philippines.

PROJECT/SITE	**TOTAL COSTS (in million USD)**
Iloilo Flood Control	86.5
Lower Agusan Flood Control	101.5
Bicol River Basin and Water Management	35.0
Agno and Allied Rivers Flood Control	67.7
KAMANAVA Flood Control	101.5
Metro-Manila Flood Control Project- West of Mangahan Floodway	65.4
Pasig Marikina River Channel Improvement Project Phase II	86.7
Cagayan River Flood Control Project	49.8
Panay River Flood Control Project	80.6
Lower Cotabato River Flood Control Project	29.8
TOTAL PROJECTS FUNDING	602.9

Source NEDA (2004)

Climate Change Initiatives

As early as 1991 the Philippines began to respond to climate change through a series of policy and legal initiatives (see Table 6). Although it does not have any responsibility or commitment to

reduce GHG emissions and is relatively a minor emitter, the Philippines, nevertheless, took an active role on the mitigation aspects of climate change especially in the application of the Clean Development Mechanism.

In the agricultural sector, the Department of Agriculture of the Philippines promotes under their Agri-Kalikasan program certain agriculture management practices that contribute to the reduction of greenhouse gas emissions. Two of these practices are the Modified Rapid Composting (i.e. turning over to the soil of rice straw instead of burning) and managing livestock waste to reduce emission of methane and promotion of organic farming (Tipid Abono Program). Soil and water conservation programs are also being undertaken as adaptation measures to prolonged drought. These includes: 1) establishment of Small Water Impounding Systems (SWIS)); 2) diversion dam; 3) shallow tube well (STW) and small farm reservoir (SFR); 4) promotion of farmers' appropriate technologies and indigenous knowledge. Biogas production is also being promoted among farmers.

Table 6. Summary table of policy and legal initiatives taken by the Philippines to respond to climate change

POLICY AND LEGAL INITIATIVES	SUMMARY
Executive Order 776 (2009)	To strengthen efforts to address climate change, President Arroyo has reorganized the Presidential Task Force on Climate Change (PTFCC) and named herself its chair
Executive Order 774 (2008)	Launched a 14-pronged national program on sustainable development as the Philippines' contribution to the worldwide campaign to curb global warming. The salient objectives of the program include the reduction of solid waste generation by 50 percent in six months to two years, establishment of a rainwater collection system, reduction of fossil fuel consumption, massive information and education campaign on effects of climate change and promotion of chemical-free farming.
House Bill 4134 (2008)	A bill imposing an excise tax of P2.50 for every plastic bag used in business establishments has been filed at the House of Representatives. House Bill 4134 of 2008 filed by Albay Representative Al Francis Bichara provides automatic allocation of the revenue generated from this proposed tax to the annual budget of the Department of Environment and Natural Resources "to fund efforts to protect the environment."
Biofuels Act of 2006 (Republic Act 9637),	On Jan. 17, 2007, President Arroyo signed into law the Biofuels Act of 2006 (Republic Act 9637), which provided for its mandatory use and incentives. This law is believed to help lessen emission of greenhouse gases (GHGs) that greatly contributes to global warming.
Executive Order 171 (2007)	Alarmed by the report of the United Nations Intergovernmental Panel on Climate Change (IPCC), President Gloria Macapagal-Arroyo has issued Executive Order 171 (of 2007) creating a Presidential Task Force on Climate Change (PTFCC) that seeks to address and mitigate the impact of climate change in the country.

Green Philippines	President Arroyo has made ”Green Philippines”, which is also a chapter in the Updated 2004-2010 Medium Term Philippine Development Plan, as one of her major priorities. Increasingly the Philippines, both at the national and local levels, have begun to pay attention to the adaptation-side of climate change, by promoting climate change risk management initiatives.
Philippine Council for Sustainable Development (PCSD)	The government has created the Philippine Council for Sustainable Development (PCSD) in response to its 1992 Earth Summit commitments. The Inter-Agency Committee on Climate Change (IACCC) was established a year earlier in 1991.

Likewise, efforts are exerted by the sector to find means in reducing greenhouse gas emission from agricultural activities. For instance, the International Rice Research Institute has completed its study on the reduction of methane from rice production. The development of clean energy technologies are also particularly important solutions to the GHG problem because they address environmental quality and present viable options for both off-grid and on-grid electrification.

A successful example of a renewable energy electrification program can be seen in the conflict-affected and poverty-stricken areas of the Autonomous Region in Muslim Mindanao (ARMM), this has been achieved through the government’s partnership with USAID and the private sector (Mirant Philippines) under the Alliance for Mindanao Off-Grid Renewable Energy Project (AMORE). AMORE has now installed electrical renewable energy systems, such as micro hydro and solar systems, in more than 400 villages, avoiding almost 5,400 tons of CO_2 emissions from kerosene lamps used by households previously unconnected to the electricity grid. The program also manages a 50-hectare watershed area to ensure the regular flow of water for the micro hydro facility. In addition to the energy benefits of this project, AMORE also promotes peace and economic growth in some of the poorest areas of the country.

Synthesis

The Philippines has an estimated 50,000 described species, more than 65% of which are endemic to the archipelago. However the environmental degradation which began centuries ago had resulted in the destruction of probably more than 90% of the primary forest cover. In addition, destructive fishing practices, like poisoning and dynamiting, has caused great harm to the rich coral reefs that surround the islands. The widespread environmental degradation has caused many endemic species to go extinct and others to become greatly endangered. As a result, there are those who believe that the Philippines is already in the point of no return. Never the less recent rediscovery of long thought of extinct species e.g. the dwarf cloud rat (*Carpomys melanurus*) and the button quail (*Turnix worcesteri*) and other success stories on conservation and discovery of new species suggest that there is till hope for the threatened biodiversity of the Philippines. However the peril posed by

climate change on habitat alteration and loss is real and can further exacerbate the conservation problems of the Philippines.

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Forest Trees, Environment and Genetic Aspects
A naïve but curious view by a bioclimatologist

GODE GRAVENHORST

In the natural and the social sciences important issues in present public as well as disciplinary and interdisciplinary discussions are concerned with questions like the following: Do humans have a free a will? Or: Are human thoughts and actions predetermined? Do genetic constitutions or do socialisation processes determine our personality? I often ask myself: Who am I? Am I merely a pile or a sequence of genes and, therefore, not responsible for my actions or am I a self determining person and responsible for the consequences of my actions? In an analogous way one can also ask: Is a tree determined more by its genome or by its environment it encountered during its lifespan? Or even more radical: is any genome (set of chromosomes) of an organism not the result of environmental conditions during the entire past including all generations altered only by a random sequence of spontaneous or environmentally influenced mutations? In scientific and ethic discussions on manipulations of the genome of organisms questions are raised like: Is it justified to transplant single genes and short gene sequences or even entire genomes (set of chromosomes) of one cellular organism into other organisms with the potential to change the entire metabolism?

Organisms, which reproduce in a sexual way, show similarities in parent and offspring generations. The question, whether genetic heritage is occurring at all, can be answered in a straight forward way. But how much genetic heritage and ambient environment do contribute to the observed appearance of an organism? For example, to the phenotype of an organism at a very concrete time? To what extent is a population of genomes selected by environmental conditions and how far is a population capable of adapting to changing environments? External living conditions for terrestrial organisms are changing all the time. External atmospheric physical and chemical influences, e. g. on growth of an individual existing organism, and reproduction processes of trees, are changing in the course of the day, of the season, from year to year, and in long term variations and during a general trend with time.

Geological soil attributes in the rooting zone of terrestrial ecosystems stay, however, rather constant. The above ground atmospheric living zone is, on the contrary, changing all the time, from day to night time, from winter to summer, from short cold to following short hot periods, from

rainy to dry seasons, from stormy to calm days. The chemical climate of the atmosphere is also changing: concentrations of trace gases and particulate concentrations in the air and the deposition rates into ecosystems change: for example, ozone and other photooxidants in the air in the course of intense photochemical episodes, alkaline particles during mineral deposition in dry periods, impaction of cloud and rain droplets with low pH values, high and low concentrations of stack, chimney and car exhaust emissions of air pollutants, as e.g. sulphur dioxide, nitrogen oxides, ammonia. These short term variations are superimposed by long term concentration and deposition trends of gases with a long atmospheric lifetime as e.g. carbon dioxide, dinitrogen oxide, methane, volatile organic compounds, persistent organic pollutants. The acidic burden of the atmosphere by airborne man made constituents is returning continuously to the earth surface since the onset of industrialisation. These atmospheric variations perpetuate into the surface layer of the soil: soil and ground water quantity and quality, soil temperatures, biological activities in the soil depend on atmospheric influences like e. g. amount and chemistry of rainfall. In addition, the biological environment changes drastically from time to time, e.g. when microbial communities establish themselves at shoot and root systems attacking the plant.

Individual organisms can react and protect themselves, when living conditions shift to hostile and stressful characteristics. They can escape this environment or adapt their metabolic and physiological processes to the new environmental situation by eliminating the stressor or its impact. A plant, which can usually not move and escape menacing environments, should be able to adapt its internal processes and outside structure to a new environment in order to survive as an entity. A survival of individual organisms at least until their regeneration phase is a prerequisite for a population to survive for several generations.

For sexually reproducing higher plants critical processes for generating offsprings are flowering, pollination, formation and dispersal of seeds, seed germination and seedling growth until the reproduction age is reached. During the critical reproductive phases the survival of consecutive generations does not only depend on genetic properties of the plant ensemble, that means on the many genomes of the numerous population members, but also on their immediate environment and its variation in time and space. Both systems have to fit so that an already existing organism can survive and consecutive generations can establish themselves.

As an atmospheric scientist I have had and still have problems to understand discussions on molecular genetics and their implications for the functioning of ecosystems. Therefore a short and naïve view on aspects of environmental genetics is attempted here.

The genetic constitution in cells of a higher plant consists of several different chromosome sets. One chromosome set consists of two chromosomes, one of which is derived from the father, one

from the mother. These cells are called diploid, because they have two (bi) chromosomes in one set. Only in sperm and egg cells one chromosome set consists of one individual parent chromosome. These cells are called haploid. These haploid cells are preferentially investigated in their molecular genetic structure because - compared to diploid cells - less alteration possibilities in the measured genetic variations are encountered. Each chromosome of a species is made up of a bio- molecule, the DNA (deoxyribonucleic acid). The DNA is made up of sequences of nucleotides (1000 to 1000 000), each nucleotide of one sugar molecule (deoxyribose), one phosphoric acid molecule and one base. Many connecting nucleotides of most different nucleotides combinations form one gene. To generate the structure and functions of the evolving plant the genes have to generate proteins. The bio-molecules of the proteins are forming the structure and function of the organisms. Different proteins with different concentrations at different times are, therefore, causing different organisms in the course of the development. Genes in higher organisms are mainly confined to the cell nucleus. The proteins are, however, formed from amino acids outside of the nucleus. The information of the genes has, therefore. to be transferred via the membrane confining the nucleus into the cell plasma. The information carrier is the RNA (ribonucleic acid), which is composed similar to the DNA. In other words, to generate a next generation existing organisms should have the capability and the possibility to duplicate their genetic blueprint and to realize the structure and function given in the blueprint. Thus, the generic information on the one hand has to be kept constant and to be duplicated and on the other hand to be realized. The bio- molecule DNA has the capability to achieve both goals. Both strands of the DNA helix are not identical but complimentary. To transfer genetic information to the next generation the DNA will be duplicated. For this purpose both strands have to be separated. They serve as a matrix for the organisation of the next complementary strand. The same genes can be present in different variants on the two strands of the chromosome set. These gene variants are called alleles. A gene or a group of genes is generating by way of its binding structure – coding – for synthesising from amino acids certain proteins which are responsible sources for certain attributes and capabilities of an organism, The different proteins stir the development of structures and functions in the emerging cells of the future organism. A gene can be active, that means can express itself by forming respective proteins or it can be suppressed and inactive. This depends on the interaction with other genes or conditions in their immediate biophysical and biochemical environment. An allele can be dominant or recessive, a gene or a sequence of genes can be chemically separated from a DNA strand at a primer at certain positions. This tiny part of the genome can be characterised by its mechanical mobility in an electric field by gel electrophoreses. The measured mobility spatial pattern is characteristic for an individual organism. Another way to identify the genetic structure of organisms is offered by a DNA microassay. With a DNA microassay numerous natural genes or artificially made genes are fixed reproducibly in a certain pattern onto a special surface. To analyse

which genes are present in a certain cell material this cell material is brought into contact with this particularly structured surface and the same genes are binding to each other. The investigated genes are made fluorescent beforehand. The non-binding genes are washed off and the remaining fluorescent intensity at certain spots of the solid matrix is an indicator for the sequence of genes within certain biological cells.

The genes can produce enzymes as bio-molecules for certain biochemical reactions. Different genes can produce different enzymes. Enzymes can be different in their structure but are still able to catalyze the same reaction. These enzymes are, therefore, called iso-enzymes. Their mechanical mobility in a gel electrical field is different. These iso-enzymes are separated from the cell solution and concentrated before analysing their mechanical properties in an electrical field. Differences in their structures are differentiated in a quite sensitive way.

A gene or a group of genes characterising a certain trait of an organism e.g. the colour of the flower, has a certain fixed position or locus on the DNA. For one offspring the gene inherited from the father can be the same as the one heritaged from the mother (homozygote), or the genes at the same locus but at the two different DNA strands can differ from one another (heterozygote). Therefore, many possibilities exist for a gene transfer from two parents to one offspring. One offspring can have several alleles at one gene locus of its two chromosomes or only one. If several alleles exist at the same locus of different individuals the genotypes of the individuals are different. If different alleles of the same genotype are expressed in individual organisms the phenotypes of these individuals are different. In higher plants the chromosomes are conformed to the cell nucleus. In order to influence structures and functions of the evolving organisms the many information manifested in the genes of the chromosomes has to be replicated and this copy has to be taken across a membrane into the cell plasma surrounding the cell nucleus. This message carrier is generating the characteristic proteins from amino acids according to the blueprint of the gene structures and positions.

The impact of a gene, that means its expression or influence on the formation of proteins can be switched on and off depending on the influence of other genes as well as of biochemical and biophysical circumstances.

One scientific hypothesis is put forward concerning the impact of alleles on the fitness of an individual organism to cope with a changing environment. This hypothesis states, that a large number of alleles at one gene locus and/or a large number of gene loci with different alleles support the capability of this single individual to adapt to a changing environment and to different realisations of the environment.

A population of organisms adapted to a constant environment does not have to sexually reproduce, because there is no need for genetic variation to be able to adjust to new environmental conditions. But in reality the physical, chemical and biological "climates" for terrestrial plants like trees are not constant. An individual tree with its long life span and especially several tree generations are exposed to quite different influences.

Therefore, the gene constitution of a single tree and the gene pool of a tree population should have an adequate genetic variation in order to withstand future environmental changes within a life of a tree and during environmental trends along several generations. How can a genetic variation within a species generation be estimated and quantified? The genetic variation within a representative tree species population can be expressed by a quantitative indicator, which takes into account the total number of gene loci within the population, which, in turn, are characterized by two or more alleles. Since a tree species can have more than 30 000 gene loci, and a representative tree population may comprise hundreds of trees it will hardly be possible in the near future to quantify such an indicator.

Several examples given in the scientific literature are indicating that such an advantageous heterozygote principal is acting in nature, when environmental conditions change or vary over short time scales. These examples will be shortly described here. They empirically demonstrate, that the environment of tree species influences the genetic structures of the species that short term environmental stress conditions can be better withstand by heterozygote individual trees at certain gene loci than homozygote at the same gene loci. Several case studies have been reported by Mueller – Starck et al. (2005), Ziehe et al. (2000), and Mueller-Starck (1989), which support this assumption. These investigations can be classified into different groups: For one tree group the geographical distribution of a tree species is correlated with its present genetic constitution in these regions. In the second tree group the effect of atmospheric SO2 concentration on the genotypes of trees reacting in a different manner is discussed. For a third tree group the relation between soil properties and genetic markers is analysed.

1. Based on two different DNA markers, that means genes at different gene loci, 22 genetically different types of sycamore tree populations were detected. Clusters of gene markers could be observed, which were typical for certain geographical regions in Europe (Bittkau 2002). Mayor refugial regions during the last glaciation of Northern Europe and of the Alps about 15 - 20 thousand years ago could be identified. In southern Italy, in south-western Europe and in regions close to the Alps different sycamore genotypes have been concentrated. From there they began their migrant way to reconquer their growth regions. The different environmental conditions at that time and during the time afterwards can still be observed at genetic markers, e.g. , in germ cells.

Differentiation in geographically distributed subpopulations of a tree species reveals that environmental conditions which prevailed several ten thousand years ago are still traceable by means of the reconoliasation pathway after glaciations.

Tree provenances, therefore, have genetic structures mirroring past environmental conditions for there growth regions.

2. New environmental conditions can stress a tree population. Different genotypes within the population can have a different viability with respect to the new stress factors. Such a different reaction can be tested. The genetic constitution of two phenotype population subsets growing under the same environmental stress but with different selections can be compared. In one empirical field and laboratory study tree pairs were chosen of which one tree looked healthy whereas the other one looked unhealthy. Both the healthy subset of trees and the unhealthy subset were aggregated and the genetic constitutions compared. The resulting comparison of tree pairs of the same age and exposed to quite similar environmental conditions could suggest, that genetic differences might cause the two different observable attributes. One factor indicating stress which showed a different reaction within paired trees was a high salinity concentration in soil solution caused by NaCl salt used to prevent icing of a nearby road.

Another stress factor was the high acidity of the soil, in which seedlings grew in the field compared to seedlings which grew in normal garden soils. The acidity may only be an indicator for other companying stress factors or of a general stress milieu (Mueller-Starck 1993).

3. A third group of tree populations exposed to another stress factor was investigated in the Ore Mountains in Saxony, Germany, where high ambient SO2–concentrations prevailed (Wolf 2001). Both a sensitive, damaged looking subsample and a tolerant, healthy looking subsample showed distinct, statistically significant different markers at the same gene loci. This genetic difference reveals that environmental conditions assigned here as the two stress factors salt concentration in soil solution and atmospheric S02 concentration select genetic constitutions of the trees which favour good or bad adaptation of the trees to the stressor.

From the many genes a tree species can have (with an upper range of about 30 000 genes) only very few genes were analysed in these investigations. It is a surprise that a correlation between the heterogeneity of these few genes at certain gene loci and the reaction of these trees to certain environmental stresses could be found.

Constitutions and positions of the many genes of a genome have been identified. Their functions for the character of the organism are, however, mostly unknown. A relevant property of plants, e.g. of trees, may depend on one gene (monogenetic), or on few genes (oligogenetic), but also on many

genes (polygenetic). The individual contribution of the many genes on one single attribute is hardly to recognise in the trait expression of the phenotype. It is even much more difficult to identify the contribution of genes and the environment to the observed phenotype variation.

One of the parameters mainly influenced by the atmosphere is the temperature of plant reproductive organs and entities. The temperature determines the speed of reactions and, therefore, the concentrations of macro-, meso-, and micro- elements and compounds of reactants in physiological processes in plants. Therefore, the genetic processes are in a large extent stirred by the temperature of the system. Concentrations of e. g. aminoacids, proteins, enzymes, lipids, ions, they all depend on temperature of their environment. They determine the expression or suppression of genetic functions. For example, the temperature of the cytoplasm and not the chromosomes determines whether a crocodile becomes a female or a male (Nüsslein-Volhard 2006). Adaptation to present and future prevailing temperature conditions will, therefore, be an advantage for long living individual organisms to generate offsprings and for populations to survive for many generations in their cooperating and competitive struggle for living resources and reproductive capabilities and possibilities. The average or mean temperature of plant organs, seeds, or seedlings are not as important as extreme values. Rare but extreme values of temperatures or other atmospheric influenced properties can cause great and permanent changes in genetic effects.

The function of some genes in plants has been identified. With molecular genetic techniques individual genes, gene groups or even entire genomes can be introduced into other organisms. Genetically fixed properties can thus be transferred from one plant to another and be heritaged for the purpose to increase resistance against biotic and abiotic threads and damages and to support better crop yield and crop quality.

In forestry caution should, however, be demonstrated in an even more sensitive way than in agriculture to apply molecular genetic techniques to alter the genome structure of widespread plant populations because forest trees are special in their properties (Finkeldey 2008): 1. they have a very long lifetime, during which the environment may change unforeseeable,2. they are immobile and grow in low in-put land use systems, 3. forest trees are still rather natural and not “domesticated” in their genetic structure although forests are often managed by introducing selected seed and seedlings .

Forests should, therefore, in the first pace not be adapted exactly to the present environment but should keep the capability to adapt to future at present unknown environmental conditions, if forests should be managed in a sustainable way. It is, therefore, necessary to understand and project future physical, chemical and biotic conditions, genetic bases of the properties of forest tree

populations and the dynamic evolution of the interaction of forests and the climatic environment. In pinpointing one can com to the conclusion that the genetic structures of an individual organism and of an entire population are the result of the everlasting and ever changing physical, chemical and biological environments. The atmosphere contributes most to shape these environments and is, therefore, of prime importance for the short and long term evolving genetic constitution of the living organisms at the interface of atmosphere, hydrosphere, and pedosphere.

Plants and humans may be viewed in a quite similar way in their relation to environmental genetics. The genetic structure of humans forms the basis for the biological existence of their carriers. The frame work of the inside and outside appearance of an individual person is prescribed by its parent generations. The function and intensity of some traits can, however, be changed by training in adapting to eustress and distress situations like e. g. in sports and thinking, so that individuals can have a wide spectrum of attributes and fulfil a large range of activities. But human generations are also shaped by the mating choices and their success of women and men. A population can maintain itself and propagate in a sustainable way, if different heritaged capabilities and learned skills are present and evolve in a dynamical way. Human beings represent, however, more than pure biological plant organisms, they have a moral compass, with which their actions are directed. Humans as well as plants can not escape their basic nature, defined by the genome and they both can adapt to a changing environment as individuals and as populations. But in addition humans can have the choice to neglect the environment for their own assumed sake. If humans have a choice, they are free.

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Climate Change – Predictions and Possible Impacts on Biodiversity and Nature Conservation in India

KAMINI BARUA

Abstract

Forests in India cover nearly 20% of the country's total geographical area and known to harbour a rich floral and faunal diversity, with 6850 species of endemic plants and 396 known endemic higher vertebrates. The two areas rich in endemism are the Eastern Himalayas and the Western Ghats which are also known to be biodiversity hotspots. The tropical monsoon climate has a strong influence on the forest and vegetation structure, biodiversity, agriculture and water resources. Climate change pertaining to increasing temperature and fluctuating patterns of rainfall is predicted to cause a major shift in biomes types which can eventually lead to species loss as well as a decline in forest productivity. Intensification of the monsoon can also trigger severe flooding in the Himalayan catchment areas during the wet season thereby affecting agriculture. The overall negative impact on forest vegetation and biodiversity will likely adversely affect the livelihoods of forest dependent communities particularly in the Himalayan region where the local communities are primarily dependant on natural resources. In the eastern Himalayas, covering entire Northeast India, climate models predict a 2-3^{o} C rise in temperature and a 250- 500 mm increase in precipitation. However it is only the temperature rise which may cause significant changes in the forest ecosystems. As a practical approach to linking climate change with nature conservation in India, rehabilitation of critical ecosystems by creating a variety of diverse habitats for both wildlife and local communities, promoting renewable energy use and incorporating climate change issues in long-term forest policy making process need to be implemented.

Key words: Climate change, Forest, Monsoon, Ecosystem, Endemic, Eastern Himalaya.

Introduction:

The Indian sub-continent which lies in the sub-tropical latitudinal belt (8° 4 ' N and 37° 6' North Latitude and 68° 7 ' and 97° 25 ' East Longitude) has a total geographical area of 3.287.240 km^2.

The Tropic of Cancer (23° 30 ' N) divides the Indian peninsula into two halves. Biogeographically, India forms a large part of the Indo-Malayan zone and has some of the world's most biodiverse

regions with significant variations in topography, altitude, precipitation patterns and local climate (Mani, 1974). The tropical monsoon climate characterized by distinct dry and wet seasons plays a very important role in influencing the seasonal changes in vegetation and habitat. The Indian Himalayan Region (IHR) and the Western Ghats are two biodiversity hotspots in the Indian subcontinent and specifically the Eastern Himalayas that are part of the Indo-Burma hotspot has a floral and faunal composition with a mixture of the Indo-Malayan, Indo-Chinese and Afro-tropical elements (Myers *et al.,* 2000). High levels of endemism and fragile ecosystems with a range of microhabitats and 'niches' makes these hotspots of biodiversity priority regions for conservation (Korner 2004). In India, the forests which cover nearly 20% of the country's geographic area are important for biodiversity, biomass supply, watersheds and livelihoods of forest-dependant communities. Out of this 20 % total forest cover, only 1.55 % represents the 'Very Dense' and 10.32 % represents the 'Moderately Dense' forest cover, the remaining being 'Open Forests' (FSI, 2006). There are 11 major biome types with the dominant forest cover type being characterized by the Tropical Moist Savanna (32.5%) and Dry Savanna (33%). The forest ecosystems and biodiversity in India as a whole are already under severe threat due to increased land-use intensity, non-sustainable use of biomass, conversion of forestland, overgrazing and forest fires.

Climate is the most important determinant of vegetation patterns globally, having a significant influence on the distribution, structure and ecology of forests, and therefore any changes in the climate will alter the configuration of forest ecosystems (Kirschbaum *et al.,* 1995). In India, although climate change related studies are still in nascent stage, climate models developed by researchers at the Indian Institute of Science, Bangalore, made a preliminary qualitative assessment of potential climate change impacts on forests in India and these studies indicated moderate to large-scale shifts in vegetation types with implications for forest dieback and biodiversity (Ravindranath & Sukumar, 1998; Ravindranath *et al.,* 1997 and 2006). With respect to India's contribution to climate change, in terms of per capita, India's emissions are very small, not exceeding 4-5% of the global CO_2 emissions. At present India is ranked amongst the 10 highest contributors but by 2020, India is predicted to occupy the 4^{th} or the 5^{th} position in terms of global carbon emissions. However, the reasons for concern are the exceptionally diverse ecosystems and the impending threat to biodiversity, specifically pertaining to the high level of endemism and hence the possible species loss due to alterations in the microclimatic conditions and ecosystem alterations.

Predicted Climate Change Impacts on Forests and Biodiversity:

Impact on Forest Biomes:

An analytical evaluation of projected climate change on forest types based on climate projections

from a regional climate model (HadRM3) of the Hadley Center were provided by the Indian Institute of Science (IISc), Bangalore in collaboration with the Forest Survey of India and the Indian Institute of Tropical Meteorology and the number and per cent of forested grids undergoing change in vegetation types based on the climate parameters were projected for 2070 and 2100. While the current climate data were used to compute the likely distribution of biome types at different locations currently under forest cover, future climate was used to obtain biome types that are expected to prevail under changed climatic conditions in these locations. Results predicted nearly 68-77 % of the forests likely to undergo change into another forest type by 2085. The dominant forest types characterized by Moist Savanna (32.5%) and Dry Savanna (33%) were expected to decrease while Tropical Dry forest (37.2%) and Tropical Seasonal forest (28.4%) were predicted to become dominant within a span of 65-70 years. In the higher elevations, Boreal Evergreen and Temperate Conifer coverage was expected to decrease while Temperate Deciduous and Temperate Evergreen cover was expected to increase (Ravindranath *et al.,* 2006). Rise in temperature was predicted to result in shift of lower altitude tropical and sub-tropical forests to the higher altitude temperate forest regions. Decrease in rainfall and resultant soil moisture stress could also possibly lead to Sal (*Shorea robusta*) dominated forests to be replaced by drier Teak (*Tectona grandis*) forests in Central India. Increased dry spells could possibly place the dry and moist deciduous forests at higher risks of forest fires. This projected change in forest biomes was likely to trigger not only a large-scale forest die-back but also loss of biodiversity especially in the transition between the forest types (Ravindranath *et al.,* 2006).

Threats to Biodiversity and Ecosystems:

In India the two important measures of climate change which will have a significant impact on biodiversity are the variation in temperature and precipitation. An increase in precipitation can change the nature of the forest with respect to floral species dominance, canopy cover and overall forest dynamics. It could rebuild connections between fragmented ecosystems, favour alteration of forests into moister vegetation types, alter tree species dominance and thereby change forest class. On the contrary, reduction in precipitation could trigger a shift towards deciduous category of forests, expansion of grass lands, lead to forest fragmentation and raise frequencies of forest fires. All these can cause significant changes in faunal species distribution, demography and composition. The upward altitudinal migration of plants in the Himalayas could reduce the Alpine

meadows and related vegetation thereby adversely impacting the habitats of several high-altitude mammals (Sukumar, 2000). The conservation status of some of these mammals like the Clouded Leopard (*Neofelis nebulosa*) and Stump-Tailed Macaque (*Macaca arctoides*) are already 'Vulnerable' (IUCN, 1998) while that of the Snow Leopard (*Uncia uncia*) is 'Endangered' (IUCN, 2006). The biogeographical location of the Indian Himalayan region being straddled in the transition zone between the Palaearctic and Indo-Malayan realms has not only contributed to its high biological diversity, but the geological, climatic and specifically the altitudinal variations have played a very important role in speciation, floral and faunal distribution and high levels of endemism in a variety of ecosystems (Mani, 1994). Out of the 300 mammal species recorded in the IHR, nearly 12 species are endemic to the region. Similarly out of the estimated 10,000 plant species in the Himalayas, 3160 species from five families are endemic to the region. The impacts of climate change could have a severe impact on the habitats and ecosystems, thereby also destroying the endemism in this hotspot. As most of the endemic plant species are unable to respond successfully as the rate of climate change increases, therefore the resultant invasions of weedy and exotic species from lower elevations creates more disastrous conditions (McCarty, 2001). Similarly in another hotspot in the Indian subcontinent, the Western Ghats (Myers *et al.,* 2000), where the forests are some of the best representatives of the non-equatorial tropical evergreen forests in the world, the region has evolved into one of the richest areas of endemism owing to their isolation from other moist areas (Ramesh *et al.,* 1997). Latitudinal length of dry season gradient, along with temperature and elevation gradients and topography have strongly contributed to a rich endemic assemblage of plants, amphibians and reptiles in this region. While 1700 endemic plant species and 18 endemic threatened mammals have been recorded in this hotspot, what is noteworthy is that 130 out of a total of 179 amphibian species found here are endemic which represents nearly 73 % of the total endemism. Amongst the flagship endangered mammal species are the Lion-Tailed Macaque (*Macaca silenus*) found in the highly fragmented tropical rainforest, the endemic Nilgiri Tahr (*Nilgiritragus hylocrius*) found in the montane grasslands and the highly threatened Malabar Civet (*Viverra civettina*) found in the densely populated and disturbed habitats of the Malabar plains. Climate change could endanger the habitats of most of these endemic and threatened species as is with the case of the Nilgiri Tahr which is likely to be threatened if the montane grasslands are replaced by woody plants and exotic weeds (Sukumar *et al.,* 1995). The Siberian Crane (*Grus leucogernaus*) is a critically endangered wetland bird that is known to migrate every year from Arctic Russia and Siberia for wintering in China and the Keoladeo National Park in India. Increasing drought due to higher temperatures has been thought to be one of the factors that have caused a sub-population of this species to shift out of the Park and become locally extinct (WWF India, 2006).

The Sunderbaans Tiger Reserve, a UNESCO World Heritage (1987) is one of the world's largest Mangrove forest in the Ganges-Brahmaputra delta in Eastern India. A 26,000 km^2 area of low-lying swamps, the Sunderbaans has a very dynamic ecosystem being characterized by an estuarine condition of high salinity, lack of soil erosion and daily inundation by high tides. The vegetation is not only very well adapted to this estuarine condition but the sensitivity of this entire ecosystem to

changes in salinity and continuous cycle of erosion and deposition has affected the plant communities in such a manner as to give rise to a dynamic floristic changes. The mangrove forest is the natural habitat of several endangered and globally threatened species like the Royal Bengal Tiger (*Panthera tigris*), while the creeks form the home of the Estuarine Crocodile, Water Monitor, River Terrapin, Gangetic Dolphin, Olive Ridley Turtle and Hawk's Bill Turtle. It is also the wintering ground of the Trans-Himalayan migratory birds. However climate change is posing a great threat to this fragile ecosystem as rising sea levels and coastal erosion caused by global warming are gradually leading to submergence of vast tracts of mangroves and salt intrusion thereby threatening the survival of the Bengal tigers.

Effect on local forest-dependent communities:

Climate is projected to change at a faster rate than the capacity of the forest ecosystems and plant communities to adapt. Any impact on forest vegetation and biodiversity will have adverse implications on the livelihoods of the forest-dependent communities. In India, with nearly 200,000 villages being classified as forest villages, there is a large dependence of communities on forest resources (Ravindranath *et al.,* 2006). The two biodiversity hotspots in India have sensitive and exceptionally diverse mountain ecosystems, and particularly the Indian Himalayan Region straddles some of the world's poorest regions with high cultural diversity (more than 171 of total 573 ethnic tribes of India inhabit the region) and the Indo-Gangetic plains below is densely populated; global climate change is predicted to lead to major shifts in the Asian monsoon system. Moreover climate change is expected to intensify in the mountain areas, especially the high relief, sub-tropical areas (Samal, *et al.,* 2000; ICIMOD, 2007). The traditional ecological knowledge systems (TEK) practiced by the ethnic hill communities in the Himalayan region can be largely described as 'sustainable development of traditional societies' – living close to nature and natural resources around them (Ramakrishnan, 1992a, 2001). The ethnic locals especially from the Eastern Himalaya (Northeast India) have over the years adopted a traditional practice of replenishment through 'Jhum' cultivation, a 'rotational bush fallow' agriculture. This practice has enabled the regeneration of forests before the same land was cultivated again. In earlier times, this cycle was long but studies in the recent past have shown that the cycle has reduced to 4-5 years (Barthakur, 1989) thereby clearly indicating the deteriorating ecological balance of the region due to increasing

human pressure on land and growing need of food (Resources IHR 2006). The Apatani cultural landscape in the north-eastern hill region of India is an example of a highly evolved and elaborated cultural landscape with a complex and productive wet rice cultivation agro-ecosystem, and a productive set of community managed forests (Kumar & Ramakrishnan, 1990).

Forest cover is the major land-use in the IHR (52% of the total reported area of the region followed by wastelands); during the period 1999-2001, the forest cover recorded a marginal increase (about 0.41%) whereas the country's total forest cover recorded a significant growth (about 6%) during the same period in spite of rapid urbanization. This could be attributed to the high dependency of the local communities on forest in the IHR rather than on arable land which contributes only about 11% of the total reported area (Resources IHR 2006). However now due to impending climate change threats, the forest dependant indigenous communities will also face difficulties in their livelihoods and how this problem can be resolved will remain a major challenge to the nature conservation managers and forest policy makers.

Climate Change – The Northeast India Scenario:

Northeast India which can be physiographically divided into Eastern Himalayas in the north, North-east hills (Patkai-Naga hills and Lushai hills) in the south and the Brahmaputra and Barrack valley plains in between (Mani, 1974) lies at the confluence of the Indo-Malayan, Indo-Chinese and Afro-tropical biogeographical realms (Olson *et al.,* 2001). While the entire Eastern Himalayas has been identified as a priority Global 200 Ecoregion by WWF, Conservation International has upscaled the entire Eastern Himalayan hotspot which includes all the eight states of Northeast India including southern China, Bhutan and Myanmar into Indo-Burma hotspot (Myers *et al.,* 2000). A region of high cultural diversity, being home to nearly 225 ethnic tribes, the high biodiversity of this region is characterized by high levels of endemism with exceptionally high plant diversity (IUCN, 1995). This high biological diversity has been attributed to its relatively complex biogeography due to a combination of factors including its age, unique plate tectonic, palaeoclimatic history, wide physiognomic range (e.g. altitude ranging from 100m to > 7000 m above sea level) and vegetation diversity from tropical to alpine (Mani, 1974). The region has been termed as the 'cradle of flowering plants' being represented by such primitive plants like *Magnolia, Michelia, Camellia* and *Rhododendron* from 8 primitive angiosperm families (Hynniewta & Baishya, 1992). There are 51 forest types with more than 60% of the total geographical area in the Indian part of the Eastern Himalayas under forest cover (Hedge, 2000; FSI, 2003).

Climate models are predicting a 2.0- 3.5 ^{o}C rise in temperature and 250- 500 mm increase in precipitation in the Northeast region (Ravindranath *et al.,* 2006). While increase in rainfall may not have a significant impact on the forested areas which are already experiencing high rainfall, change

in temperature regime may have a strong impact and cause significant changes (Ravindranath & Sukumar, 1996). Therefore in the Eastern Himalayas, the forest vegetation is expected to expand significantly, the forest productivity will also increase from 1-10% (ICIMOD, 2007). An increase in precipitation over Northeast India will however lead to severe flooding in the Brahmaputra river thereby placing the wildlife of the Kaziranga National Park at risk (Sukumar, 2000). The alluvial grasslands in the floodplains of the river Brahmaputra is the natural habitat of the one-horned Rhino (*Rhinoceros unicornis*) in Kaziranga National Park in Assam, Northeast India.

Practical ways to link climate change and nature conservation in India:

Climate is projected to change at a rate exceeding the capacity of the forest ecosystems and plant species to adapt. Ecosystems dominated by long-lived species (e.g. long-lived trees) will often be slow to show evidence of change and slow to recover from climate-related stresses (IPCC, 2002).

In India, although field studies of climate change impacts are still non-existent as reported by scientists at the Indian Institute of Science in Bangalore, substantial studies of climate change impacts on flora are already in progress and this will be beneficial for the future implementation of the forest management policies.

A focus on national programs for disaster management could be a practical beginning to link climate change and nature conservation. Protecting a variety of diverse habitats and factoring in the effects of climate change by ensuring the safe migration of species to safer habitats if climate adversely affects their present one has been recommended as the most practical approach to mitigate climate change in the context of conservation and management of ecosystems and wildlife. Rehabilitation of critical ecosystems for creating valuable habitats for both wildlife and local communities and incorporating climate concern in long-term forest policy making process is another practical way to mitigate the effects of climate change. Reducing forest fragmentation, promoting mixed species forestry to reduce vulnerability and initiating forest fire management strategies are some of the other key issues to be addressed at the national level to resolve the likely impacts of climate change (Ravindranath *et al*., 2006). As much as adaptation strategies are needed to ensure a proper balance between demand and supply of forest products keeping in view the dependence of local communities on forest resources, the policymakers will have to address the ecological impacts of climate change on the forestry sector as well as the social and economic impacts on the communities (Ravindranath *et al*., 2006). Therefore a proper coordination between the policy makers, foresters and conservation managers, local communities and private sectors like NGOs working on issues of wildlife management and environment protection is needed to address this whole issue of climate change and its impact of forests and biodiversity.

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Climate Change in Indonesia: Impacts and Mitigation strategies

MARGARETHA PANGAU-ADAM

Indonesia is known as a mega-biodiversity country and has the third largest area of rain forest after the Amazon forest and Congo Basin. Being an archipelagic country with about 17,000 islands, Indonesia has also the world's highest marine diversity. Unfortunately this country has become one of the highest greenhouse gas emitters in the world. Deforestation including logging and forest conversion, degradation of peatland and forest fires have been accounted as the major contributors to the greenhouses gas emissions in Indonesia. As a major emitter, Indonesia is also facing severe impacts of climate change which could threaten the existence of human population. Intense rain fall leading to the large flood, erosion, prolonged drought, rising sea level and increased frequency in extreme weather are a few examples of the climate change impacts that could endanger the dwellings and livelihoods of millions of people in Indonesia. Inundation of some parts of the country such as the Jakarta Bay and other coastal areas in Java Island has been predicted. Indonesia's rich biodiversity is at risk because climate change is leading to the species extinction and the spread of vector-borne diseases. The latter may lead to harmful effects on agriculture, fishery and forestry, resulting in threats to food security and livelihoods, and leads to the impacts on local communities. Climate change is a common global concern and has become one of the key development issues in Indonesia that requires long term sustainable solution. Research on climate change has grown and it is also happening in Indonesia. This short review will discuss the major contributors to climate change, its impacts on human and biodiversity and the strategies to mitigate the climate change in Indonesia.

Main contributors to the climate change in Indonesia

Deforestation

Until late 1900, Indonesia was still covered by the large forest area with the total forest representing about 80 per cent of the total land area. In the early 1970s, Indonesia started to use this valuable resource to its economic benefit by developing the wood-processing industries. Under Soeharto government period, the so-called New Order, one of the Principal Forestry Law of Indonesia stated that all forest areas in Indonesia are to be controlled by the state (Arnold, 2008)

and therefore the Forestry ministry had to manage over 140 million hectares of forest – approximately 70 percent of country's land mass. For that purpose the government maintained the direct control over the timber industry in Java, and contracted the management of forests on the outer islands to timber companies through the granting of timber concessions called forest commercialisation rights (Hak Pengusahaan Hutan or HPH) (Arnold, 2008). Moreover, the Government designated conversion forests (approximately one-quarter of total forest land) as areas appropriate for deforestation. Deforestation and degradation, however, moved beyond the boundaries of conversion forests, and there have been some notable problems with inappropriate land use designations (Sunderlin, *et al*, 1996). In many cases forest clearers had ignored the existence of indigenous groups that depended on forests concerning their livelihood. Since middle 1990's deforestation in Indonesia has increased at an alarming rate with an average of 2 million ha per year leading to the serious environmental destruction. Indonesia lost some 21.7 million hectares of forest cover between 1990 and 2005, an extent second only to Brazil, which lost 42.3 million hectares, according to the U.N reports. About 77 percent of this loss was primary forest, the most biologically diverse and carbon-dense form of forest. Logging, establishment of pulp and paper plantations, oil palm estates, and agricultural expansion were the dominant drivers of deforestation in Indonesia during this period (Butler, 2009). In three of the world's largest tropical timber suppliers, illegal logging has been estimated to represent 80 percent of log production in Brazil, 50 per cent in Cameroon, and about 70 per cent in Indonesia, where illegal logging is believed to have destroyed some 10 million ha of forest (ABC News, 2002). The worldwide demand for tropical timber and the high prices paid for it in the international market have fuelled this burgeoning trade, particularly as there are few systems internationally in place to stop the import of illegal timber and timber products. Apart of logging and illegal logging, the other main pressures of deforestation in Indonesia nowadays are conversion to plantations mainly palm oil and forest clearance for mining activities. The demand for palm oil, which requires much of the forest clearance has risen in recent years to meet the global demand for biofuels.

The clearance of forests on a large scale has had a devastating environmental impact. Lowland tropical forests, which are the richest in resources and biodiversity, were the first to be exploited for timber and also to open the forest area for plantation. If this continues, pristine forests will no longer exist in Sumatra by 2005 and in Kalimantan by 2010 (Rautner and Hardiono, 2005). With these forests will disappear the diverse range of flora and fauna, including the Orangutan which is already under threat of extinction. Currently, forest loggers are moving their eyes to Papua, the eastest part of Indonesia, because it still has a huge area of lowland rainforest. Consequently, large area of Papuan rainforest is already converted to plantations and further extension is planned. The

impacts of deforestation are complex and immense and amongst the globally significant implications is the effect on climate as the results of increased carbon emissions through forest clearing.

Degradation of peatland

Peat is accumulation of undecomposed plant material that has happened over thousands of years. Because of the absence of oxygen in water-saturated environments, the decomposition of this material has been halted. Peatlands are found in many places around the world and cover over 400 million hectares of land, which is only about 3% of the global surface of land and fresh water (Parish, 2002). However, they store huge quantities of organic material, equivalent to approximately two million tonne CO_2 and comparable with 100 years of the current emissions of fossil fuels (Silvius, *et al*., 2006). In certain parts of the world, peat has become and harvested as an important source of fuel.

About 83% of the South-east Asian peatlands are situated in Indonesia and 12% of Indonesia is covered by peatlands (225,000 km2). These areas are lowland peatland with the humid tropical forests which exist in several islands such as Sumatera, Kalimantan and Papua. In these areas the peat soils store 30 times more carbon comparable than stored above ground in normal rainforests, for example peatland thickness in Indonesia ranges from 1 meter to over 1 meters and 1 meter peatland stores about 60 tonnes carbon (Silvius, *et al*, 2006).

The value of peat land

Indonesian peat swamp forest vegetation has been recognized as an important reservoir of plant diversity (Whitmore, 1984), because these forest types have a relatively high diversity of tree species. More than 300 tree species have been recorded in swamp forests of Sumatra, some of which are becoming increasingly rare, and from Berbak National Park in Jambi, Sumatra alone, more than 160 tree species are already known and reported (Giesen, 1991). Many of the plants are restricted or endemic to this habitat. The peat forests of Indonesia provide many commercial timber species including Ramin (*Gonystylus bancanus*), Jelutung (*Dyera costulata*) and Meranti (Shorea *spp*.) (Parish, 2002). These forests are also home to many rare and endangered wildlife species such as Sumatran tiger (*Panthera tigris sumatranus*), Tapir (*Tapirus indicus*), Asian elephant (*Elephas maximus sumatrensis*), Lesser One-horned Rhino (*Rhinoceros sondaicus*), Orangutan (*Pongo pygmaeus*) and hundreds of bird species, including hornbills, birds of paradise and cassowaries. Peatland rivers or black-water rivers in Indonesia are important fish habitats that often have a higher degree of localized endemism than other rivers, and the peat swamp forests also play important functional roles in regulation of hydrology (Parish, 2002). The functions as flood control,

flow regulation, water supply and prevention of saline water intrusion are crucial to maintain the integrity of the surrounding ecosystem.

Peatland and Climate Change

Over the past 10-15 years large areas of peat swamp forests in this region have been cleared and converted for other uses, mainly agriculture and forestry. This has led to the loss of significant carbon stores and sinks as well as loss of biodiversity and hydrological functions. Some of this land conversion has not been successful, such as the so-called Million hectares or Mega-Rice project which was abandoned in 1998. It is now recognized by the Indonesian Government that the remaining peat swamp forests need to be protected and that measures are needed to ensure sustainability and minimize GHG emissions from previously developed areas. However, this is a significant challenge to the world's fourth most populous country with significant economic constraints.

The anthropogenic uses of peatlands include mining for fuel and drainage mostly for agriculture and forestry purposes. In the current time, peatlands in Indonesia are being destroyed at an alarming rate. Large-scale drainage of (former) peat rainforest has occurred to enable logging of the peat swamp forests and to transport logs in the drainage canals (Silvius, *et al,* 2006). After deforestation, drainage has continued or even intensified to establish oil palm plantation and pulp wood such as Acacia plantations and this tree species requires deep drainage. Currently there are about 14 million ha of peat swamp forests and six million ha of peatland are under agricultural production in Indonesia, mainly in Sumatra, Kalimantan and Papua and this represents over 70% of the peatland area in Southeast Asia and about 50% of the world's tropical peatlands (Peat Portal, 2002). Peatlands can storage a large number of greenhouse gases. If disturbed by drainage and burning, the stored carbon is released to the atmosphere contributing to the greenhouse effect. If maintained in their natural state, CO_2 is incorporated as organic carbon into the dying biomass and stored in the peat, and this will moderate the climate change. Due to development and rising population pressure, severe degradation of peatland in Indonesia (resulting in loss of sink capacity and high carbon emissions) is likely to continue in the coming years unless prompt action is taken to protect these resources.

More than 3 million ha of Central Kalimantan is peatland and nearly 14% of it has already been converted to palm oil plantation area (Forest Watch, 2007). The similar figure happened in Sumatera and this also begins with Papuan peat swamp forest. To grow palm oil, the large area of peat land should be cleared and drained, releasing millions of tonnes of CO_2 into the atmosphere. The oil of palm is a major export product and is used in numerous foods, soaps, washing powders and as a feedstock for biofuels (MacKinnon, 2009). Palm oil plantation is expanding rapidly due to

the increased demand of palm oil from western countries, who find it as a good source of biofuel, a 'clean' alternative for fossil fuels. Therefore, the European Union implements all kind of legislation for a large scale use of biofuels. As a result, large areas of peatlands have been converted to palm oil plantations, and similar figures apply to Malaysia. It is estimated that production of one tonne of palm oil will result in an average emission of 20 tonnes of CO_2 from peat decomposition alone without taking into account the emissions from fire and other CO_2 emissions during the production cycle (Silvius, *et al*., 2006).

Burn and drain of the peatland and peatswamp for plantation and agriculture purposes have multiplied the emission of CO_2 into the atmosphere. Greenhouse gases are released into the atmosphere every time wetlands or peatlands are burned, drained, converted to agriculture or degraded (Reid, *et al.,* 2004). A dramatic example of this was the peatland forest fires that occurred in Indonesia in 1997/1998 which degraded more than 1.45 million ha of peatlands, about 10% of the total peatland area in Indonesia, and these fires released amounts of carbon dioxide equivalent to 40 per cent of the world's average yearly carbon emissions from fossil fuels (Page, et al., 2002). The current findings documented that Indonesia emits about 6.5 times as much CO_2 from degraded peatlands as it does by burning fuels every year (WWF, 2010). In a ranking of countries based on their total CO_2 emissions, Indonesia is placed at the 21st rank, if peatland emissions are excluded (Silvius, *et al*., 2006). However, if peatland emissions are included, Indonesia becomes the third-largest CO_2 emitter in the world.

Forest fires

Forest fires have also been the major contributor to climate change in Indonesia, because these have produced a huge amount of CO_2 emission. Some fires occur naturally and even play an ecological role for ecosystems, but a large number are human-induced, either directly for land clearance or indirectly by opening the canopy of closed forests. The correlation between forest fires and climate change could be indicated through, first, changes in climate have significant implications on the humidity of a region (e.g. they can lead to drier conditions) and, second, they could increase the production of biomass, resulting from more rain, higher temperatures and a higher concentration of CO_2 in the atmosphere (Herawati, *et al*., 2006). It is estimated that most of Indonesia's land will become warmer and wetter, except its southern part (including Java and Bali) which will become drier (Hulme and Sheard, 1999). As a consequence of inter-annual variability mechanism such as El Niño-Southern Oscillation (ENSO) or Indian Ocean Dipole Mode (IODM) dry conditions over the whole region are exacerbated during the dry season and this leads to the high risk of fire (Herawati, *et al*., 2006). Forest areas are vulnerable to fire during the long period of drought. Furthermore, with increased seasonal variability, there is a tendency of shifting from

rain forest ecology to seasonal rain forest ecology which provides more open canopy and drier forest floor in dry season (Condit, 1998).

Peatlands, which are rich with organic substances and have high water content, are difficult to burn. However, in the event of extreme dryness caused by ENSO and IODM, the biomass becomes drier and the water table on peatlands drops, thus exposing large quantities of biomass and making them easy to burn (Herawati, *et al.,* 2006). A combination of ENSO and IODM, such as those in 1993 and 1997-1998, have caused severe droughts that correlates with the increased number of hotspots of forest fires over Indonesia. Using satellite images of a 2.5 million hectare study area in Central Kalimantan, from before and after the 1997 fires, it was calculated that 32% (0.79 Mha) of the area had burned, of which peatland accounted for 91.5% (0.73 Mha) (Page *et al*., 2002). The large forest fires can directly lead to a serious and extreme loss in biodiversity, specifically fires can quickly eliminate fire sensitive plant species, and this can cause the forests to degrade and to be more susceptible to repeated fires (Herawati *et al,* 2006).

Impacts of climate change

The series of impact of climate change on human being and biodiversity are still invisible, but several studies have documented the severe impacts that should be taken into account seriously.

Food security will be threatened by climate change

Since the country is home to almost 250 millions of human population, impact on food security might be the most important concern for Indonesia with regards to the risk of decreased food security. Climate change will alter the precipitation, evaporation, run-off water and soil moisture; consequently will have adverse effects on agriculture and thus the food security (Sari, *et al*., 2007). The droughts caused by the 1997 El Nino event affected more than 420,000 hectares of rice and caused the food crises in certain regions. Important income generating from non-food crops such as coffee, cocoa and rubber were also affected (FAO, 1996 in Sari, et al, 2007). A model simulating the impacts of climate change on crops (Goddard Institute of Space Studies, UK Meteorological Office) shows a decrease of crop harvest in West and East Java (Sari, *et al.,* 2007). Climate change will likely reduce soil fertility and subsequently result in the decreases of rice yield, soybean, maize and other annual crops. This will worsen the living conditions of farmers, fishers and forest-dependent people who are already vulnerable and food insecure, and as a result hunger and malnutrition will increase. More frequent and more intense extreme weather events will have impacts on food availability, accessibility, stability and utilization, as well as on livelihood assets and opportunities in both rural and urban areas. In particular, rural communities that living in already fragile environments are facing a direct and high risk of increased crop failure, loss of

livestock, reduced availability of marine, aquaculture and forest products (Glantz, *et al*, 2009). Poor people will be at a risk of food insecurity due to loss of food resources and lack of adequate insurance coverage. The ability of rural people to cope with climate change impacts depends on the existing cultural and policy context, as well as on socio-economic factors like gender, household composition, age, and the distribution of household assets (FAO).

Sea level rise

The global **c**limate change is causing the rising sea level due to increased volume of the sea water and the melting of polar ice caps. This will affect the productivity of coastal area and reduce farming and coastal livelihood, because more salt water will be inundated to the ground. For example, the mean sea level in the Jakarta Bay will increase to as high as 0.57 centimeters (cm) per year (World Bank, 2007). In some coastal regions, the crop yield such as rice production per year would be reduced due to inundation of salt water. Sea level rise would also likely affect fish and prawn production, because increasing sea level surfaces could drive the inundation of aquaculture, and this could result in the loss of fish, shrimp and prawns output (Sari *et al*, 2007). The overall effect of climate change would be reducing potential average income of the coastal communities such as fishermen. A number of labours will lose their jobs and thousands of farmers would have to look for other sources of income due to the inundation of their rice fields or prawn and fish farms due to sea level rise (*Parry & Nih,* 1992 in Sari, *et al.,* 2007). Several cities in Java are facing ground water problems, due to the pressure of salt water and this could lead to the water shortage faced by human population.

Furthermore, sea level rise will affect some very important and unique cultural and spiritual sites in coastal areas and hence the people that are living there (Gitay, *et al.,* 2002). For example, several coastal communities in Mollucas usually celebrate such a traditional ceremony along the coast in certain time to harvest the marine resources in appropriate ways. Temperature change and sea surface increases will affect the reproduction systems of marine biodiversity and, consequently confuse traditional culture and utilisation of marine resources. A number of small islands in Indonesia would disappear if the sea levels continue to rise. A high tide and waves will first damage the food resources and homes and slowly the island will be swallowed by a rising sea.

Impacts on coastal and marine biodiversity

Climate change will influence Indonesia's ocean water, leading to an increase in temperature of 0.2 to 2.5°C. The 50,000 km^2 of coral reefs in Indonesia, about 18% of the world's total, are already in an alarming state (Sari, *et al*, 2007). Many coral reefs occur and grow at or close to the temperature tolerance threshold. The El Nino event in 1997 – 1998 alone was estimated to have caused coral

bleaching to 16% of the world's coral reef (Wilkinson, 2010). Furthermore, a number of surveys reported that only 6% of Indonesia's coral reefs are still in excellent condition, 24% in good condition, and the remaining 70% are in fair to poor condition (Johns Hopkins University, 2003). During the El Nino events, many corals were damaged and coral bleaching occurred, as the temperature of sea surface rose by 1°C above the mean seasonal sea surface temperatures in only one season and extensive mortality occurred as the temperature increased by 3°C (Gitay, *et al.*, 2002).

A survey in the Bali Barat National Park found that a majority of coral reefs were in poor condition and more than half of that was due to coral bleaching (Sari, *et al.*, 2007). This problem might also occur in other coral reefs of Indonesia. If the climate continues to change and the sea water increases, up to 90 % of the coral reefs will be affected. Coral bleaching may occur when corals expel their colourful symbiotic algae as a reaction to environmental pressure such as high sea temperature (Ka 'Ellele, 2008). This process can permanently damage coral reefs.

Impacts on terrestrial biodiversity

The impacts of climate change on biodiversity will vary considerably from region to region, partly because changes in temperature and precipitation will differ among regions. The most rapid changes in climate are expected to emerge in the very north and south of the planet, and in the mountainous regions. However, tropical regions such as Indonesia will also suffer biodiversity loss due to climate change. Species in high-elevation ecosystems such as Jayawijaya mountain range in Papua are likely to shift faster.

Climate change may lead to a rapid increase in rates of species extinction. According to one recent study focusing on five regions of the world, if the climate continues to warm it could dramatically increase the number of species going extinct. Mid-range predictions suggest that 24 per cent of species in these regions will be on their way to extinction by 2050 due to climate change. This study also indicates that for many species, climate change poses a greater threat to their survival than the destruction of their natural habitat (Thomas, *et al.,* 2004). The other impacts of climate change may include changes in the reproduction cycle of certain species; change in the length of the growing season of such a species in many regions; change in the abundance of different species; and also in the frequency of pest and disease outbreaks (Reid, *et al.*, 2004). For example, higher temperatures have led to an increase in the number of eggs laid by the spruce budworm, already one of the most devastating pests in North America's boreal forest. This could in turn contribute to more severe outbreaks of this pest (Gitay, et al., 2002). Certain species are vulnerable in different ways. Corals and other organisms living in coral reefs, for example, have already shown devastating losses as a result of increased water temperatures. Species restricted to small

areas or in small populations are also particularly vulnerable. A catastrophic event such as disease or drought, for example, can kill off a small population and populations in small, isolated habitats are unlikely to be replenished once decimated by outbreaks of fire or other catastrophes (Reid, *et al.*, 2004).

Impacts on traditional and indigenous people

Traditional and indigenous people are mostly depending on diverse resources from ecosystems and biodiversity for goods and services, such as food and medicines from forests. These ecosystems are predicted to be adversely affected by climate change and already under pressure from the current human activities (Gitay, *et al.*, 2002). Climate change causing the loss of biodiversity and habitats will threaten the existence of indigenous people, because they will loose the food resources and living place. Reef ecosystems provide many goods and services, and changes in these ecosystems due to climate change will affect the people living in coastal areas that depend on them. Wildlife and its habitats also play important roles in cultural and traditional belief systems of many traditional groups in Indonesia. For example several indigenous groups in Papua and Mollucas believe that their ancestors were from wild animals like birds of paradise, cassowaries, marsupials, etc. Wildlife is important culturally since various animal parts are used, like feathers and fur, as ornaments and bones and teeth in tool making (MacKinnon, 1992). They will disappear, if their ecosystems are damaged.

Climate change will intensify water and vector-borne diseases

El Nino and La Nina events in the late 1990s could be associated with the outbreaks of some diseases such as malaria, dengue and plague, and especially in 1997 malaria has spread to high elevations where it was detected for the first time as high as 2103 m in the highlands of Papua (Sari, *et al.,* 2007). According to WHO, many countries in Asia experienced unusually high levels of dengue disease and/or dengue haemorrhagic fever in 1998, and this was higher than in any other year (Githeko, 2000). In 2004, it appeared that a more virulent strain of the potentially deadly dengue fever virus may have emerged and this disease has been spreading faster and killing more victims than in the past years (Sari, *et al.,* 2007). Extreme high temperatures can also cause other health problems. For example, people with heart dysfunction might be vulnerable to hot weathers because they need extra energy to keep the body cool during the heat time; high temperatures can exhaustion and certain respiratory problems; and the concentration of ozone at ground level may also increase due to the higher air temperatures and this will cause lung tissue damages (loc.cit). An equally rapid warming event would have catastrophic implications for vector-borne diseases, with rapid geographical expansion of tropical ranges affecting non-immune populations (**Sutherst,** 2004) especially local communities. The relations between climate change and diseases including

health problems is still poorly researched. However, perhaps as a forewarning of what is to come, the rise in the number of dengue fever cases during the rainy seasons in Indonesia particularly in Java, could have been partially caused by warmer weather. Research has reported that warmer temperature has led to such a mutation of the dengue virus which is more difficult to handle, and this might cause to an increase in fatalities (Sari, *et al.,* 2007). Impacts will be vary across the country, but are likely to result in significant economic damage and loss of livelihoods. Local communities that are vulnerable to epidemic disease will suffer and especially those living in certain areas with lack of permanent health services.

The other consequence of climate change is increased of rainfall in Indonesia. The entire country will experience about 2% to 3% more rainfall per year, with the largest change being in the Moluccas (Sari, *et al.*, 2007). This might continue due to climate change, leading to a shorter rainy season (fewer number of rainy days in a year), with significant increase in the risk of flooding (loc.cit). The shorter rainy season will be subsequently followed by the long period of dry season and may lead to increased drought period and higher daily temperature. Strong and intensive rainfall can damage several sensible ecosystems, resulting in landslides, coastal erosion and sedimentation.

Potential strategies to mitigate the climate change

Climate change has become a complex global issue that should be elucidated at the international level. Several attempts have been undertaken to find the integrated ways to mitigate the global climate change, for example Convention on Biological Diversity (CBD) and the UN Framework Convention on Climate Change (UNFCCC). The climate convention aims to stabilise the concentrations of greenhouse gases, primarily through negotiation of global agreements such as the Kyoto Protocol, but also by providing guidance to governments on practical ways to adapt to a changing climate (Reid, *et al.,* 2004). The goals of the biodiversity convention are "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources (CBD, 1992).

One mechanism that could provide stronger links between policymakers working on climate change and biodiversity, and that could have positive implications for biodiversity, is the Clean Development Mechanism of the Kyoto Protocol (Reid, *et al.,* 2004). This allows industrialized countries to invest in emissions-reducing projects in developing countries to obtain credits, which they put towards meeting their own emissions targets under the Kyoto Protocol (The Nature Conservancy, 2009). Projects to establish planting trees as carbon sinks could be added to the activities under this mechanism. If reforestation and planting indigenous species is established in

degraded areas, then such plantations could become valuable habitats that can help to conserve biodiversity (Reid, *et al.,* 2004).

Indonesia was one of the first countries that signed the convention on Biological Diversity (CBD) in 1992. Afterwards a National Biodiversity Strategy and Action Plan had been established and Indonesian government also imposed a moratorium on further conversion of natural forest in May 2000. However this has not had much effect in the regions where the corruption left over by the former regime is still embedded in the system (ABC News, 2002). Following the national biodiversity strategy, several efforts have been done to reduce deforestation. For example in August 2001, an action was declared to stop illegal logging by placing ramin (*Gonystylus* spp), hardwood tree species, on Appendix III of the Convention on International Trade in Endangered Species (CITES) with a zero quota, seeking international support for their actions. This international support is essential in order to stop the trade in illegal timber. As demand for the product is largely external, the international community also holds a responsibility to implement policies that stop the import of illegal timber (ABC News, 2002). Indonesia also contributed to sign the Kyoto Protocol in 1998 and ratified it in 2004 through national Law No.17/2004. Since then, a lot has happened, notably in the field of the clean development mechanism (CDM), although less so in the other fields (Reid, *et al.*, 2004).

During UN climate change conference in Bali in 2008, the Indonesian minister for Forestry promised to provide incentives to stop unsustainable forestry practices and to protect Indonesia's forests. If these commitments by the Indonesian government are implemented, it will not only reduce the rate of global climate change through the carbon savings, but will also save Indonesia's biodiversity. Protecting the forests can also contribute to the economies of local and traditional communities that are dependent on these forests. Urgent action is becoming more critical in the light of the forest fire episodes and increasing deforestation in Indonesia. Improved appropriate management of forests has been identified as one of the important keys to mitigate the emission of GHG. According to the measures in the First National Communication, Indonesia, specific controls and mitigation measures should include: Strengthen forest management policy and enforcement; prevent forest fires; rehabilitate forest areas; promote low-impact logging and reduction in land conversion (Peat Portal, 2002).

In order to save the remaining natural forests in Indonesia from the threats posed by palm oil development, Forest Watch suggested that Indonesian government should immediately (1) Evaluate all plantation licenses where concessions fall on natural forests and use previously cleared land instead; (2) Create new regulation which strictly forbids the conversion of peat land into large scale palm oil plantations and (3) Punish severely those palm oil holding companies which,

intentionally or unintentionally cause forest or peat land fires; using fines and/or criminal punishments in order to set a precedence. Concerning the issue of carbon trade, Indonesia has an opportunity to create capital from reducing its deforestation rate under a proposed mechanism that would pay countries for protecting their forests. If Indonesia can halt deforestation (an unlikely scenario), it would avoid at minimum level the emissions of 680 million metric tons of carbon dioxide per year (Butler, 2009). Increased people awareness on climate change through media and education, and effective law enforcement could be addressed as the important mitigation strategies.

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Climate Change Threats to Estuary Ecosystems: The Case Study of Segara Anakan Cilacap

MOH. HUSEIN SASTRANEGARA

Abstract

Segara Anakan Cilacap is an estuary ecosystem. According to the delegation of authority, it is called Segara Anakan management areas that consists of west swamp – managed, east swamp – managed, and Nusa Kambangan management areas. The climate is tropical and humid. Normally, this region has the dry season from July to September, whereas the wet season is from October to June. Therefore the rainfall pattern and the regional climate does not show a normal trend. In the west – managed areas, there is an increasing eutrophication due to unsustainable land use practices in the river catchments, thereby leading to changes in the distribution of water and land-covered areas, alteration or destruction of habitats of benthic organisms and affecting the benthic-pelagic coupling and carbon and nutrient cycling. In the east – managed areas, there are increasing levels of Hydrogen sulphide inside the water bodies coming from Sulphur dioxide emissions into the atmosphere. Therefore, the changing climate poses a threat to the ecosystem.

Key words: Climate, estuary, Segara Anakan Cilacap

Segara Anakan Cilacap

Segara Anakan Cilacap, 108°46' E – 109°03' E and 8°35' S – 8°48' S, is an estuary ecosystem, located at the northern part of Nusa Kambangan Island and at the South coast of Central Java, Indonesia. In the north, freshwater discharges into the areas from rivers such as Citanduy, Cibeureum and Cikonde. In the south, seawater enters the areas from the tidal channel of the western and eastern side of Nusa Kambangan Island.

According to the delegation of authority, Segara Anakan management areas consist of three areas. The west swamp – managed areas (108°46' E – 108°53' E and 8°35' S – 8°43' S) as mangrove-fringed lagoon areas and the east swamp – managed areas (108°53' E – 109°03' E and 8°40' S – 8°45' S) as riverine areas. It has been managed by the Ministry of Forestry which is delegated by the Cilacap State Forest

Corporation. The last area is Nusa Kambangan management areas as primary land forest and prison areas. It has been managed by Ministry of Justice (Fig. 1). We will discuss the first two areas into two chapters.

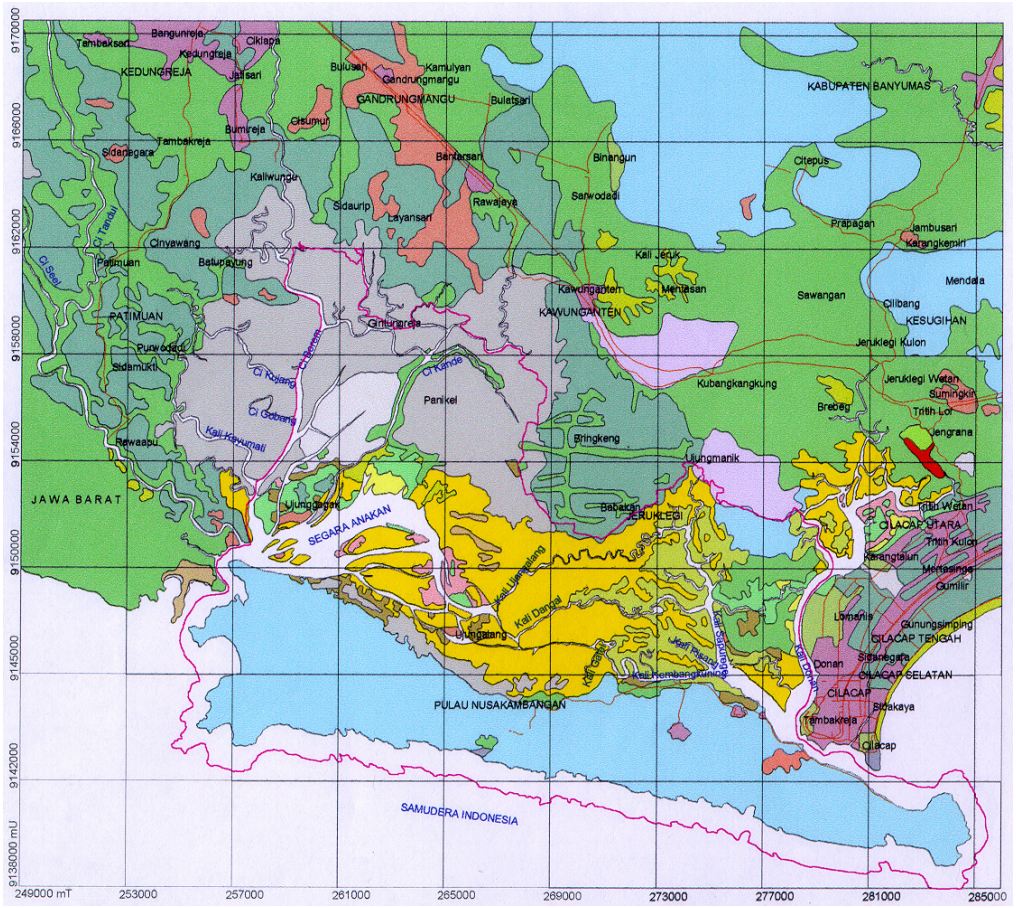

Figure 1: Segara Anakan management areas (Geographic Information System Laboratory of Project Management Office – Segara Anakan Conservation and Development Project, 2000).

The climate of Segara Anakan Cilacap is tropical (ASEAN/ US CRMP, 1992) and humid, with the southeast monsoon dry season and the northwest monsoon wet season (Tomascik *et al*., 1997). Normally, Segara Anakan Cilacap has the dry seasons between July and September, whereas the other months are the wet season. It was detected by the average rainfall per year, especially the average of 30 years from 1961 to 1990 (Fig. 2, The Ministry of Communication, 2002).

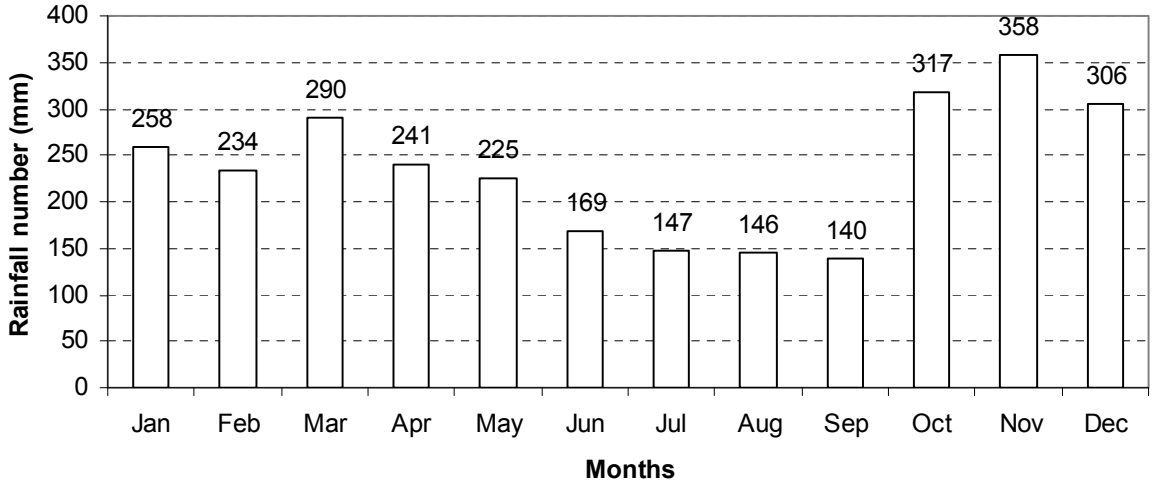

Figure 2: Rainfall in Cilacap representing the dry seasons in July, August and September, and the wet seasons (other months). It fluctuates between 140 mm (September) and 358 mm (November). Samples were taken from 1961 to 1990 (The Ministry of Communication, 2002). Column chart produced using the software of Excel (Microsoft, 2000).

Unfortunately, based on the data of research from October 2000 to January 2002, the rainfall is highly variable and varies seasonally from October 2000 to April 2001 as wet season (ranging between 190.3 mm and 854.0 mm), May 2001 as dry season (127.5 mm), June 2001 as wet season (302.8 mm), from July 2001 to September 2001 as dry season (ranging between 4.7 mm and 84.8 mm) and from October 2001 to January 2002 as wet season (ranging between 273.2 mm and 1,441.2 mm) with the highest precipitation in October 2001 (1,441.2 mm) and the lowest one in August 2001 (4.6 mm). Annual rainfall increased from 4,189.1 mm in the year 2000 to 4,327.2 mm in the year 2001 (Sastranegara, 2004). Therefore, the rainfall pattern was characterized as type "B" in 2001. This means that rainfall and regional climate could not be considered to show a normal trend as the dry season came two months earlier compared to the average rainfall (The Ministry of Communication, 2002). In fact, regional climate and hydrology have to be considered as major factors in determining the ecological response to rapid-scale climate change (Jennerjahn *et al*., 2004).

West Swamp – Managed Areas

The hydrology of the lagoon is governed by seasonally varying river runoff mainly of the Citanduy River where there are threats to ecosystem functions of the lagoon (Jennerjahn *et al.*, 2007). Of the 446,000-ha Segara Anakan catchment area, the 350,000-ha Citanduy Basin supplies about 95% of water flowing into the 51,700-ha Segara Anakan management areas. In Citanduy River, the

average flow at wet season, 24.45 million m^3 per day, is higher than dry season, 14.77 million m^3 per day. Therefore, of the 5.24-million ton per year total estimated silt transport into the lagoon, there is a 3.04-million ton per year estimated silt transport from Citanduy River (ASEAN/ US CRMP, 1992). High sediment input from the Citanduy River due to unsustainable land use practices in the river catchments lead to changes in the distribution of water and land-covered area, alters or destroys habitats of benthic organisms and affects benthic-pelagic coupling and carbon and nutrient cycling (Jennerjahn *et al.*, 2007).

As for the nutrient cycling, Dissolved Inorganic Nutrient (DIN) analyses indicate a large spatio-temporal variability in the lagoon. Dissolved silicate was in the range of 10-230 µM between May 2004 and February 2005 while dissolved phosphate was mostly <1 µM. DIN ranged between 4-40 µM and displayed an W-E gradient with maximum DIN in the Citanduy River and a decrease in concentration towards the East Swamp – managed areas (Jennerjahn *et al.*, 2007). Maximum concentration in the river and its eastward decrease appeared to reflect the land use and hydrology pattern of the lagoon's environments. More than half of the land use in the Segara Anakan region is agriculture, predominantly the cultivation of rice under irrigation and fertilizer application in the north areas (Yuwono *et al*., 2007). The observed DIN pattern indicates that major part of the nitrogen probably originated from agricultural soils and was introduced into the lagoon by the Citanduy River (Jennerjahn *et al.*, 2007). In the north areas, there are also other rivers such Cibeureum and Cikonde.

In general, there is a nutrient enrichment tendency or eutrophication process. Because of three factors such as erosion, agriculture intensification and human population growth, the eutrophic state tends to become hypertrophic state. It means that the estuary will change to land (Sastranegara, 1996). The water surface of lagoon and canal network for the year 1993 showed that 2,800 ha had a tendency to become smaller than 282 years before, 8,500 ha. In 2007, the water surface is only 2,200 ha (Máñez and Lukas, 2009).

East Swamp – Managed Areas

East Swamp – managed areas consist of Swamp – protected areas (108°53’ E – 108°58’ E and 8°39’ S – 8°44’ S) and Swamp – production areas (108°57’ E – 109°02’ E and 8°40’ S – 8°45’ S) which has a border of Sapuregel River. The first area is as mangrove areas, whereas the second one is silvofishery, settlement and Donan River (Geographic Information System Laboratory of Project Management Office – Segara Anakan Conservation and Development Project, 2000).

Mangroves grow in protected coast, river mouth or lagoon. Their distribution and composition are not dependent upon climate, but edaphic factor (soil type) and tide. Structure of mangroves is

simple and consists of one layer of canopy (Bupati Cilacap, 2001). Unfortunately, there is no research on climate change threats to mangrove ecosystems yet and illegal logging of mangroves is still continuing and will disturb the availability of mangroves in Segara Anakan Cilacap (Sastranegara *et al*., 2007). Yuwono *et al*. (2007) declared that mangroves in Segara Anakan Cilacap are considered to be the largest remaining single mangrove in the south coast of Java. In seasonal patterns, there was no significant difference in intertidal crab species richness between the wet and dry season, except one species of *Uca coarctata* was only found in the wet season. Two species of intertidal crab communities such as *Uca demani* and *U. dussumieri* showed significantly higher abundances in wet samples (Sastranegara, 2004).

Donan River has the potential of international ship's channel due to the availability of industry such as PT Holcim Indonesia Tbk. as a cement plant, Cilacap Industrial Areas, PT UP IV Pertamina as an oil refinery factory, and Intan Harbour (White *et al*., 1989). In general, industries contribute a climate change problem from their air quality such as TSP, So_x, Co_x, O_x, HC and Pb. Therefore, the Central Java Province has the air quality of industry (Gubernur Jawa Tengah, 2001). Unfortunately, the drift gill net operation was predicted causing river shallowness and disturbs the limestone transportation channel for industries, especially PT Holcim Indonesia Tbk. The water quality concentration of TDS, NH_3, Mn and Fe was above levels considered as water quality standard at all areas at Donan River; even the concentration decreases after dredging. On the other hand, increasing the concentration of H_2S was only at the location near PT Holcim Indonesia Tbk., whereas the concentration of Pb, silty clay sediment texture, and domination of benthic of *Rhinoclavis asper* and plankton of *Lyngbya spirulinoides* were at the location near PT Holcim Indonesia Tbk., Cilacap Industrial Areas and PT UP IV Pertamina. Similarity index of this research was 95.14%; the research before was 99.15% (Sastranegara and Lestari, 2008). H_2S inside water coming from (1) soil and sediment such as organic S, S, SO_4 and H_2S; and (2) atmosphere such as SO_2 (Odum, 1971). The chimney of cement industry produces SO_2 and dust emissions in the atmosphere, but the circulating fluidized bed installation was replaced by a wet scrubber. This cut the SO_2 emissions by 70% and cut the dust emissions by 50 to 60%.

Conclusion

Hydrology and regional climate have to be considered as major factors in determining the ecological response. For example, there are the west – managed areas and the east – managed areas, respectively. In the west – managed areas, the increasing eutrophication determines the distribution of water and land-covered areas, alters or destroys habitats, whereas there is increasing H_2S inside water coming from SO_2 emissions into the atmosphere in the east – managed areas. It means that the regional climate poses a threat to the estuarine ecosystems.

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Ironwood (*Eusideroxylon zwageri* Teijsm. & Binn.) diversity and its conservation in Jambi, Indonesia

BAMBANG IRAWAN

Abstract

Eusideroxylon zwageri Teijsm. & Binn. belongs to the family Lauraceae, tribus of Cryptocaryeae and subtribus of Eusideroxylineae. It is a threatened tree species which grows naturally in some of Sumatera and Borneo forest areas. The variability of *E. zwageri* has been reported by many scientists since the middle of the 19th century. In Jambi, local people recognized at least four types of *E. zwageri*. Those types had been investigated thoroughly by morphological and molecular genetic analysis, the results showed that the diversity that was recognized by local people had genetic basis and therefore, four new varieties were described namely, *zwageri*, *ovoidus, exilis* and *grandis*. In order to conserve the genetic diversity of *E. zwageri*, some conservation areas were developed. Those conservation areas are Senami forest, Durian Luncuk I and II and some forest areas that are managed by Forestry Corporations and local people.

Keywords: conservation, diversity, *Eusideroxylon zwageri,* Jambi

1. Eusideroxylon zwageri *condition in Jambi*

Bulian/ulin/belian/borneo ironwood (ironwood) (*Eusideroxylon zwageri* Teijsm. & Binn.), synonymous with *Bihania borneensis* Meissner and *Eusideroxylon lauriflora* Auct., belongs to the family of Lauraceae, tribus of Cryptocaryeae and subtribus of Eusideroxylineae (Kostermans, 1957). Symington (1940) cit. in De Wit (1949) described a new species in this genus, *Eusideroxylon melagangai* Sym., but Kostermans (1979) moved it into the new genus Potoxylon (*Potoxylon melagangai*). Jambi is located in the southern part of Sumatra. It is geographically located between 0° 45′ and 2° 25′ latitude south and 101° 10′ and 104° 55′ longitude East. It is bordered by Riau province in the North, Berhala gulf in the East, South Sumatra in the South and West Sumatra in the West (Anonymous, 1997).

According to Governor's decree no. 108, 1999, the area of forest in Jambi province is 2,179,440 ha (42.73% of the total land area). 870,250 ha of this is conservation forest (17% of land area) and about 1.320.700 ha production forest (25,67% of total area). The highest rainfall ranges from 2000 mm to 3000 mm per year with the highest falls in January. Temperature differences between day and night are small. The highest temperature is 33º C. Humidity varies from 75% to 90%.

In the past, *E. zwageri* grew in almost every part of Jambi forests except in Kerinci District, but due to over exploitation and other disturbances, in the present time, this species can be found only in some forest areas namely Senami forest, Sengkati, Durian luncuk and some forest clusters in Merangin, Sarolangun, Bungo and Tebo Districts.

The most pronounced example of this phenomenon is in the forest stand called Senami. The degradation of Senami forest is very clear from the comparison of *E. zwageri* volume in 1919 and the results of the research conducted by Masano and Omon (1983) and Irawan (2005). Irawan (2005) reported that the volume of *E. zwageri* was about 5.18 m^3 ha^{-1} while the mean volume of *E. zwageri* according to Masano and Omon (1983) was 120.9 m^3 ha^{-1} for undisturbed forest and 56.45 m^3 ha^{-1} for logged over forest area. Another research conducted by Gresser (1919) in the same areas found that the mean volume of *E. zwageri* was 105.6 m^3 ha^{-1}.

In order to conserve the existence of *E. zwageri* in Jambi, Governor of Jambi Province issued the decree no. 522.12/760/PP, on January 25, 1989. This decree regulated forest product concession and placed *E. zwageri* into a protected tree species category. In 1995, the Jambi Governor also issued a circular letter to regulate *E. zwageri* distribution and trading in Jambi. Nationally, according to the Indonesian Ministry of Agriculture decree no. 54/Kpts/UM/2/1972, *E. zwageri* is included into protected tree species and only cutting trees of over 60 cm diameter at breast height is allowed. Indonesia has also imposed a ban on its export.

2. *Eusideroxylon zwageri* diversity

2.1. Diversity recognized through Indigenous knowledge

The variability of *E. zwageri* has been reported by many scientists since the middle of 19th century (see Van Lijnden & Groll, 1851; Teijsmann, 1858; Teijsmann & Binnendijk, 1863; Heyne, 1927; Koopman & Verhoef, 1938; De Wit, 1949; Kostermans, *et al.,* 1994). However, they did not give further explanation about this variability. Most of them only reported the variability, which was recognized by local people based on certain morphological structures such as fruit form or bark and wood structures.

Van Lijnden and Groll (1851) reported that local people in Kalimantan recognized three types of *E. zwageri*. Teijsmann (1858) and Teijsmann and Binnendijk (1863) reported some variability of *E. zwageri*'s fruits and used the term "variety" to explain their variability. One of the types that was mentioned is *bulian telor* (local name, telor = egg), which is found in Banka island and has a rounded fruit shape.

Heyne (1927) reported that there are four types of *E. zwageri* in West Kalimantan. The first is *belian tando*, which is reddish brown. The second is *belian lilin,* which is very suitable for foundations and floors. The third is *belian tembaga,* which is yellow and is utilized for foundations and floors. The fourth is *belian kapur,* which is brown and is the only type which is easy to split; therefore, it is suitable for shingles.

Furthermore, Koopman and Verhoef (1938) reported that the native people distinguished several types of *E. zwageri* based on fruit form and wood characteristics. In Palembang, Sumatra, the first type of *E. zwageri* is *onglen regis*, with long cylindrical, and clearly pointed fruit. The second is *onglen arang*, with large, thick and more oval fruit. The third type is *onglen Koenjit,* which has wood that is yellow in color and easy to split. The fourth is *onglen arang* with dark-colored wood that is not easy to split, and the last is *onglen regis* with wood characteristics that are in-between. There is no further explanation about these types of *E. zwageri*. In Jambi, Sumatra, one distinguishes *boelian arang* and *boelian kapur;* the last has white lines or hyphens in the cortex. These characteristics of the cortex would go together with a thick cross-section of leaves.

De Wit (1949) reported that in Jambi, *E. zwageri* is known as *bulian gundjing* or *bulian regis*, *bulian rambai*, *bulian ketimun* (with large fruit) and *bulian terkujung.* Additionally, several varieties can possibly be distinguished within *E. zwageri* based on the form and size of the fruits. In practice, `*bulian sirap,*` having wood suitable for the manufacture of shingles, is sometimes distinguished from `*bulian tanduk*` or `*bulian daging,*` which are suitable for the production of timber (Kostermans, *et al.,* 1994).

Local people recognized four types of *E. zwageri* which grow in the Senami forest in Jambi, Indonesia - namely *daging, kapur, sirap,* and *tanduk*. The meaning of those vernacular names is directly related to the wood or bark structure of each type. *Daging* means "meat", and this describes an *E. zwageri* type whose wood is not easy to split; it is also watery and relatively heavier than other types. *Kapur* means "chalk" and this name is used to describe the *E. zwageri* type which has smooth bark and a whitish color. The word *sirap* means "shingle" and is used to describe the *E. zwageri* type whose wood is easy to split, making it very suitable for shingle production. *Tanduk* means "horn". It is used to describe the type of *E. zwageri* that has waved and bruised bark like a horn structure, especially in the base of the trunk (Irawan, 2005).

2.2. Eusideroxylon zwageri *varieties*

Irawan (2005) reported that in the natural forest, morphological structures of *E. zwageri* vary significantly on leaves, seeds and stems (bark surface). They can be used as keys to identify *E. zwageri* varieties. Four varieties of *E. zwageri* namely - *zwageri*, *ovoidus*, *exilis* and *grandis* – all of which are significantly different from one to another, can be determined. *E. zwageri*'s seeds have different shapes and sizes. They have been used as main characteristics to distinguish E. zwageri varieties. *Grandis's* seed is sub-cylindrical; *exilis* has slender seeds, *ovoidus* has rounded seeds while *zwageri's* seed is in between cylindrical and rounded. The leaf form of *E. zwageri* varieties varies. The forms of *zwageri's* leaves are oblong to elliptic; *grandis's* and *exilis's* leaves tend to obovate while *ovoidus*'s leaves tend to ovate. The most different bark structure and color of *E. zwageri* belong to *ovoidus* variety. It is smooth and white to pale yellow color. Molecular genetic analysis proved that differentiation on morphological structures, which was revealed by the researches and recognized by local people, has a genetic basis (Irawan, 2005).

3. *Eusideoxylon zwageri* conservations

3.1. *In situ* conservation

3.1.1. Senami forest

Senami forest stand is located at Tembesi resort forest on Batanghari district forest in Provincial Forestry Service of Jambi. Field conditions of the Senami forest are flat to undulate. During Dutch colonization, the forest belonged to local people (adat or marga forest) and since 1955, the forest area has been managed by the Forestry Service. It has been managed under a scheme of the Forest Product Concession (HPHH = Hak Pengusahaan Hasil Hutan) with the area size of 50 ha per plot (Masano and Omon, 1983).

The field research found that *E. zwageri* grew associatively with more than a hundred tree species. At tree stage, the number of tree species that were recorded was 99 species; at pole stage, 90 species; at sapling stage, 125 species; and at seedling stage, 92 species. From those species, only some are economically important for wood production, namely balam (*Palaquim spp.*), *E. zwageri*, jelutung (*Dyera costulata*), Kacang-kacang *(Strombosia javanica), keruing (Dipterocarpus spp.),* medang (*Litsea spp.*) meranti (*Shorea spp.*), petaling (*Ochanostachys amentacea*), kempas (*Koompassia malaccensis),* and sungkai *(Peronema canescens)* Some other species produce fruit

and vegetables that are economically important, especially for local people. Those species were *Nephelium sp*, *Artocarpus rigida*, *Baccarurea crassifolia, Archidendron pauciflorum, Archidendron microflorum*, and *Parkia speciosa*. Species that produce traditional medicine were

Eurycoma longifolia and *E. zwageri* (Irawan and Gruber, 2003; Irawan, 2005). *E. zwageri* was the most important species in the research site. The species important value of this species was 19.98. Among *E. zwageri* varieties, *zwageri* was the most common varieties followed by *exilis, ovoidus* and *grandis* varieties. The important indexes of those types were 4.15, 1.03, 12.69 and 2.11, respectively (Irawan, 2005).

Those data proved that Senami forest is one of the most important and suitable habitat of *E. zwageri*. It is one of the largest forest areas which is dominated by *E. zwageri* in Jambi. To conserve the last remaining genetic resources of *E. zwageri* and other species, this forest area has been promoted into Grand forest. However, the change of forest status from Forest Product Concession (HPHH = Hak Pengusahaan Hasil Hutan) to Grand forest in 2003 is too late since most of trees were already felled.

Some activities have been conducted to conserve and to increase the remaining population of *E. zwageri*. Almost every year, *E. zwageri* plantation has been conducted in this area but the results are not enough to overcome its population reduction. The only hope to conserve the remaining genetic resources of *E. zwageri* in this forest area is by tending and managing new sprouts. Irawan and Gruber (2004); Irawan (2005) reported that *E. zwageri* has good sprouting ability. Field data show that all of ironwood stumps produced sprouts (see also Irawan, 2002).

3.1.2. Durian Luncuk I and II

Geographically, Durian Luncuk I is located between 01° 55′ and 02° 00′ latitude South and 103° 00′ and 103° 05′ longitude East. Durian Luncuk II is located between 01° 45′ and 02° 00′ latitude South and 103° 00′ and 103° 15′ longitude East. Administratively, Durian Luncuk I is located in Guruh Baru Village, Sarolangun District and Durian Luncuk II in Jangga Baru Village, Batanghari District.

Since 1987, those forest areas have been promoted into conservation areas mostly to conserve *E. zwageri*. The area is 73.74 ha for Durian Luncuk I and 41.37 for Durian Luncuk II. Generally, the physical condition of those forest areas is almost the same. They are located in 30-40 m asl with alluvial soil. The precipitation was 3,196 mm/year in 1995 to 1998 with 16 rainy days in average per month (Jambi Natural Resource Conservation Unit (BKSDA), 2004).

Durian Luncuk's ecosystem is dominated by *E. zwageri* followed by balam (*palaquium spp*.), meranti (*Shorea spp*.), medang (*Listea spp*.), ara (*Ficus sp*.), terap (*Arthocarpus spp*.) and kelat (*Eugenia* sp.). The wildlife which can be found in those conservation areas are beruang madu (*Helarcios malayanus*), kera ekor panjang (*Macaca fascularis*), babi hutan (*Sus scrofa*), beruk (*Macaca nemestrina*), musang (*Paradoxurus hemaproditus*), napu (*Tragulus napu*), kancil

(*Tragulus javanicus*) and landak (*Hystrix brachyura*) etc. (Jambi Natural Resource Conservation Unit (BKSDA), 2004).

Those conservation areas are managed by Jambi Natural Resource Conservation Unit (BKSDA). To the present time, they can keep the existence of the conservation areas and the flora and fauna which present in those areas, even, surrounding areas have changed to oil palm plantation. One of the most important aspects of their management is involvement of local people in conservation effort. The local people involve in activities of conservation especially in security aspect. The people will protect the conservation areas when outsiders try to come and fell the trees. As reward, the Government trough BKSDA helps the people in developing their villages and also helping them in their economic activities for example by providing capital.

3.1.3. Other forest areas

Other than Senami and Durian Luncuk conservation areas, there are also some habitats of *E. zwageri* which are protected. For example in forest concession area belongs to Asialog there is about 100 ha of *E. zwageri* habitat which is protected. In forest areas belong to Wirakarya Sakti, a pulp and paper corporation, there are also some protected areas for *E. zwageri*. In Mandiangin and Mengupeh villages can be found small forest clusters which are dominated by *E. zwageri.* Those areas are managed by local people as conservation forest.

3.2. *Ex situ* conservation

There is no report on *ex situ* conservation of *E. zwageri* in Jambi. There are only some small activities of planting *E. zwageri* outside its natural distribution. Many people including some foresters believe that it is impossible to plant *E. zwageri* outside its natural distribution. They believe that, there is a specific soil property which is obligatory needed by *E. zwageri*. However, Irawan (2005) reported that *E. zwageri* is able to grow in poor soil fertility in almost any soil textures, from sandy soil to clay soil. No data obtained that *E. zwageri* needs specific soil properties to grow.

Small number of *E. zwageri* seedlings was planted out side its natural distribution. They were planted in Jambi University Education Forest. The size of this forest is 15 ha and the number of *E. zwageri* which were planted is 111. The results show that *E. zwageri* is able to grow well even when planted outside its natural distribution areas.

4. Future Development

The effort of protecting the last remaining *E. zwageri* genetic resources is mandatory to be conducted. Those genetic resources are important as basic materials for breeding programs. It is

therefore necessary to initiate the development of future integrated and comprehensive conservation and breeding programs.

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Distribution of mother trees of *Eusideroxylon zwageri* Teijsm. & Binn. varieties in Durian Luncuk II, Jambi Indonesia

BAMBANG IRAWAN, MOHD. ZUHDI AND FAZRIYAS

Abstract

An investigation and mapping on mother trees of Eusideroxylon *zwageri* varieties had been conducted in Durian Luncuk II, Jambi, Indonesia. The objectives of the study are to get information on number of trees which can be classified as mother trees; to determine the distribution of mother trees in the forests and geographical positions of each mother tree. The results show that the mother trees of *E. zwageri* are distributed evenly in the forest. 47 mother trees of *E. zwageri* were determined and recorded which separated into 17 mother trees belong to *zwageri* variety; 10 trees belong to *ovoidus*; 8 and 12 trees belong to *grandis* and *exilis* respectively. The mean diameters of mother trees were 66.53 cm for *zwageri*; 57.60 cm for *ovoidus*; 47.75 cm and 59.83 cm for *grandis* and *exilis* respectively. A digital map had been developed.

Keywords: Durian Luncuk, *Eusideroxylon zwageri*, mother trees, varieties

Introduction

Background

Eusideoxylon zwageri Teijsm. & Binn is one of the most important construction woods in Indonesia. The wood is used for making furniture, window and door frames, harbors, heavy construction, roofs, bridges, railway sleepers, marine pilling, boat construction, fence posts, heavy duty industrial flooring, shingles and vehicle body work. The most valuable characteristic of *E. zwageri* is that it is not vulnerable to termites and other ubiquitous tropical wood-eating insects and fungi. It has been favored both for local use and export trade. Over-exploitation together with forest clearance has led to the decline of this slow-growing timber species. The increased availability of forest roads opened by concessionaires is leading to greater problems of uncontrollable exploitation in Kalimantan (Partomihardjo, 1987).

Oldfield, *et al.* (1998) showed that *E. zwageri* is included in the list of threatened tree species. Its decline was first noted in 1955. Population reduction caused by overexploitation and shifting agriculture has been noted in the following regions: Kalimantan, Sumatra, Sabah, Sarawak and the Philippines. Based on the 2000 IUCN red list of threatened species. It is not critically endangered or endangered but is facing a high risk of extinction in the wild in the medium-term future (IUCN, 2001).

One example of the degradation of E.*zwageri* forest is Senami forest, Jambi. The degradation is very clear from the comparison of *E. zwageri* volume in 1919, 1983 and the results of research in 2004. Irawan (2005), who conducted research in 2004, obtained that the volume of *E. zwageri* was only 5.18 m^3 ha^{-1} while the mean volume of *E. zwageri* according to Masano and Omon (1983) was 120.9 m^3 ha^{-1} for undisturbed forest and 56.45 m^3 ha^{-1} for logged over forest area. Another research conducted by Gresser (1919) in the same areas found that the mean volume of *E. zwageri* was 105.6 m^3 ha^{-1}.

On the other hand, *E. zwageri* has high genetic variability. This variability had been reported by many scientists since the middle of 19th century (see Van Lijnden & Groll, 1851; Teijsmann, 1858; Teijsmann & Binnendijk, 1863; Heyne, 1927; Koopman & Verhoef, 1938; De Wit, 1949; Kostermans, *et al.,* 1994). Irawan (2005) reported that in the natural forest, morphological structures of *E. zwageri* vary significantly on leaves, seeds and stems (bark surface). They can be used as keys to identify *E. zwageri* varieties. Four varieties of *E. zwageri* namely - *zwageri*, *ovoidus*, *exilis* and *grandis* – all of which are significantly different from one to another, can be determined.

The potential lost of genetic resources of *E. zwageri* become worse, since it is very slow growing species even under optimal conditions (Kostermans, *et al.*, (1994). In natural forests, *E. zwageri* will reach their mature size in 200 years or even more (Beekman, 1949). Additionally, Ashton (1981) reported that the average girth increment of *E. zwageri* at all sizes was extremely low, about 0.3 inches (8 mm) per annum. Kiyono and Hastaniah (2000) reported that in natural forests, *E. zwageri* grows slowly when its stem diameter at breast height is below 10 cm. The time required for the *E. zwageri* stem to reach 30 cm in diameter at breast height is estimated at 120 years, and for 120 cm, at 403 years. The diameter increment of trees of *E. zwageri* varieties which had grown in Senami forest, Jambi range from 0.46 cm to 0.52 cm per year (Irawan, 2005).

For future use and development of *E. zwageri* through breeding programs, it is needed enough source of seeds with high genetic variability. To fulfill this condition, it is important to have enough number of mother trees which can supply seeds for new regeneration. The number of mother trees should be enough to ensure that high variability of *E. zwageri* is maintained and

inherited to its offspring. Breeding program of *E. zwageri* had been developed in Jambi and an investigation and mapping on mother trees of *E. zwageri* varieties is an early step.

Objectives

The objectives of the study are:

(1) to get information on number of trees which can be classified as mother trees;

(2) to determine the distribution of mother trees in the forests and geographical positions of each mother tree.

Outputs

The outputs of the study are

1. Information on number of trees which can be used as sources of seeds for both plantation and breeding programs

2. Digital and print out maps of distribution of *E. zwageri* mother trees based on its varieties. This map will help in finding each mother tree for future use.

Materials and Methods

Time and Place

The study had been conducted from May to June 2006 in Durian Luncuk II – a conservation area for *E. zwageri* in Jambi Indonesia. Durian Luncuk II is located between 01° 45′ and 02° 00′ latitude South and 103° 00′ and 103° 15′ longitude East. Administratively, Durian Luncuk II located in Jangga Baru Village, Batanghari District. Since 1987, this forest had been promoted into conservation areas mostly to conserve *E. zwageri*. The area is 41.37 ha and

located in 30-40 m asl with alluvial soil. The mean precipitation was 3,196 mm/year with 16 rainy days in average per month. Durian Luncuk's ecosystem is dominated by *E. zwageri* followed by balam (*palaquium spp*.), meranti (*Shorea spp*.), medang (*Listea spp*.), ara (*Ficus sp*.), terap (*Arthocarpus spp*.) and kelat (*Eugenia sp.*) (Jambi Natural Resource Conservation Unit (BKSDA), 2004).

Investigation on mother trees

The criteria that were used to determine *E. zwageri* tree as mother tree were minimum diameter at breast height which was 40 cm; straight and good clear bole and free from serious diseases. The minimum diameter was fixed at 40 cm because this species is slow growing and therefore trees

with diameter more than 40 cm are mature enough to produce good seeds. Since the number of trees with big diameter was limited, some numbers of trees with diameter less than 40 cm but having exceptional good performance were also included as potential mother trees.

The materials that were used were mother trees from the natural forest stand of *E. zwageri*. The instruments were compass, GPS, a clinometer, tape, data sheet, rope and stationery. The study had been conducted by direct observation in the field using purposive random sampling. The sample plots were the plots where *E. zwageri* mother trees could be recognized. Each mother tree was determined as the center of each plot and the plots were determined as area with a radius of 20 m from the center. The data on diameter and height of mother trees were recorded. Species which grew inside the plot were also identified and recorded. A local expert helped in identifying the names of the species.

Mapping on Mother Trees

Mapping was done using GPS *Garmin Map III*+. The spatial position of each *E. zwageri* mother tree or its clusters was marked through the facility of *mark waypoint* in GPS unit. In order to reduce the position error, the method of *averaging position* was applied when marking the position. It was 2 to 5 minutes or at least 120 position data for every measurement. Besides, the data were taken only when the *EPE (Estimated Position Error)*, shown in GPS display, is less than 10. It means that no data with greater than 10 meter error were taken. However, in practice the required condition (EPE < 10) was very rare under thick vegetation coverage; therefore the position measurement was done in any place close to the *E. zwageri* mother tree wherever it was possible. Then, the distance and direction from this point to the *E. zwageri* tree position were measured using compass and measurement tape.

Results

Investigation on mother trees

a. Dimension of mother trees

47 mother trees of *E. zwageri* were determined and recorded which separated into 17 mother trees belong to *zwageri* variety; 10 trees belong to *ovoidus*; 8 and 12 trees belong to *grandis* and *exilis* respectively. The diameter and height of trees that identified and determined as mother trees of *E. zwageri* are presented in Table 1.

Table 1. Diameter and height of mother trees of *E. zwageri* varieties

Code	Diameter (cm)	Height (m)	Code	Diameter (cm)	Height (m)	Code	Diameter (cm)	Height (m)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Z_{12}	87	12	G_{08}	32	8	O_{16}	43	12
Z_{13}	46	11	G_{09}	43	15	O_{17}	90	14
Z_{14}	44	10	G_{10}	43	7.5	O_{18}	122	24
Z_{15}	80	15	G_{11}	40	8			
Z_{16}	44	8	G_{12}	70	12			
Z_{17}	65	12	G_{13}	58	10	E_{04}	59	12
Z_{18}	45	10	G_{14}	48	10	E_{05}	50	12
Z_{19}	70	13	G_{15}	48	16	E_{06}	50	12
Z_{20}	64	10				E_{07}	48	13
Z_{21}	43	8				E_{08}	35	8
Z_{22}	37	12	O_{09}	40	15	E_{09}	41	14
Z_{23}	48	14	O_{10}	50	10	E_{11}	40	15
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Z_{24}	39	15	O_{11}	50	15	E_{12}	65	14
Z_{25}	192	18	O_{12}	36	10	E_{13}	82	13
Z_{26}	80	17	O_{13}	41	10	E_{14}	42	10
Z_{27}	79	17	O_{14}	47	11	E_{15}	66	15
Z_{28}	51	12	O_{15}	57	14	E_{16}	140	25

Note: Z : *zwageri* variety; G : *grandis* variety; O : *ovoidus* variety and E : *exilis* variety

The mean diameter of mother trees of *zwageri* variety was 65.53 cm; *ovoidus* was 57.60 cm; *grandis* was 47.75 cm and *exilis* variety was 59.83 cm. While mean heights of the mother trees

which belongs to *zwageri*, *ovoidus*, *grandis* and *exilis* variety were 12.59 cm; 13.50 cm; 10.81 cm and 13.58 m respectively.

b. Tree species association

The field research found that *E. zwageri* mother tree grew associatively with few tree species in this forest area. There were only 5 tree species could be found namely kempas (*Koompassia malaccensis),* kulim, sebasah (*Aporosa* sp.) mahang (*Macaranga sp*.) and tembesu (*Fragrarea fragrans*)

3.2. Mapping of mother trees

Mapping results show that mother trees of *E. zwageri* was distributed almost evenly in a whole conservation area. However, small cluster of them was performed (see Fig. 1).

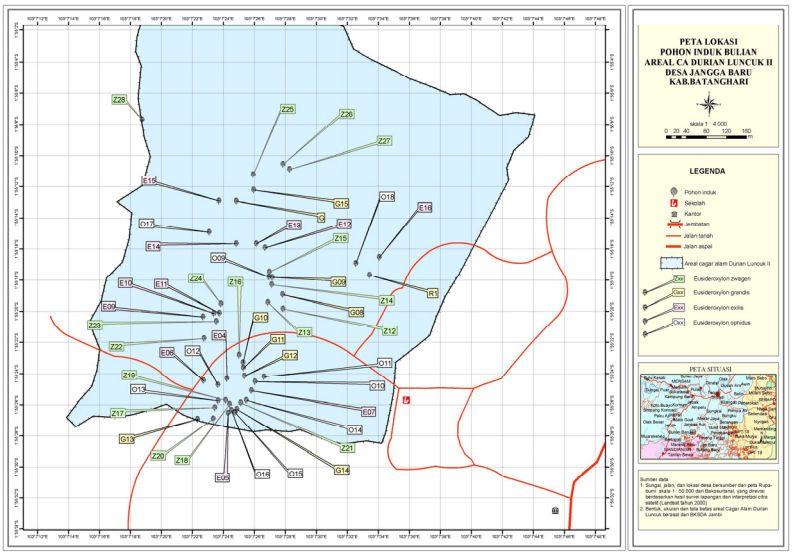

Figure 1. Distribution of mother trees of *E. zwageri* in Durian Luncuk II

Discussion

The results of this study revealed that only about one mother tree could be found in one hectare of forest area. However this condition is much better compare to other forests where *E. zwageri* could be found in Jambi, especially when the dimensions of those trees are taken into account. Mean diameter of *E. zwageri* trees with more than 50 cm at breast high is very rare in the natural forests since most big trees were felled. Even, in this forest still can be found trees with diameter more than 100 cm. Irawan (2005) reported that tree mean diameter of *E. zwageri* varieties in Senami

forest was between 22 cm to 28 cm. Our recent investigation in Senami forest, Jambi found that almost no standing trees of *E. zwageri* with diameter at breast high more than 20 cm. Durian Luncuk II, conservation area is managed by Jambi Natural Resource Conservation Unit (BKSDA). To the present time, they can keep the existence of the conservation areas and the flora and fauna which present in those areas, even, surrounding areas have changed to oil palm plantation. One of the most important aspects of their management is involvement of local people in conservation efforts. The local people involve in activities of conservation especially in security aspect. The people protect the conservation areas when outsiders come to destroy the forest.

All four varieties of *E. zwageri* could be found in this conservation area. It means that this forest has very high conservation values. It reserves high genetic resources of *E. zwageri* which is very rare at the present of time. It can serve as sources of seeds for future use both for plantation as well as breeding programs. *Zwageri* variety is the most frequent mother trees that can be found. This is parallel to another investigation before. (Irawan, 2005) reported that among *E. zwageri* varieties which grew in Senami forest, *zwageri* is the most dominant variety. The variety important value is more than twice that of the second most dominant variety (*exilis*). The dominance of *zwageri* variety correlates with the ability of this variety to grow on various soil types and with the vitality of its seedlings.The number of species that grow associatively with *E. zwageri* as revealed by this research is much smaller than the results obtained by other researches before. For example, Hastuti, *et al*., (1999), who conducted research in Senami area, found 51 tree species. Suselo (1981) found 37 species with plot size of 0.2 ha and 65 trees with diameter of more than 10 cm, but 17 (26%) are *E. zwageri*. Irawan and Gruber (2003); Irawan (2005) reported that in Senami, *E. zwageri* grow associatively with more than a hundred tree species. However, The results of this study parallel to Whitemore (1984) who reported that that in Sumatra forests, *E. zwageri* grew very dominantly which was characterized by an exceptionally low species diversity.

The mother trees seem to be distributed evenly in a whole forest area. Indeed, clusters is characteristics distribution pattern of *E. zwageri* instead of even distribution. Therefore it can be assumed that Durian Luncuk is a big cluster of *E. zwageri*. It is similar to natural distribution pattern of *E. zwageri* in some other forest areas (see Riswan, 1982; Irawan, 2005). The distribution pattern is affected by the dispersal mechanism of its seed. Since *E. zwageri* has a very big seed, the dispersal mechanisms are mainly gravity (slope) and in some cases mammals (Burton *et al.,* 1981; Kostermans, *et al.*, 1994; Weidelt, 1997; Irawan 2005).

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Bioenergy, does it mean for biodiversity and nature conservation in Europe?

JOLANTA SLOWIK

The former prime minister of Great Britain, Tony Blair had declared that climate change will be the greatest challenge facing mankind in this millennium. Since climate is a key driving force for ecological processes, climate change is likely to have considerable effect on the biodiversity and therefore the conservation goals of countries and NGO's.

The world energy consumption after the prognosis of specialists will climb continuously at least to 2050 mainly due to transport and industry. It means that without our actions carbon dioxide and other gases like methane or N_2O (dinitrogen monoxide, laughing gas) which warms up the surface of the planet, will further raise the temperature of the Earth.

The human well-being and civilisation is dependent on energy. Currently the question arises as to how to realise the UN Millennium Development goals in order to ensure environmental sustainability, stop the ongoing crisis of loss of biodiversity and mitigate climate change? We are also faced with additional economical crisis. International effort is therefore necessary to solve these global problems and challenges.

The first step towards climate change control was the United Nations Framework Convention on Climate Change (UNFCCC or FCCC) aimed at stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system declared during Rio Earth Summit 1992 in Rio. Unfortunately this convention is without enforcement provisions and therefore legally non-binding. The succession of Convention on Climate Change was United Nations Framework, Kyoto Protocol 1997.

The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change and was opened for signature in December 11, 1997 and entered into force in February 16, 2006. The major attribute of the Kyoto Protocol was that it sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions. The outcome of the next 13th United Nations Climate Change Conference in Bali (13-14.12.2007) was the agreement on the so-called "Bali Roadmap" which established a negotiation process for the post-2012 fight against climate change. The COP14 meet was held in

Poznań, Poland, in December 2007. Some important decisions taken during this meet were the development and transfer of technology, capacity–building for developing countries under the convention and reducing emissions from deforestation and forest degradation.

The politicians are just in the process of preparing to come to Copenhagen to discuss the same topics. The US President Barak Obama promised to reduce carbon emissions to their 1990 levels by 2020 and reduce them by an additional 80% by 2050.

The world meeting of scientists dealing with climate change in Chicago December 2008 did not bring any all clear signal regarding climate change. The scientists calculated three times faster CO_2 output as predicted.

What is the response of biodiversity to the climate change? The response of biodiversity to climate change could be very variable and complicated and depends on many factors like for example the biology of the species and fragmentation of their habitat (Opdam, 2004; Heller & Zavaleta, 2009). Climate change could be proclaimed as the second major cause for species extinction after the habitats loss and alteration. Predicted temperature increases could be so rapid that many species will be unable to change their ranges and will therefore become extinct (Hulme, 2005)

The scientists expect that climate change brings :

- Changes in the timings of seasonal events, leading to loss of synchrony between species and the availability of food, and other resources they are depending on.
- Shifts in suitable climate condition for individual species leading to change in abundance and range
- Changes in the habitats which species occupy
- Changes in the composition of plant and animal communities
- Changes of habitats and ecosystems, such as altered water regimes, increased rates of decomposition in bogs and higher growth rates in forests.

Climate change creates new and additional problems and challenges for biodiversity conservation and raises concern about the effectiveness of existing biodiversity protection strategies.

The invasion of Mediterranean species like Dragonfly *Crocothemis erythraea* from the Mediterranean region to Northern and Central Europe has been observed since many years and

indicates a general change of the natural ecosystems and global warming. Dragonflies are in this context a nearly perfect group, as the indicators of climate change as they are easy to determine and observe, their ecology is mostly well known, they react directly to changes in the climate and they are widespread. As they have aquatic larval stages and the adults are terrestrial, they are also perfect indicators for terrestrial and aquatic ecosystems.

When the annual average temperature in Europe will rise by about 2°C, new species from South Europe and North Africa will arrive and occupy new habitats. The melodious warbler *Hippolais polyglotta* has already been observed to migrate from the southern warmer regions to the north. Some bird species in Europe have even already changed their migration patterns. The Eurasian crane, *Grus grus* from North Europe was observed flying to the winter quarter in Spain as late as the beginning of January 2009.

Climate change analyses predict that higher temperatures and lower precipitation will dramatically increase the vulnerability of forests for diseases and insects mass outbreaks.

Several studies have shown that mass outbreaks can even cause a complete devastation of large areas, with considerable economic losses at a large spatial scale that will continue in future times (Karnosky,2003).

The negative effect of climate change on many ecosystem functions and quality has direct influence on human well being (FAO 2007) and have mobilised politicians to look for solutions to reduce or stop this human induced phenomenon. One of the most favourable solutions to slowing down global warming combined with sustainable energy production is promoting bio energy production from biomass. The primary motive behind promoting and supporting the development of bio-energy derived from biomass, i.e. living plants and plant components by conversion of the complex carbohydrates in organic matter to energy was to establish independence from non renewable energy resources like oil, gas, coal, nuclear power and for climate change mitigation it means reduction of greenhouse (GHG) emissions. Bio-energy sources are renewable and have low carbon characteristics. Organic matter may either be used directly as a fuel or processed into liquids and gases for electricity production, heat and liquid fuels for vehicles- known as biofuels (biodiesel and bioethanol) which are used in place of petrol and diesel. Bio-energy crops with greatest potential for commercial scale use as sources of bioenergy in Europe are:

Energy from perennial grasses:

- *Miscanthus giganteus (*Elephant grass)
- *Paniculum visgatum (*Switch grass)

Woody biomass crop

Lingo-cellulose- liquid fuel

Shot rotation coppice (SRC)

- *Salix spp. (*Willow)
- *Populus spp.* (Poplar)

Oilseed crops

Oilseed rape

Oil seed Sunflower

Conventional arable crops grown for sugar or starch

Wheat

Potatoes

Sugar beet

Energy crops have some characteristics which influence the biodiversity. Production of bio energy requires considerable changes in land-use. The biomass plants are intensively cultivated, perennial (87-25 years), have long harvesting cycles from winter to spring, dense plants with high crops, use of herbicides and fertilizers to control weeds during establishment and after cut back is practiced, they are often hybrids, introduced species or even genetically modified. In March 2007- EU set the target to provide 10% of transport fuel as bio-fuel and generate 20% of energy consumption from renewable sources and this goal has already produced consequences for nature. To achieve this goal 14-27% of the agricultural land in the EU will be required and the landscape scale impacts are already affecting the biodiversity (Ammerman, 2006).

The large-scale cultivation of new crops, including woody crops and perennial grasses, represents a large ecological shift from the conventional farmland habitats and are critical to the health of farmland bird populations and the other components of biodiversity. The overland impact of the crop on farmland bird populations is likely to depend also on what habitats these crops replace, their geographic distribution, and spatial arrangement within the landscape.

The most immediate threat to biodiversity in Europe is the loss of set-aside land for production of bioenergy crops, after the introduction of the Bio-energy Act (August 2004) – the so called NawaRo-Bonus. Plants generating energy from biomass are getting a subsidy of 4 € - 6 €-

Cent/kWh. The conversion of land may result in loss of high wildlife value habitats like wetlands, wet meadows, extensively managed semi-natural grassland, marginal farmland habitats such as hedgerows, small areas of unmanaged grassland and scrub for bio energy production.

Many species are presently dependent on set-aside land like Linnet (*Caduelis cannabina,* Bluthänfling) with 80% of the wintering population spending their winter on set-aside land. The German NGO, NABU (Naturschutzbund Deutschland) proposed, to couple NawaRo bonus on regulations concerning minimum standard and environment criteria.

- Bio-gas plant should use not more than 50% of one crop
- Renunciation of genetic technology
- Renunciation rejection from 1.04 to 30.06 of farm activities at the former set aside areas use for bio-plants cultivation.
- Bonus for nature and environment confident (secure) methods
- Deterioration of the nature conservation area, ploughing and intensification of grassland should be disqualified.

Due to biomass production for energy, there is a growing competition between uses of land and conflict with nature protection and water supply. Although the scale and spatial distribution of bio energy production determines their impact on biodiversity, the current policy strongly favours the large-scale production with significant simplification of the landscape in terms of habitat and vegetation structure. Bio energy is not the golden solution for energy and climate crisis and the agriculture politics of European countries, and specially EU policies should initiate nature conservation bonus and pay supplement for nature conservation to the farmers to motivate them to support their nature conservation efforts.

The other important problem concerning biomass production is the fact that the biomass market in Europe is dependent on import from countries belonging to the so called hotspots of biodiversity like Brazil (sugar cane, Soya bean), and Indonesia (palm oil). New plantations of oil palm are destroying tropical forest with very high biodiversity and its high storage capacity for CO_2. Further research studies are absolutely necessary to examine the influence of biomass production on European biodiversity. The interesting and important topics should be comparison between conventional and bio energy seed-crops on biodiversity, the effect of replacing set-aside land with bio energy crops on farmland biodiversity, detailed studies of species ecology in bio energy crop

field (source or sink populations) and effect of Miscanthus crops in Europe on biodiversity and comparison with other perennial grass crops. The use of bio fuel is predictable, limited and production of biomass competes with the use of that land for growing of food, and for putting aside the land for nature conservation. Bio fuel is not the proper answer on climate change and unfortunately brings new social and environmental problems. Climate change and the alarming rate of biodiversity decline and growing demand for energy will not be stopped by production of biofuel.

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Distribution and Abundance of the Soft coral and Hard Coral in Coral Reef Ecosystem of Bunaken National Park by Digital Image

MEITA J. W. LEPAR AND GEORIS J. F. KALIGIS

Abstract

A study on the distribution and abundance of soft and hard coral in coral reef ecosystem of Bunaken National Park by digital image had been done from January to August 2008. The study consisted of two parts, first part was in Bunaken and Siladen Islands for sampling and the second part was in Marine Laboratory of the Faculty of Science Polytechnica Universitas delle Marche in Italy for data analysis.

Samples (as image pictures) were taken from three fixed depths (6, 12, and 18 m) in each site (6 sites in both Islands, randomly), and then the images were analysed by counting the percent cover of the main taxonomic group of the animals in the coral reef ecosystem, mainly hard corals and soft corals.

The results showed that the observed animals randomly distributed in all sites and depths of observation in both islands. The abundance which represents by percent cover of each group showed also quite variative. Even in some depths the abserved group were absent.

Soft corals of Siladen Barat were high in Chacha at 6 m, then decreased in 12 and 18 m. The same tendency was also shown in Satchiko and Siladen Onong. **Hard corals** showed quite interesting result, where in Bunaken Island (Likuan 1, and relatively also in Chacha) was high at 6 m, and then decrased at 12 and 18 m, whereas in Siladen Island (Siladen Onong) they were low in 6 m, and then gradually incrased in 12 and 18 m. The comparison between islands, sites, and depths was discussed.

Introduction

Coral reef is one o f the ecosystems in the world which are complex and unique in the tropical areas. This ecosystem has very pronounced characteristic because of its high productivity and biodiversity. Coral reef in Indonesia are big resources, and play an important role for fisheries

development such as to support the income of fishermen from fishing and marine culture, nutrient improvement, and also to increase country devisa. The diversity of fish, molluscs, crustaceans, echinodermata, and seaweed exist and make association in this environment.

Indonesia's coral reef resources are among the richest and most diverse in the world. Eastern Indonesia lies at the centre of diversity for corals, molluscs, reef fishes and other reef organisms, along with the Philippines (McManus, 1985) and the north coast of Papua New Guinea. This wealth in biodiversity emphasizes Indonesia's importance in global efforts to conserve marine resources and preserve biodiversity (BAPPENAS, 1993).

Indonesian archipelago has a wide range of seawater characterized by coral reefs and small islands. These two objects are very sensitive with environmental change and exploitation by the people. Generally the people who live in the small islands and the border areas are poor with lack of knowledge about the natural resources around them. It is because development by the government rarely reaches these areas, therefore the local people in these areas use the available resources to fulfill their needs.

A famous marine park in North Sulawesi located in the capital city of this province is called Bunaken National Park. It is already known world wide because of its beauty and variative coral reef ecosystem, and is a paradise for divers that visits this park from all over the world. They come to enjoy the beauty of the underwater sea garden and conduct researches on coral reef ecosystem.

Based on the letter of decision from Ministry of Forestry No. 730/KPTS-II/1986, Bunaken Island is considered as National Park. With this consideration the island as a national park has to be managed based on its function especially for the marine resource exploitation. In order to defend the function of the park for its sustainability, it is necessary to consider rational works to prepare actual information about the existence of the community in the ecosystem by measuring percent cover of the main taxonomic groups such as: soft coral and hard coral that are present in this park, especially Bunaken and Siladen islands.

Depth has been previously shown to be important in structuring marine communities (Garpe and Ohman, 2003; Torruco et al., 2003; Syms and Jones, 2004 in De Vantier and Turak, 2004). (The range of depth used by benthic taxa has generally been attributed to post-settlement mortality as a function of physiological tolerance along environmental gradients related to light and water movement. Larvae may, however, also be able to select their preferred habitat (Baird et al., 2003 in De Vantier and Turak, 2004). Finally, coral reef habitats can differ in their exposure to wave action and water currents with exposed and sheltered habitats having distinct environmental conditions (Done, 1982 in De Vantier and Turak, 2004).

Research question

Based on visual observation, there are some coral reefs in the Bunaken National Park that are already damaged. So far there only few available data on soft and hard coral (example of main taxonomy group) as components that exist in this ecosystem from year to year. Therefore research is necessary in order to explain to the people and authority about how important it is to keep the coral reef ecosystem sustainable especially by aggregating information about the main taxonomic groups that builts the coral reef.

Objectives

This research is aimed to know about the distribution and abundance of main taxonomic groups that built coral reef like soft coral and hard coral which exist in Bunaken National Park Bunaken and Siladen islands.

Research Target

The target of this research is to prepare information about the existence of this group from time to time to make the people more sensitive with the situation. So they can also play a role to maintain the sustainability of the park.

Time and Place of Research

The research started from January to April 2008 with the theory preparation and Pre-research in Bunaken National Park (BNP) especially in Bunaken island and in Siladen island. In Each island, three sites were selected. In Bunaken island consisted of Likuan 1, Cha cha, and Satchiko. In Siladen Island i.e. Siladen Barat, Siladen Jeti and Siladen Onong. The research continued from May to August 2008 with data analysis in Manado, and also in Marine Laboratory ofthe Faculty of Science Polytechnica Universita delle Marche in Italy.

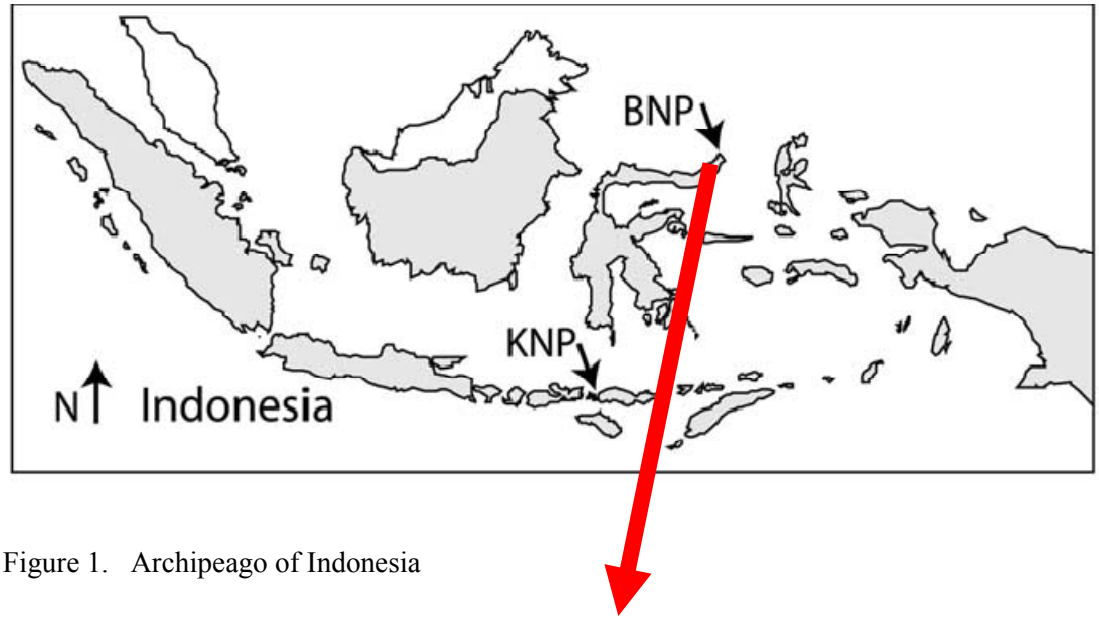

Figure 1. Archipeago of Indonesia

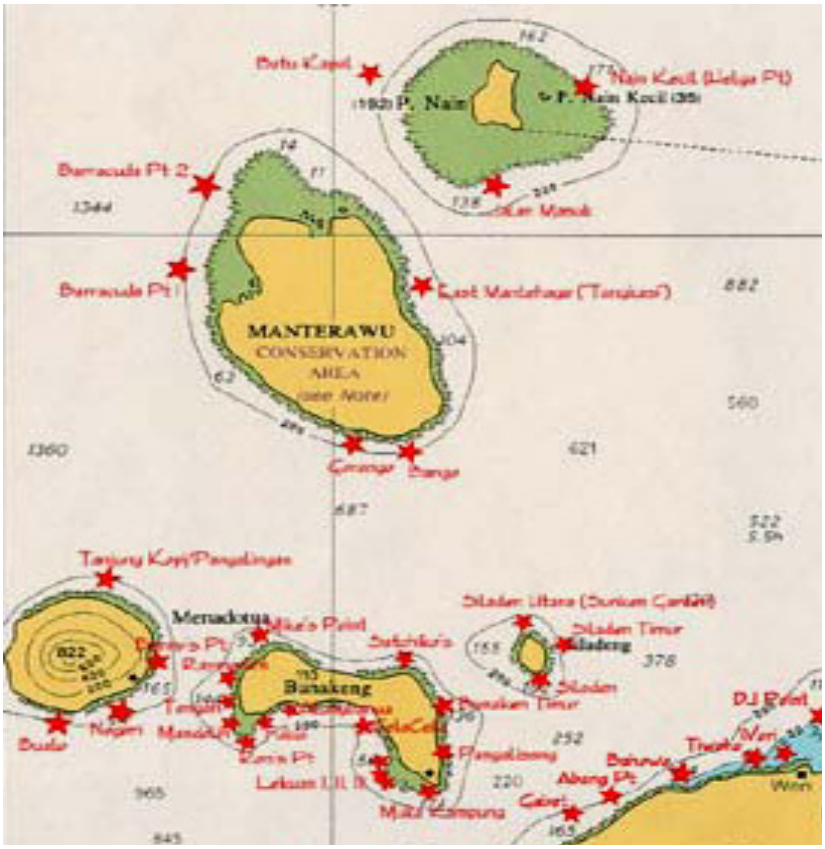

Figure 2. Bunaken National Park

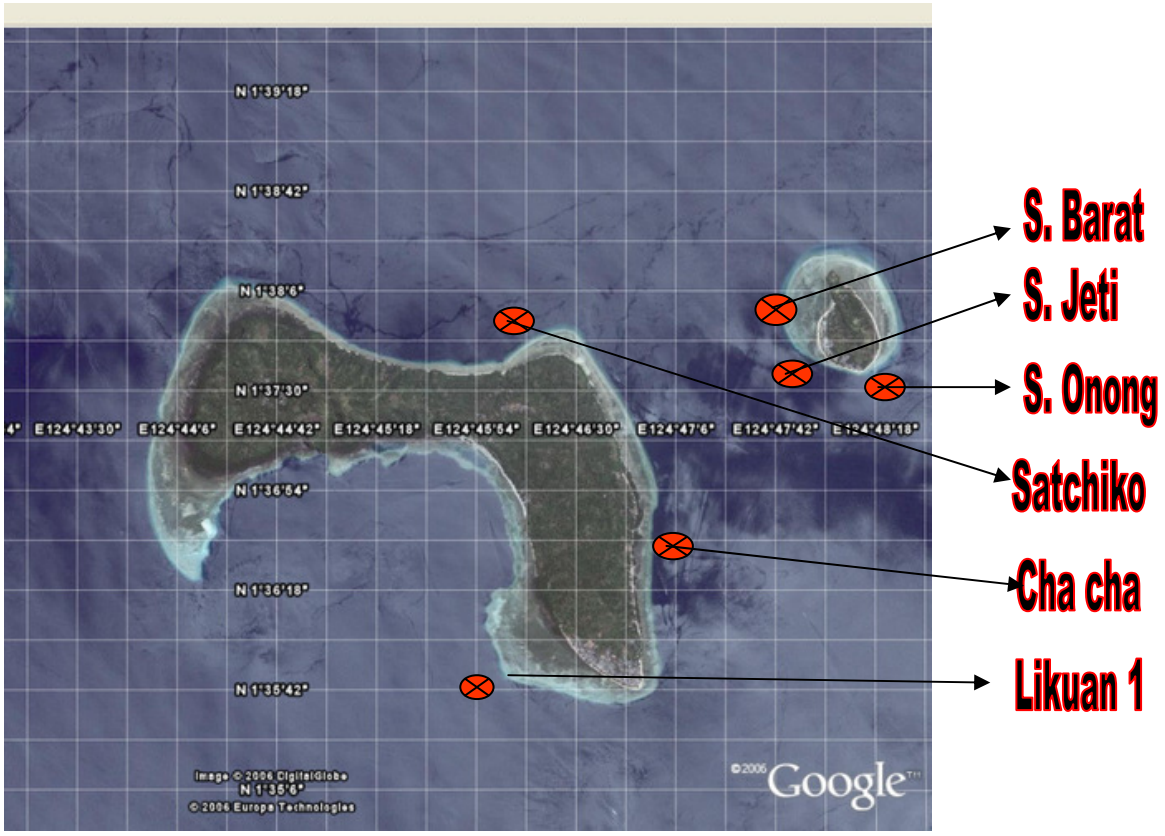

Figure 3. Sites at Bunaken and Siladen Islands

Materials and methods

This study was conducted underwater with scuba diving equipment, underwater camera, line transect (20 m) and frame (50 x 50 cm). Dive boat was also used to reach the remote areas (sites). The dive was first carried out at 18 m depth. The depth was measured with computer. 100 m line transect was set up horizontally. After that frame was put vertically and than after fixing the quadrate, picture was taken properly to ease reading when counting the percentage cover of the organisms. Therefore two divers had to do the work; one held the frame and the other took the picture. Line transect was then moved to 12 m depth. The same procedure was also applied in 6 m depth. At every depth 6 pictures were taken, and from amongst them, the best of 5 pictures were selected for analysis. The analysis was done using grid (figure 4) to make the calculation of the percentage cover easier. The data was then transfered to excel program to be analysed further.

Study Area

Located near the centre of the 'coral triangle' of highest coral reef biodiversity (Veron 2000), the reefs of North Sulawesi are of crucial conservation importance, and management measures are now

being implemented. Predominant among these measures is Bunaken National Park, established in 1991, and considered one of the most strategically important Marine Protected Areas in the world. The Park covers approx. 90,000 ha of coral reefs, mangrove forests and seagrass beds surrounding five islands and coastal sections of the northern area of Sulawesi, and supports a local population of some 30,000 villagers. As with most coastal areas of the region, the integrity of the natural ecosystem of the Park is threatened by human activities that are both marine and landbased, such as resource over-exploitation, destructive fishing practices and unsustainable tourism (see eg. Erdmann and Merrill 2003, Erdmann and Toengkagie 2003, Erdmann et al. 2003a,b).

Sites Description

Likuan I

A very popular diving spot, Lekuan I is home to the Bannerfish, Napoleon Wrasses, and a large school of Pyramid Butterflyfish. It is also possible to see Turtles and Angelfish here. At 35 meters it is common to encounter Blacktip Sharks and large Trevallies . This is not for the faint hearted ! Rated : Advanced diver with 20 logged dives; currents; average visibility 30m Sachiko.This popular dive site provides a stunning wall with breath-taking soft and hard corals at the top of the reef. Reef black tip sharks, Stonefish, several types of Moray eels, and many small schools of reef fish and large Gorgonians are found here. At the deeper levels, you will find some nice caves. Rated: Advanced diver; vertical wall diving; depth 5 – 30m; av vis 30m Bunaken Timur (Cha cha) This dive site is located at the Timur (East) part of Bunaken Island, right next to Bunaken village. Beautiful soft coral is found at shallower depths. Ascidians, Spotted Eagle Rays, turtles, Nudibranches, Shrimpfish, Butterflyfish, and Sharks are pretty common here. It is a special site for macro photography. Rated: Advanced diver; vertical wall diving; depth 5 – 25m, av vis 25m; strong currents.

Siladen

A very nice spot for both snorkeling and diving. This site is located off Siladen Island about a 45 minute trip by boat. There is a variety of exquisite soft corals at the reef top. Turtles, Napoleon Wrasses, and other small creatures are common sights here. Groupers, Butterflyfish, Sting Rays, and Spotted Eagle Rays are possible to encounter. The currents are moderate to strong. Rated : Advanced diver; vertical wall diving; depth 5-30m; av vis 25m; strong currents.

(source: www_sulawesi-dive-quest_com-images-bunaken_diving_satelite1_jpg.mht)

Image analyses

Grid percent cover

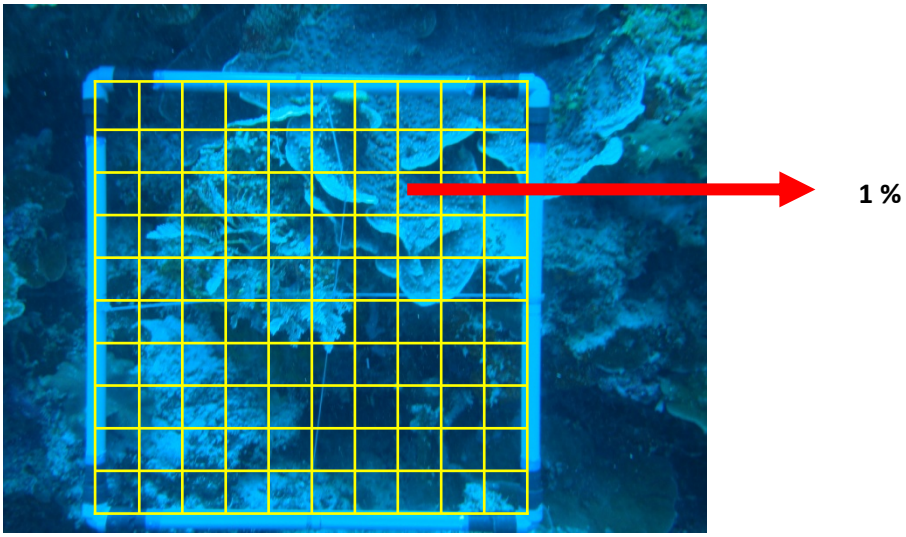

Figure 4. Sampling quadrate (50 x 50 cm) with grid percent cover to make easier counting percent cover of animals and objects.

Data Analysis

For the analyses, each site is considered simple as a different place, while the depths are common to all sites. Plots were drawn to compare the mean abundances (+ standard error) of the most abundant taxa between sites at the same depth, and between depth in the same sites. The formal statistical test for significance in the differences between observed means was applied - that is the analysis of variance (ANOVA). Cochran's Test was applied to analyse the levels of significance.

Levels of significance were ranged as follows:

$0.05 \geq P \geq 0.01$ *) the relation is significant.

$0.01 \geq P \geq 0.00$ **) the relation is very significant.

$P > 0.05$ the relation is not significant.

Experimental Details

Number of factor : 3

Factor 1 is island has 2 levels is orthogonal and fixed

Factor 2 is Site has 3 levels is nested in 1 and is random

Factor 3 is Depth has 3 levels is orthogonal and is fixed

Number of replicates : 5

Results

The results of main taxonomic group found in the research area is presented in the following figures. These figures represent percentage (percent cover) of the organisms based on site and depth.

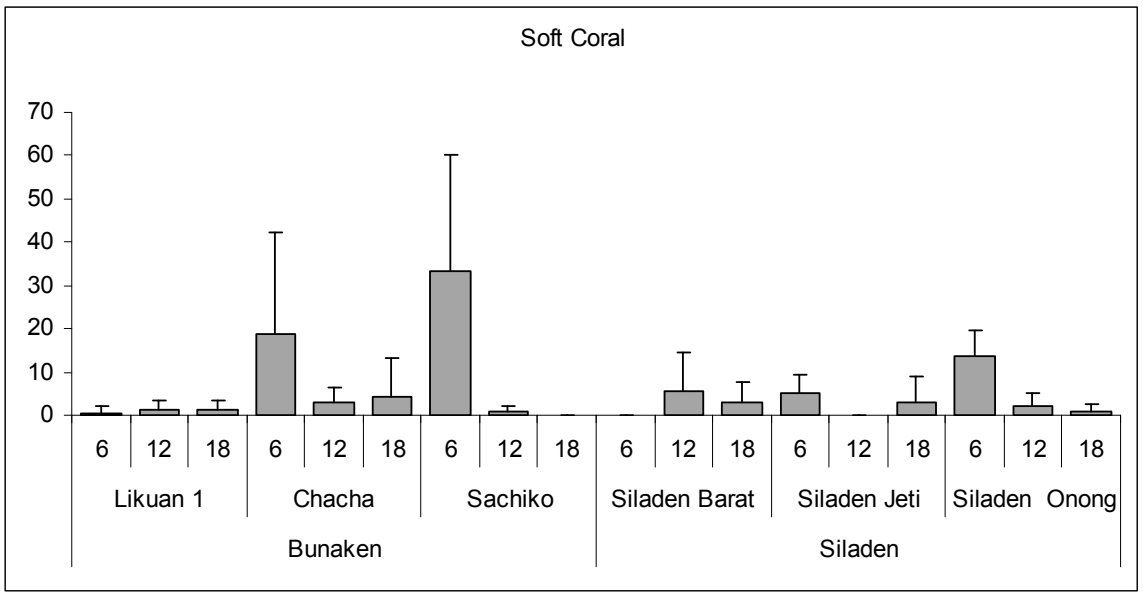

Figure 5. Percentage cover of Soft Corals in the site and depth

As shown in figure 6 , at the depth 18m in Satchiko, 6 m in Siladen Barat and 12 m in Siladen Jeti there are no soft algae. The highest percentage of Soft algae was found in Sachico at the depth 6m (33,4%) followed by Cha cha at the same depth (18,8%) and then Siladen Onong at the same depth (13,6%). A very few of soft algae also occured at the depth 6m,12m and 18 m in Likuan which are under 1,5%, and 12 m in Satchiko (1%). At the depth 12m and 18m in Siladen Barat the percent cover of soft corals are 5,4% and 3% each, meanwhile in Siladen Jeti at the depth 6m (5,2%) and 18m (2,8%). In the Siladen Onong the percent cover at the depth 12m is 2,2% and 18m is 0,8%.

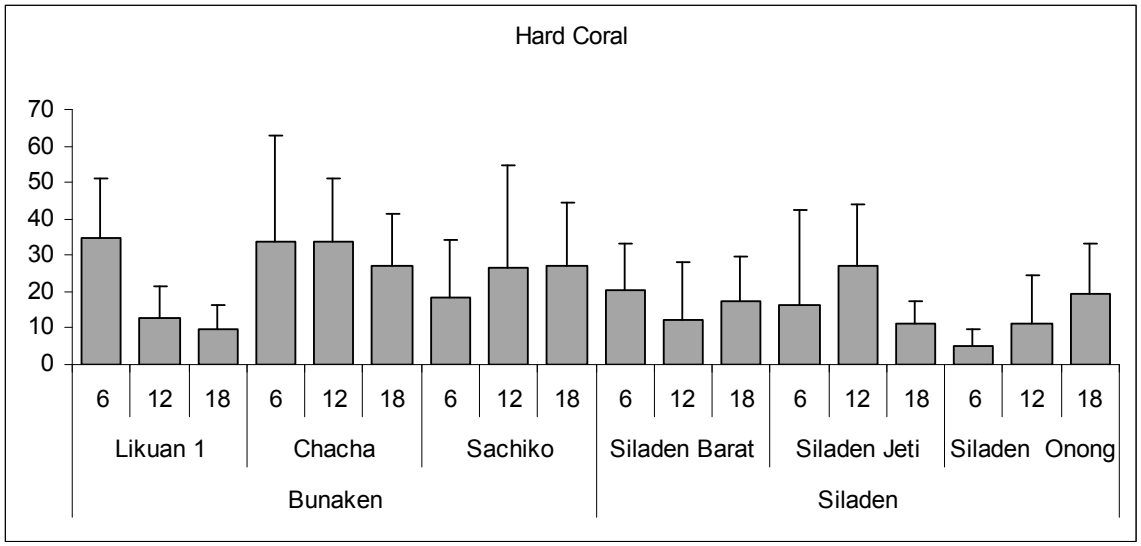

Figure 6. Percent Cover of Hard coral in site and at the depth.

As shown in figure 9. at all sites and at all depths there occured hard corals. The highest percentage of hard corals were found in Likuan at the depth 6m (34,6%) followed by Cha cha 6m and 12m with 33,8%. In Likuan 1, the deeper the water the lesser hard corals were found and vice versa in Satchiko and in Siladen Onong, the deeper the water, the more hard corals were found. Presence of Hard Corals was also observed in Likuan 1 at the depth 12m (13%) at the depth 18m (7,5%). In Cha cha, hard corals were with almost same populations and growth were found at all depths. At the depth 6m ,12m there are 33,8 % and 18m (27,2%). In Satchiko at the depth 6m (18,6%), 12m (26,4%), 18m (33,24%) In Siladen Barat at the depth 6m (18,6%), 12 m (26,4%) and 18m(27,2%). In Siladen Jeti at the depth 6m (16,4%), 12m (27,2%) and at the depth 18m (11%). In Siladen Onong at the depth 6m (5%), 12m (11%) and 18m (19,2%).

Discussion

The advantages of using digital image analysis of sample are as follows:

1. the sample can be evaluated as objective as possible (Evaluations objective). 2. it can be repeated (Repeatability), 3. the time lapse could be automated, 4.it can make the underwater work fast, 5. replicates can be taken in high numbers, 6. there is no need for taxonomic expertise in the field, and last but not the least there is no impact on ecosystem. On the other hand the disadvantages of such research are scarce taxonomic precision and problems may arise when reading and interpreting the image a posteriori.

This research can be used as preliminary studies, exploratory surveys, analyses of differences, life cycle or temporal variation studies, and deep water work.

The chosen sites of Bunaken and Siladen Islands which are Likuan 1, Cha cha, Sachiko, Siladen Barat, Siladen Jeti, and Siladen Onong are aimed to represent the few parts of dive sites in Bunaken National Park. The sites were chosen randomly, even if the substrates were relatively the same, but still the result showed variable percentage cover of main taxonomic groups in coral reef ecosystem.

Comparison among depths (6m, 12m, 18m) in two islands : Bunaken and Siladen.

Soft Coral

Header File: None

Data File : C:\Documents and Settings\Administrator\Desktop\Meita**Soft coral**.dta

Experimental Details

Number of factors: 3

Factor 1 is Island has 2 levels is orthogonal and is fixed

Factor 2 is Site has 3 levels is nested in 1 and is random

Factor 3 is Depth has 3 levels is orthogonal and is fixed

Number of replicates: 5

Transform: Ln(X+1)

Cochran's Test

C = 0.1735 (Not Significant)

Largest variance = 3.0662, this belongs to cell Level: 1 2 1

The model for this analysis is

X = MEAN + Is + Si(Is) + De + IsXDe + DeXSi(Is) + RES

Source	SS	DF	MS	F	P	F versus	
Is	0.2187	1	0.2187	0.1	0.7712	Si(Is)	Ns
Si(Is)	9.033	4	2.2583	2.3	0.067	RES	Ns
De	19.4677	2	9.7338	2.43	0.1493	DeXSi(Is)	Ns
IsXDe	0.8557	2	0.4279	0.11	0.8998	DeXSi(Is)	Ns
DeXSi(Is)	31.9801	8	3.9975	4.07	0.0005	RES	**
RES	70.7046	72	0.982				
TOT	132.2598	89					

The results of the analysis of soft corals showed that the relation of island X depth was not significant. The same situation also was shown between depth , between island and between sites. But between depth X sites were highly significant.

According to Fox et.al (2005) the soft coral studies show inhibition of scleractinian growth and survival on the time scale of this study. However, on a longer time scale, soft corals may facilitate hard coral recovery. It does serve to stabilize the rubble from shifting with the currents. Patches of rubble are periodically exposed within the soft coral field, for example from storm action or anchor drag. These more stable rubble patches then might serve as sites for increased scleractinian settlement and survival. Depending on how quickly the soft coral re-grows over the patch, the hard corals would either succumb to the soft coral, or grow large enough to resist encroachment. Further studies are needed to tease apart the different processes occurring at different spatial and temporal scales.

In addition Fox et al. (2003) stated that heavily disturbed or overfished sites often undergo a ‘‘phase shift’’ to communities dominated by soft corals and macroalgae, which limit recovery of hard coral colonies (Done, 1992a,b; Hughes, 1994a,b; Roberts, 1995 in Fox et al. 2003). In Komodo National Park (KNP), large fields of the soft coral Xenia are often found to grow on top of rubble (Fox, personal observation); it is not only a successful colonizer, with high fecundity and

several dispersal modes, but also a superior competitor against hard coral (Benayahu and Loya, 1985 in Fox et al. 2003). Soft corals also can inhibit larval recruitment of scleractinian corals via allelopathy (Maida et al., 1995 in Fox et al. 2003). However, there are also cases where soft corals and macro algae do not invade space cleared by the death of hard corals, particularly in ‘‘sub-optimal’’ physical environments (Fabricius, 1997 in Fox et al. 2003). A variety of other factors may influence coral reef recovery, including grazing intensity, sedimentation rate, larval availability and survival, and the network of source and sink populations, which is in turn dependent on ocean current patterns (Dias, 1996; Done, 1992a; Fabricus and De_ath, 1997; Gleason, 1996; McClanahan, 1997; Pearson,1981; Roberts, 1997; Sammarco, 1996 in Fox et al., 2003).

Haphazardly located quadrats within the soft coral fields typically had 95–100% soft coral cover (primarily the genera Xenia, Sarcophyton, Nepthea, and Clavularia) with no visible hard corals. However, clearing soft coral from the rubble often revealed small scleractinian colonies below. These hard corals fared much better once the soft coral was removed, suggesting that although they had been surviving amid the soft corals, they were inhibited. Additional hard corals recruited to the cleared rubble, as well.

Hard Coral

Header File: None

Data File : C:\Documents and Settings\Administrator\Desktop\Meita**Hard corals**.dta

Experimental Details

Number of factors: 3

Factor 1 is Island has 2 levels is orthogonal and is fixed

Factor 2 is Site has 3 levels is nested in 1 and is random

Factor 3 is Depth has 3 levels is orthogonal and is fixed

Number of replicates: 5

Transform: None

Cochran's Test

C = 0.1666 (Not Significant)

Largest variance = 839.2000, this belongs to cell Level: 1 2 1

The model for this analysis is :

X = MEAN + Is + Si(Is) + De + IsXDe + DeXSi(Is) + RES

Source	SS	DF	MS	F	P	F versus	
Is	2025.878	1	2025.878	7.24	0.0089	RES	**
*Si(Is)	1519.822	4	379.9556				
De	117.0667	2	58.5333	0.15	0.8628	DeXSi(Is)	Ns
IsXDe	351.2889	2	175.6444	0.45	0.6522	DeXSi(Is)	Ns
DeXSi(Is)	3115.244	8	389.4056	1.39	0.2148	RES	Ns
RES	20143.6	72	279.7722				
TOT	27272.9	89					

The result of the analysis of hard corals showed that the relation of island X depth was not significant. The same situation also was seen between depth X site, also among depths. The relation is very significant between islands, in Bunaken more than in Siladen.

Soft Coral

The highest abundance of Soft Corals occured in Sachico (11,45%), followed by Cha cha (8,73%), and then in Siladen Onong (5,53%), Siladen Barat (2,8%), in Siladen Jeti (2,67%), and the last in 135

Likuan 1 (0,75%).

Hard Coral

The highest average abundance of Hard Corals were found in Cha cha (31,6%) followed and then in Satchiko (24,4%), Likuan 1 (18,37%),in Siladen Jeti (18,2%), in Siladen Barat (16,73%), and the last in Siladen Onong (11,73%).

Conclusion

From the results obtained the following conclusions can be drawn

1. Soft corals showed a tendency to decrease from surface to deeper water both in Cha cha and Sachiko.

2. Hard corals showed variations in distributions; In Likuan 1 they showed a tendency to decrease from surface to deeper water but on the other hand in Satchiko and Siladen Onong they tended to increase from surface to deeper water.

Acknowledgements

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DNA-based Biodiversity of Black Coral (Cnidaria: Antipatharia) collected from Manado, Indonesia

HAPRY F N LAPIAN

Abstract

Study regarding biodiversity of black coral (order Antipatharia) collected from the Bunaken Marine Park (Manado Sea, Indonesia) based on the Internal Transcribed Spacers (ITS) region of rDNA gene was conducted. Results showed that the 18 species of Antipatharia considered were separated in two groups, one containing the genera belonging to the family Myriopathidae and the other belonging to the families Antipathidae-Aphanipathida. A significant species-specific signal has been detected among the families Antipathidae and Aphanipathida. However, more studies on different species need to be clearly interpreted. The new species *Pseudocirrhipates mapia*, the new genus *Reticulopathes*, and possibly a new taxon of the family Myriopathidae has been recognized based on ITS sequence data.

Keywords: Biodiversity, Bunaken, rDNA ITS, Antipatharia, Black Coral

Introduction

Antipatharians have been traditionally classified according to morphological and anatomical characters. The primary characters that are usually used in this type of systematics are the general morphology of the corallum, the pattern of ramification, the spines arising on the skeleton surface, the morphology of the polyps and the number of their mesenteries. Milne-Edwards and Haime (1857) had proposed one of the first systems of classification that is entirely based on the skeletal features. The polypar characteristics are considered important also in most recent taxonomic works where the number of mesenteries, the size and position of tentacles around the mouth and the arrangement of zooids around the axis and the kind of ramification of the corallum are characters used in the genus separation (Cooper, 1909; Opresko, 1972).

In line with developing technology, more specific tools in biology such as electron microscope enhance the placing of black coral in a more specific taxon. The study of spines surface using scanning electron microscopy has recently been employed with success in taxonomic works,

putting in evidence micro-differences in the deposition of skeletal material on the spines, which are often useful for species distinction.

At a specific level, although there is an increasing study of systematic of Antipatharia based on morphological and anatomical characters, the main problem in taxon definition by means of this approach is the extreme plasticity of the colonies. The number of species obtained tends to be overestimated because it may contain some ecotypes. For this reason, sequences data of DNA are an obvious source of additional evidences regarding black corals systematic relationships. Genetic consideration has been widely used to clarify one of the largest problems arising from identifying coral at the species level.

Genes of internal transcribed spacers (ITS) have been used for molecular markers at the species level of coral in order to study intra- and inter-specific diversity (Diekmann *et al*., 2001; van Oppen *et al*., 2002). Sequences of internal transcribed spacers of rDNA was also used in resolving phylogenetic relationship of closely related taxa in some corals (Odorico and Miller, 1997; Takabayashi *et al*., 1998; van Oppen *et al*., 2000; Lam and Morton, 2003; Chen *et al*., 2004). The internal transcribed spacer (ITS) region, consisting of the ITS1, 5.8S, and ITS2 sequenced from protists (Hunter *et al*., 1997), animals (Gonzalez *et al*., 1990), plants (Baldwin *et al*., 1995), fungi (Lee and Taylor 1992), and macrophyte algae (Coleman *et al*., 1994 and Goff *et al*. 1994), typically provide phylogenetic resolution at or below the species level in each of these groups.

In this present study, in order to investigate the biodiversity of black corals in the sea of Manado, genetic relationships of 18 species of black corals belonging to nine genera and three families have been investigated. The application of a molecular approach to the systematic of this group represents an interesting possibility to test, by an alternative method, the traditional morphological taxonomy.

Material and Methods

Sample collection

Eighteen species of black corals belonging to three families and nine genera of the order have been used in this study. All the specimens were collected by SCUBA diving on the shallow-water reefs of the Bunaken Marine Park (North Sulawesi, Indonesia) within a depth range of 10 - 50 m.

DNA Analysis

Isolation

Using protocol of Qiamp tissue kit (QIAGEN) the genomic DNA was isolated using primer RA2 5'-GTCCCTGCCCTTTGTACACA-3' and primer ITS 2.2 5'-CCTGGTTAGTTTCTTTTCCTCCGC-3' (Wörheide, 1998) for the internal transcribed spacer regions (ITS1 and ITS2).

Amplification

Thirty cycles of PCR were conducted using a *Perkin Elmer GeneAmp PCR System 2400* under the following profiles: 94°C for 30 s; 52°C for 30 s; and 72°C for 60 s using HotStarTaq Master Mix Kit (Qiagen). The PCR product was then purified using the QIAquick Gel Extraction Kit (Qiagen) following the manufacturer's recommended protocol.

Sequencing

Cycle sequencing reactions were done using DNA Sequencing Kit (Applied Biosystem) according to the protocol provided by the manufacturer with the same primers used in PCR. To obtain the sequences in both directions the forward primer 5'-CAACGGGCGGGCTGGTGCGCA-3' and the reverse primer 5'-TGCGCACCAGCCCGCCCGTTG-3' designed on the 5.8S rDNA have been used. The sequencing reaction product was purified using Qiagen DyeEx Spin Kit and then was sequenced on an automated DNA sequencer (ABI PRISM 310, Applied Biosystems). The sequences are about 850 *nt*. long except for *Cirrhipathes spiralis* (partial sequences of 642 *nt*). The nucleotide sequences have been deposited in GenBank (accession numbers AM404315–AM404329).

Phylogenetic analysis for Biodiversity Observation

The trees were produced by maximum parsimony (MP), maximum likelihood (ML), and neighbour-joining (NJ) methods, using the PAUP 4.8 beta version (Swofford, 1998) program. For the heuristic ML analysis, the optimum substitution model was determined using the Model test 3.06 program (Posada and Crandall, 1998). Once the appropriate model was determined (TrNef + G) (Tamura and Nei, 1993), ML analysis was performed with all the parameter values of the model (Gamma distribution shape parameter = 0.2411; substitution model: A-C 1.000; A-G 2.3660; A-T 1.000; C-G 1.000; C-T 3.4329; G-T 1.000; equal base frequencies). *Porites lutea* was used as an outgroup.

Results and Discussion

Results

Sequencing of the ITS region (spanning a partial sequence of the 5' end of the 18S gene, complete ITS1-5.8S-ITS2 and partial sequence of the 3' end of the 28S gene) results sequences ranged between 804 (*Pseudocirrhipathes mapia*) and 912 (*Cirrhipathes sp*) nucleotides for the species of the family Antipathidae, and between 812 (*Myriopathes myriophylla*) and 836 (*Antipatella subpinnata*) nucleotides for the species of the family Myriopathidae, while the sequence of *Rhipidipathes reticulata* (Aphanipathidae) was 832 nucleotides long.

Figure 1 shows that the 18 species of Antipatharia considered are separated into two groups, one containing the genera belonging to the family Myriopathidae and the other belonging to the families Antipathidae-Aphanipathidae. The distance matrix shows that in the first group genetic distances among the Indonesian Myriopathidae species *Cupressopathes abies*, *Myriopathes myriophylla* and *Myriopathes* sp.1, *Myriopathes* sp.2 and the Mediterranean species *Antipathella subpinnata* were very small (0.25% to 2.6%). The second group is divided into three well-differentiated clades: the first group, in basal position, is composed of the new species *Pseudocirripathes mapia*, the second is made up of the genera *Cirrhipathes*, *Rhipidipathes*, and *Reticulopathes*, the last clade is made up of the genera *Stichopathes* and *Antipathes* and the species *Cirripathes* cf. *anguina* 2. The analysis showed that the species belonging to *Cirrhipathes* genus are not monophyletic. In fact although *Cirripathes spiralis* and *Cirripathes* sp. show a genetic distance of 0.99%, the two speciemens of *Cirripathes anguina* display, with respect to those mentioned above, a genetic distance not smaller than 9% and between them of 11.20%. Similarly, *Stichopathes* sp.2 is not clustered with *Stichopathes sp1* although it shows a genetic distance of 3.53%. In the *Cirrhipathes-Rhipidipathes-Reticulopathes* group, the new genus *Reticulopathes* differs from the other species belonging to this group by genetic distances ranging from 11.06% (*Cirrhipathes* cf. *anguina* 1) to 14.80% (*Cirrhipathes* sp.).

The phylogenetic tree obtained by Neighbor-Joining method (Figure 2) presents the same tipology of the described tree with the exception of the species *Reticulopathes* which are separated from the *Stichopathes-Antipathes* group and the *Cirrhipathes-Rhipidipathes* group which is supported by a low bootstrap value (54%).

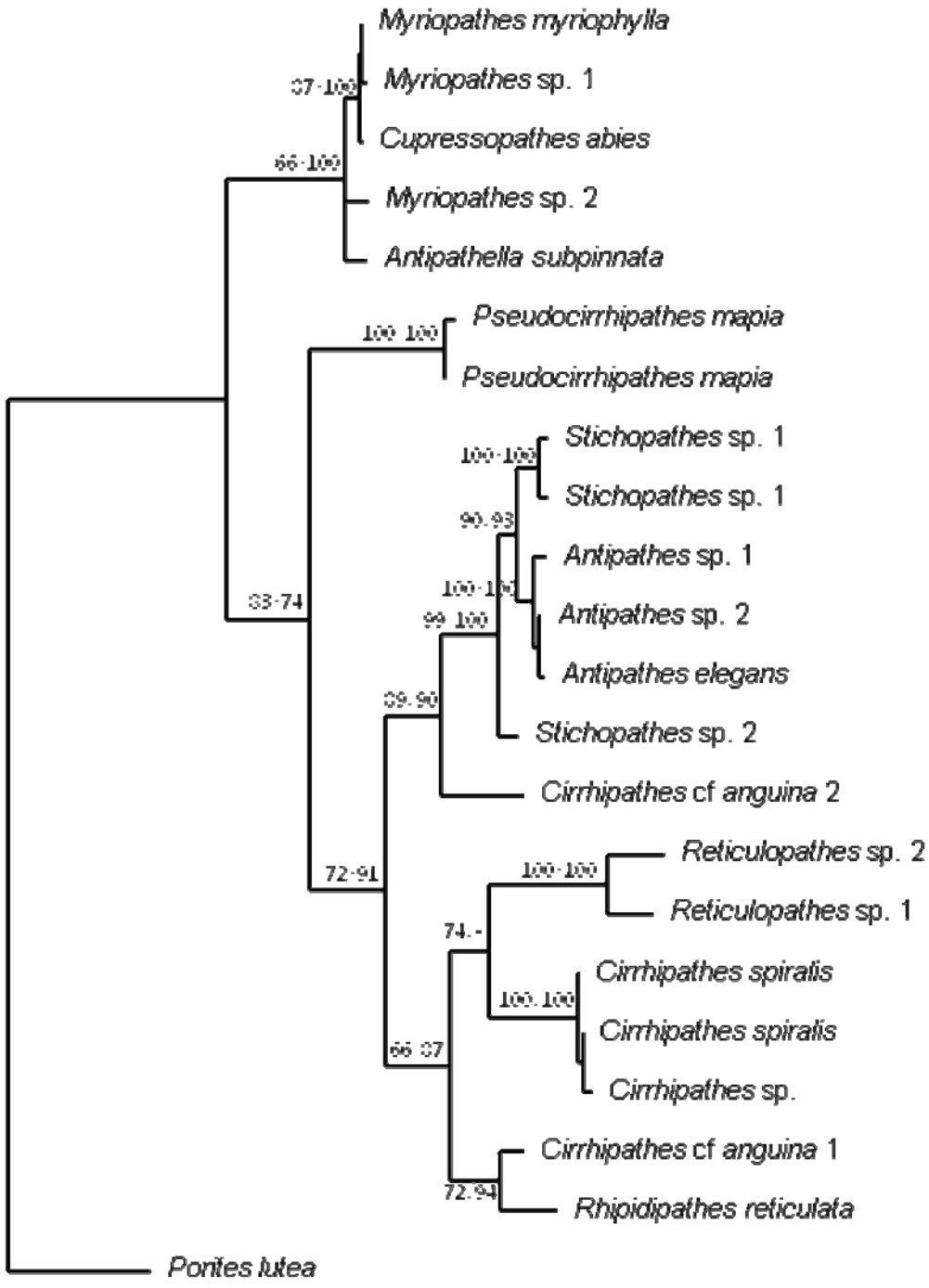
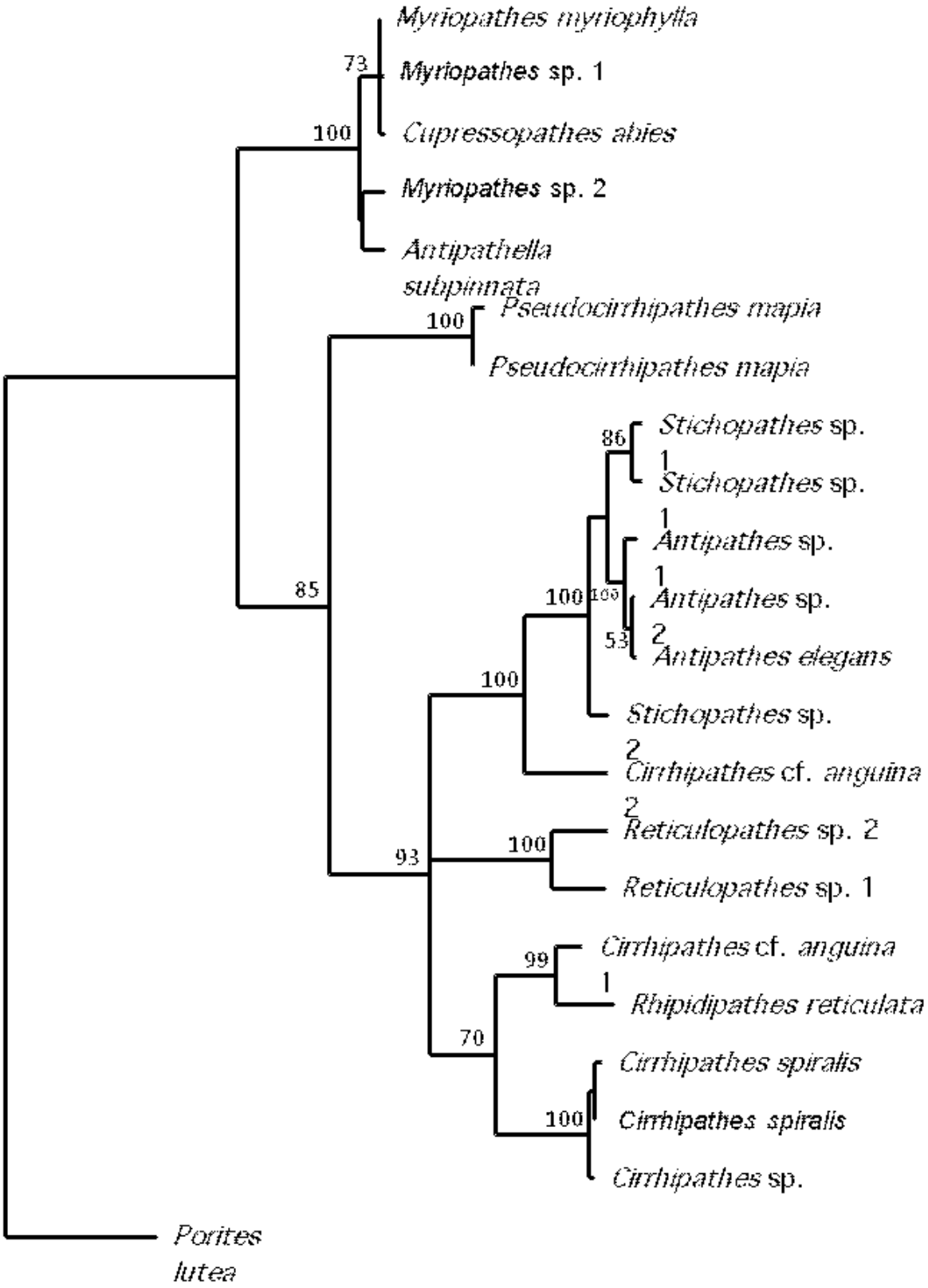


Figure 1. Phylogenetic tree obtained by Maximum Likelihood and Maximum Parsimony of the Antipatharian species based on internal transcribed spacers rDNA. On the left is the ML value, on the right is the MP value.


Myriopathes myriophylla
73
Myriopathes sp. 1
100
Cupressopathes abies
Myriopathes sp. 2
Antipathella subpinnata
100
Pseudocirrhipathes mapia
Pseudocirrhipathes mapia
86
Stichopathes sp. 1
Stichopathes sp. 1
Antipathes sp. 1
85
100
100
Antipathes sp. 1
53
Antipathes elegans 2
100
Stichopathes sp.
Cirrhipathes cf. anguina 2
Reticulopathes sp. 2
93
100
Reticulopathes sp. 1
Cirrhipathes cf. anguina
99
Rhipidipathes reticulata 1
70
Cirrhipathes spiralis
100
Cirrhipathes spiralis
Cirrhipathes sp.
Porites lutea

Discussion

The molecular data obtained from this analysis supports the difference amongst the families Antipathidae, Aphanipathidae and Myriopathidae with the first two being more closely related. The families Myriopathidae and Antipathidae are genetically divergent from one another and are obviously not considered as sister taxa. The degree of genetic variation differs inside the families Antipathidae and Myriopathidae. In the Myriopathidae, the analysis by means of DNA sequences is not able to separate the species of *Myriopathes* and *Cupressopathes* and a clear difference is detected only with the Mediterranean *Antipathella subpinnata*. Particularly the similarity amongst the species *Cupressopathes* and *Myriopathes* could suggest the possibility of a reticulate evolution due to hybridization amongst these species (Diekmann *et al*., 2001; van Oppen *et al*., 2002).

Although the genetic distance between the species of Myriopathidae is not clearly visible, it could be identified in the tree as a group of new species or at least a new genus of *Myriopathes*- like the Antipatharians. When it is compared to the morphological data, the description confirms the existence of either new species or new genus of Myriopathidae.

Based on ITS rDNA , the Antipathidae was clustered into different clades. The first clade comprised of *Antipathes* sp.1, *Antipathes* sp.2, and *Stichopathes*. The second clade comprised of the genus *Cirrhipathes*, while the last clade included *Reticulopathes*. This present study has also shown that *Cirrhipathes* cf. *anguina* and *Cirrhipathes spiralis* were not clustered in a monophyletic group which indicated that the placement of these two species need to be re-examined.

The separation of *Rhipidipathes reticulata* from the *Cirrhipathes* and *Antipathes* groups supports, although with low bootstrap values, the recent establishment (Opresko, 2004), based on polyp morphology and on the size and shape of spines, of the family Aphanipathidae. The agreement between the genetic variability and spine morphology, suggests that this morphological character is largely independent from the environmental cues and therefore particularly suitable for a diagnostic verification. To some extent, the ITS region of rDNA provides a great systematic resolution for Antipatharians and it is useful to distinguish among high taxa of the order. Further analysis of the data set supports the establishment of new genera and species. At the tip of the tree, *Pseudocirrhipathes mapia*, as a new undescribed species, is significantly different from the other groups.

Conclusion

In general, the gene of ITS, has the ability to describe a variety among three families of Antipatharians. Significant species-specific signal has been detected among the families Antipathidae and Aphanipathidae; even studies on different species of the latter needs to be clearly

interpreted. The new species *Pseudocirrhipathes mapia*, the new genus *Reticulopathes*, and possibly a new taxon of the family Myriopathidae have been recognized based on ITS sequence data.

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Basic Biology of Lesoqlati Sulawesi *Maxomys hellwandii* (Jentink, 1879) Rats

INDYAH WAHYUNI AND HANRY J. LENGKONG

Abstract

White tail rat is a special local food in Minahasa North Sulawesi. In addition, this small mammal has an ecological function by contributing to the plant seed vegetation which is advantageous for forest conservation. Therefore, white tail rat existence is important for sustainable nature conservation. A practical solution for the conservation of this animal is to cultivate and breed them as domesticated animals. For the domestication of this animal, the information related to its biological activities, such as feeding behavior, feeding habitat, feeding availability, and reproductive behavior needs to be studied. The objective of this study was to evaluate white tail rat behavior as basic information for its conservation strategy. The research was conducted in the native habitat of White tail rats in the forest of Minahasa, and in the farm outside the habitat in Tateli village of Pineleng District. The study was done for 3 months, using 90 rats comprising of 45 males and 45 females. Measure was done in the laboratory of Animal Husbandry of Sam Ratulangi University. The study in the original habitat showed that white tail forest rats adapted very well to environmental condition. Activity was done mostly in the evening (nocturnal) and the rats were often found at wild piper, bamboo, and other fruit trees. During the day time the rats entered subterranean cave in bushes, in the roots of trees or inside small stone caves. Activities done in the evening were coloning, grooming, resting, and playing. They ate most of all food types. The male rats consumed 3,89 g DM/head/day; while female rats consumed 3,34 g DM/head/day. The estrus cycle was 3 to 5 days, consisted of proestrus (12 hours), estrus (12 hours), metestrus (18-24 hours), and diestrus (45-54 hours). *Lesoqlati Sulawesi Maxomys hellwandii(jentink,1879)* was a nocturnal animal, staying in the hole at mid day and active during the evening hours.White tail rat fed on fruits and insects at its original habitat. Adult age of white tail rats was longer than that of *Rattus norvegicus*. Body size and biological characteristics of white tail rats were quite different from that of *Rattus norvegicus.*

CLIMATE CHANGE AND FOREST FIRE

The Effect of Forest Fire on Fern Species Abundance and Diversity in Burned and Unburned Areas of Klias Peat Swamp Forest (KPSF), Sabah-Malaysia

ANDY RUSSEL MOJIOL AND MARIA ARLENE JACKAN

Abstract

The aim of this study is to compare the fern species abundance and diversity due to the effect of fire at burned and unburned area of Klias Peat Swamp Forest (KPSF). The study measured relative density, cover and frequency of fern species in adjacent burned and unburned areas. Importance values (IV) were then calculated to each fern species in both areas for comparison. Random sampling method was used in this study with the size of 25 m x 25 m square for each plot. The size for the whole plots in the both area accumulate by 1 ha. There were 3715 individuals of fern species found in burned area while there were 1339 individuals found in unburned area. Seven (7) species with 7 families were found in burned area. In unburned area, there were 9 species and 6 families have been found. From the analysis, most of the fern species found in burned area were belong to tree fern species (terrestrial fern) while in unburned area was dominated by epiphytic fern. The IVI value for both areas shown that *Stenochlaena palustris* (Lemiding) has the highest value which is 80% (for burned area) and 73% (for unburned area). For the comparison of species diversity in both areas, Shannon-wiener diversity index (H') has been used. The value of H' in burned area is higher (H' = 1.66) than unburned area (H' = 0.88). The evenness value (E') in burned area is 0.85 and in unburned area is 0.42. Burned area has a higher E' value because the total number of individuals are quite evenly distributed between the fern species. In unburned area, most the individuals are dominated by *Stenochlaena palustris* (Lemiding), with only a few other fern species present. The unburned area is therefore considered to be less diverse than burned area.

Keywords: Fern species diversity, Shannon-wiener, forest fire, abundance, important value index

Introduction

The global centre of tropical peat swamp forest distribution lies in the Indo-Malayan realm, in Malaysia, Indonesia, Vietnam, Thailand and Philippines. In Malaysia, peat swamp forest is the

most important wetland type both in term of area and biodiversity (Page, 2004). In Sabah, remaining peat swamp forests areas are relatively small, although biologically significant (Page, 2004). One of remaining peat swamp forests in Sabah is Klias Forest Reserve which situated between Weston and Beaufort town (see Figure 1). Ferns are considered as one of an important group of plant in peat swamp forests. Forest fire occurred in peat land usually will generate more colonies of ferns at the first stage regeneration (Mansor & Mansor, Undated). According to Schooley (1997), there are about 10000 species of ferns around the world; most of them are found in the tropics.

Scientific collections and documentation of Malaysian pteridophytes were initiated in the early part of the 20th Century but were few and far apart (Bidin & Jaman, 1995).

On 1998 Klias Forest Reserve has experienced peat fires on several areas. The immediate effects of fires on soils may include changes in soil moisture conditions, as a result of reduced infiltration or reduced evapotranspiration by plants, and increased short-termed availability of most nutrients (Fisher & Binkley, 2000). Beside that, water is often the limiting factor in burned area of Klias Forest Reserve. That is why; the watershed management largely focuses on onsite water collection and erosion prevention. In early stage of succession, the secondary species such as fern species tend to grow after peat fire.

Ferns can play the important role in ecology by controlling the soil erosion and holding the soil together since they have the spreading root system. Besides playing the important role in ecology, fern also have other importance to mankind nowadays. The local people frequently use ferns as medicines for the cure of various ailments. As peat fire influencing the abundance of the vegetation in that area, so this study aims to compare the fern species abundance and diversity at burned and unburned area of Klias Forest Reserve.

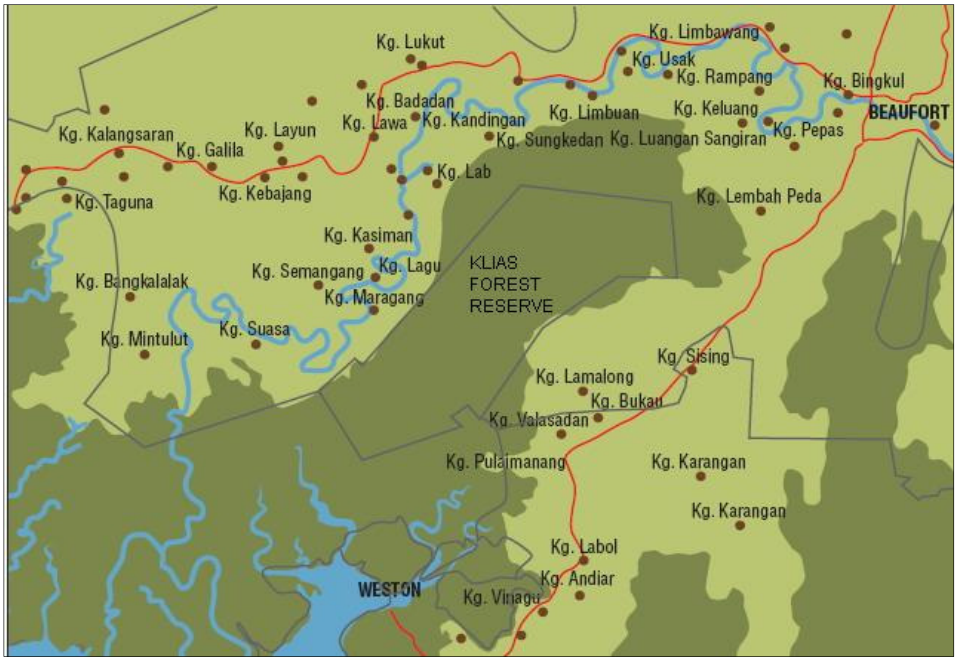

Figure 1. The location of Klias Peat Swamp Forest Reserve

(Source: Sabah Forestry Department, 2005)

Methods

Description on Study Area

Three months inventory and plotting had been done, from the month of October until December 2007. The study area for this research is Klias Forest Reserve which is located approximately 100 km from Kota Kinabalu city and situated on the lower west coast of Sabah (latitude: 5º22'60N with longitude 115º45'0E). Klias Forest Reserve covered 3630 **hectares** and was gazette as Class I Protection Forest in 1984 under the Section 12, Sabah Forest Enactment 1968 (see Figure 2). The temperature of this area is between 26º -30º C, with an average annual rainfall of about 3,680 mm and the soil pH is between 3.66-3.56 pH (Sabah Forestry Department, 2005).

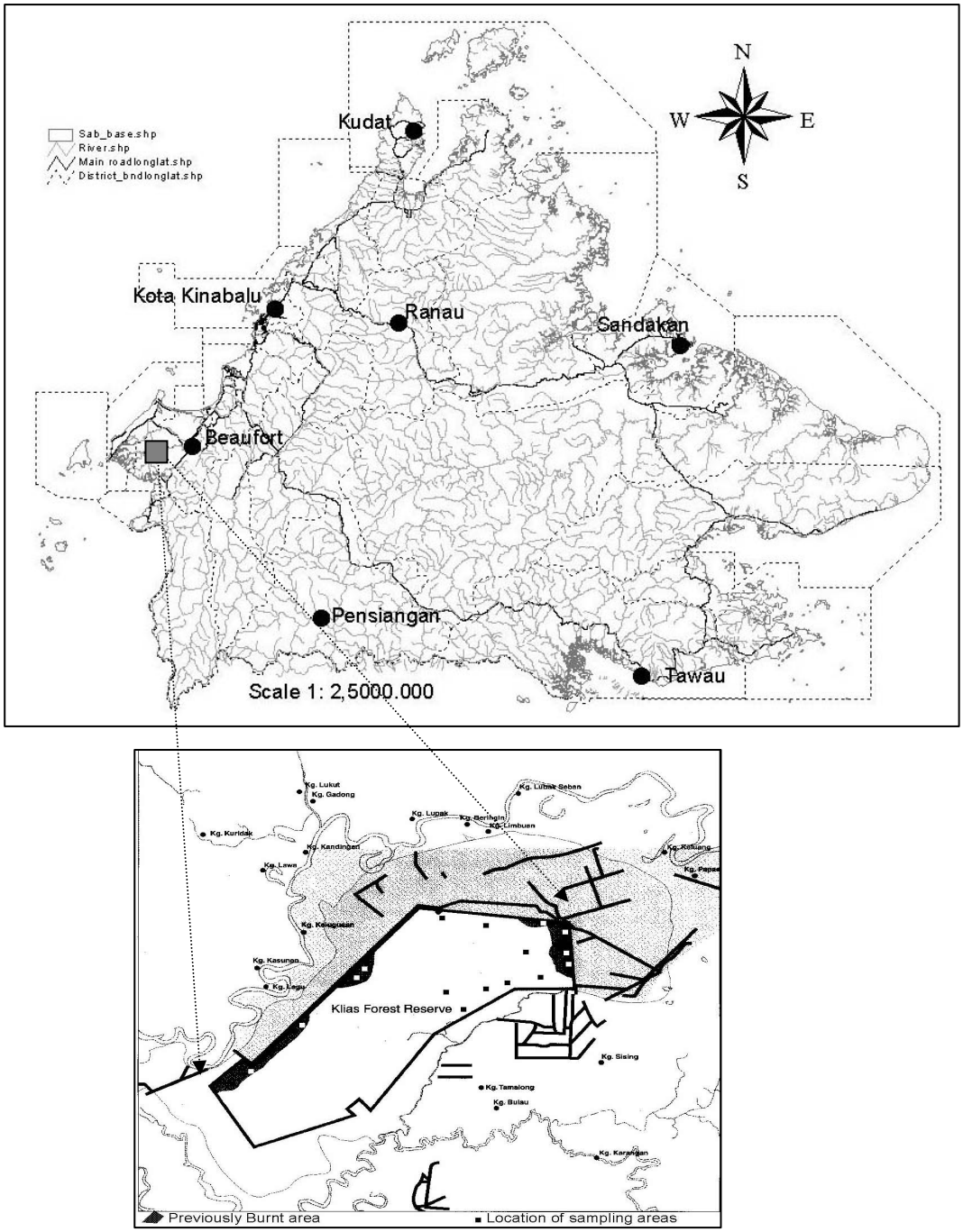

Figure 2:

Location of sixteen (16) randomly selected sampling plots at burned and unburned areas of Klias Peat Swamp Forest

(Source: Mojiol *et al.*, 2010)

Field observation and inventory (plot sampling)

Before establishing the plots, decision on making the appropriate choice of site should be carefully decided. Random sampling has been set up in this study. The total size of the whole plots is 0.5 hectares where eight plots were built. Each plot was set randomly within the burned area and unburned area with the size of 25 m x 25 m in a square shape. This process was repeated again within all plots and the shape of the plot is illustrated in Figure 3. From this study, the number of individuals, coverage and species name were recorded.

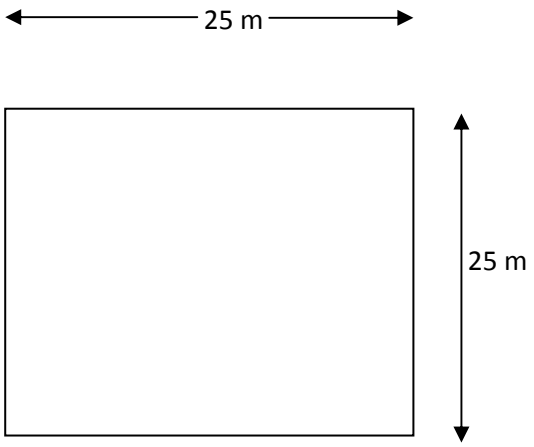

Figure 3. Sampling Plot Layout

Plant Community Analysis

This study measured the abundance and comparing the density, frequency and coverage of the fern species in burned and unburned area of Klias Forest Reserve. The abundance of the species is referring to the measurement of the amount of a species in a sample. The abundance provides information about the density, the frequency and the coverage of the species can be determined. The calculation of important values (IV) incorporates with the relative density, relative coverage and relative frequency of the species. Besides calculating the abundance (density, coverage and frequency) of fern species, the index of diversity of fern species in Klias Forest Reserve both in burned and unburned area also calculated. By using the Shannon index, the comparison of the diversity of fern species in burned and unburned area of Klias Forest Reserve is determined.

Results

Floristic Pattern

In term of number of individual, *Stenochlaena palustris* (Lemiding) has the highest number in burned area with 939 individuals (25.28% from the total of individuals). While for the lowest number of individual is belong to *Lypodium flexuosum* (Ribu-ribu gajah) with 49 individuals (1.32% from the total of individuals). In the unburned area, *Stenochlaena palustris* (Lemiding) also has the highest number of individual compared to the other fern species with 620 individuals and about 46.30% from the total of individuals. The number of *Histiopteris incisa* was the lowest which is only 6 individuals (about 0.45% from the total number of individuals) (refer to Appendix A).

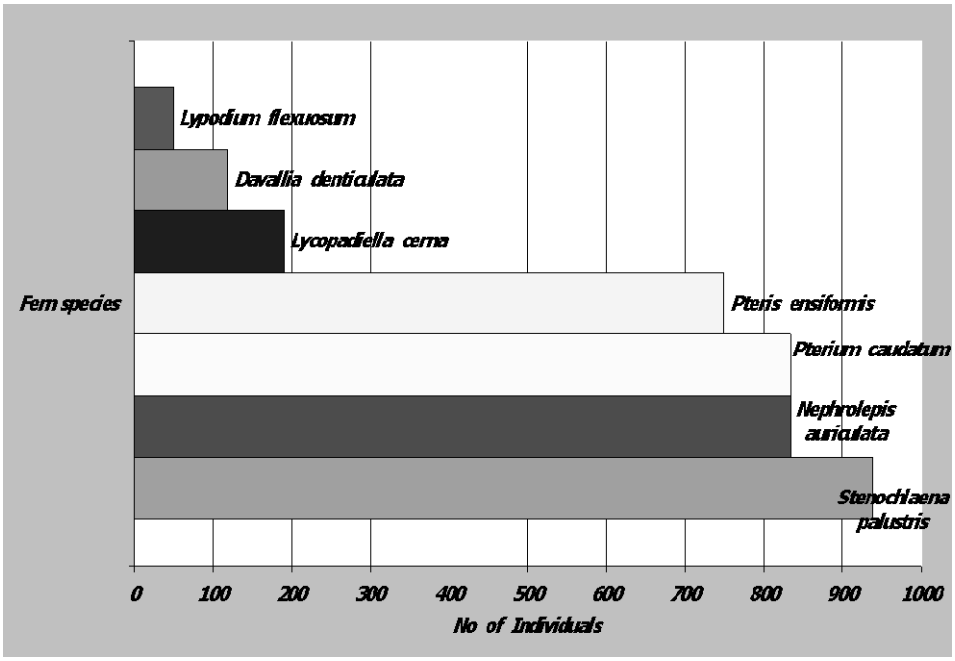

Figure 4. Fern species found in burned area

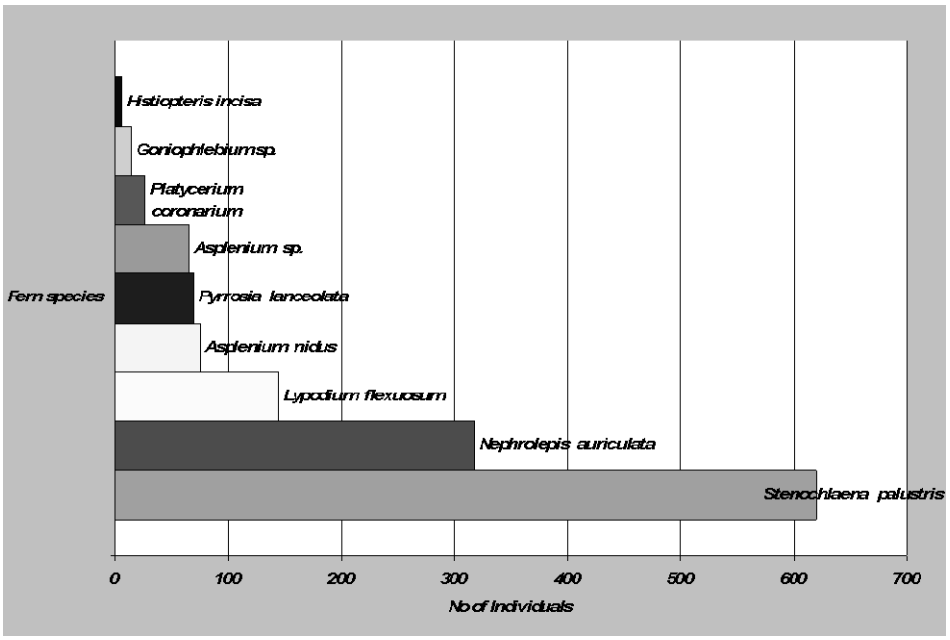

Figure 5. Fern species found in unburned area

Dominance Pattern

In this analysis, the Importance Value Index (IVI) for every fern species was counted. The IVI of the each species is the sum of relative density, relative frequency and relative coverage of fern species, each expressed as a percentage.

Table 1. The IVI of fern species in burned area

Species	*RF (%)	*RD (%)	*RC (%)	*IVI (%)
Stenochlaena palustris	21	28	24	73.3
Pterium caudatum	18	25	24	67.78
Nephrolepis auriculata	21	13	24	57.4
Pteris ensiformis	15	23	19	56.92
Lycopadiella cerna	9	6	5	19.74
Davallia denticulata	9	4	4	16.11
Lypodium flexuosum	6	1	1	8.76
Σ				300

**Note: RF is stands for Relative Frequency, RD for Relative Density, RC for Relative Coverage and IVI for Importance Value Index*

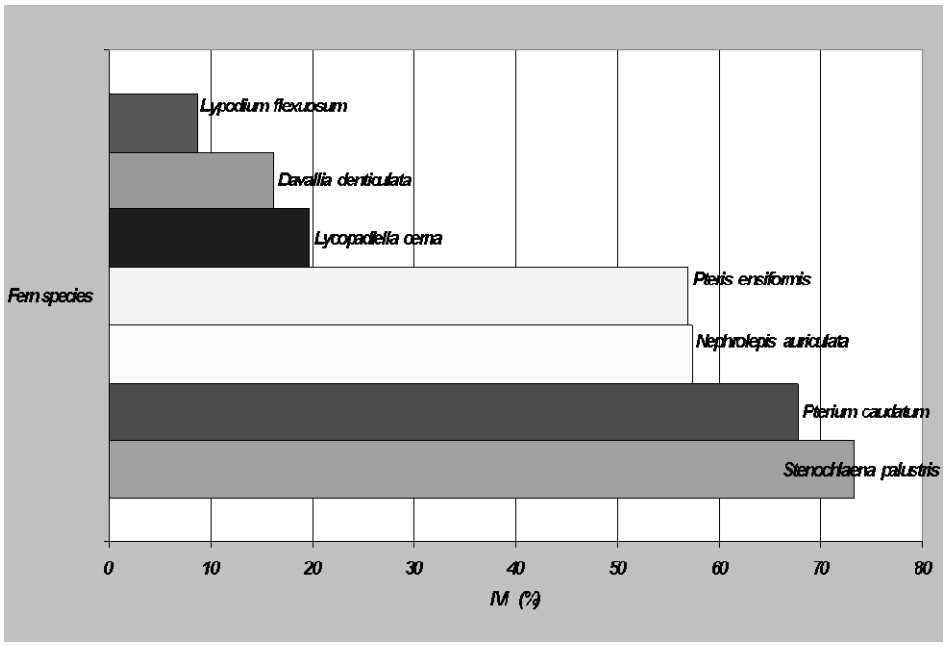

Figure 6. IVI of fern species in burned area

The data shows result of importance value of fern species in burned area. When assessing the fern species in burned area, *Pterium caudatum* (Tropical bracken) had the highest relative coverage (24% with 1004.6 m/ha), the relative frequency was the greatest for *Stenochlaena palustris* (Lemiding) and *Nephrolepis auriculata* (Boston fern) with the value of 21%(shown in Appendix B). *Stenochlaena palustris* (Lemiding) also dominated the relative density (28%) and received the highest importance value (73%) in the burned area. Unlike the unburned area, the percentage of the relative frequency, relative density and relative cover of *Stenochlaena palustris* (Lemiding) were significantly high.

Table 2. The IVI of fern species in unburned area

Species	***RF (%)**	***RD (%)**	***RC (%)**	***IVI (%)**
Stenochlaena palustris	15	46.8	1.83	80.1
Asplenium nidus	12.	5.6	4.86	66.79
Nephrolepis auriculata	7.5	24	8.84	40.33
Lypodium flexuosum	15	10.9	6.83	32.78
Asplenium sp.	15	4.9	6.6	26.54
Pyrrosia lanceolata	1	5.2	5.6	20.81

Platycerium coronarium	1	1	4.1	15.15
Goniophlebium sp.	1	1.1	8.5	11.91
Histiopteris incisa	5	0.5	0.14	5.6
Σ				300

**Note: RF is stands for Relative Frequency, RD for Relative Density, RC for Relative Coverage and IVI for Importance Value Index.*

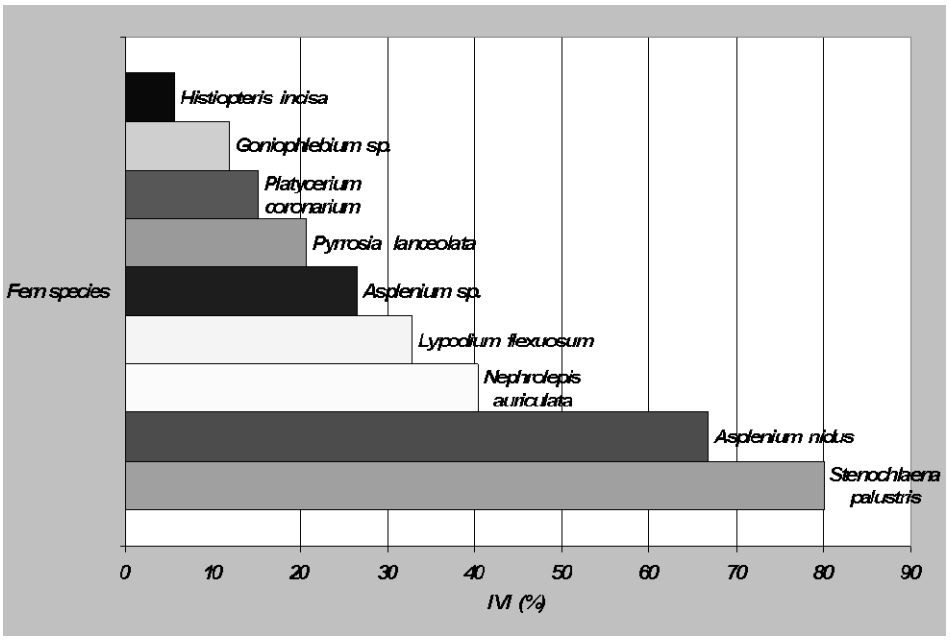

Figure 8. IVI of fern species in unburned area

Slightly different results were indicated for fern species in the unburned area. Similar to the burned area, *Stenochlaena palustris* (Lemiding) has the greatest importance value with 80.1%. *Histiopteris incisa* has the lowest IVI with 5.59%. *Stenochlaena palustris* (Lemiding), *Lypodium flexuosum* (Ribu-ribu gajah) and *Asplenium sp.* were found in the most of the plots that have been established in unburned area which is 15%. *Asplenium nidus* (Bird's nest fern) has the highest value of relative cover with 49%.

Measure of Diversity

For comparison of the diversity of fern species in burned and unburned area, the equation that has been used was the Shannon-wiener Index. The ultimate result of diversity of fern species in burned and unburned area was shown as below:-

Table 3. Shannon-wiener Index for fern species in burned area (H')

SPECIES	n,	n,/N	In (n,/N)	n,/N*In (n,/N)
Stenochlaena palustris	939	0.2527	-1.3753	-0.3476
Nephrolepis auriculata	834	0.2244	-1.4939	-0.3353
Pterium caudatum	833	0.2242	-1.4951	-0.3352
Pteris ensiformis	750	0.2018	-1.6000	-0.3230
Lycopadiella cerna	190	0.0511	-2.9731	-0.1520
Davallia denticulata	120	0.0323	-3.4326	-0.1108
Lypodium flexuosum	49	0.0131	-4.3283	-0.0570

Sum of n,/N*In (n,/N)	-1.66
Number of individual, N	3715
Shannon index, H'	1.66
Evenness (E')	0.85

**Note: n represent the total number of individuals*

Table 4. Shannon-wiener Index for fern species in unburned area (H')

SPECIES	n,	n,/N	In (n,/N)	n,/N*In (n,/N)
Stenochlaena palustris	620	0.4630	-0.7699	-0.6013
Nephrolepis auriculata	318	0.2374	-1.4376	-0.1651
Lypodium flexuosum	145	0.1082	-2.2229	-0.0487
Asplenium nidus	75	0.0560	-2.8821	-0.0194
Pyrrosia lanceolata	69	0.0515	-2.9655	-0.0173
Asplenium sp.	65	0.0485	-3.0252	-0.0160
Platycerium coronarium	27	0.0201	-3.9038	-0.0051
Goniophlebium sp.	14	0.0104	-4.5606	-0.0022
Histiopteris incisa	6	0.0044	-5.4079	-0.0008

Sum of n,/N*In (n,/N)	-0.88
Number of individual, N	1339
Shannon index, H'	0.88
Evenness (E')	0.42

**Note: n represent the total number of individuals*

From the tables, burned area has a higher Shannon-wiener index than unburned area. It means that, burned area has a higher species diversity of fern species (H' = 1.66) compared to unburned area (H' = 0.88). In general, the more species in the community and the more equally abundant the species, the higher H' would be. The value of Evenness (E') is the value of a measurement of the relative abundance of the different species of fern making up the richness of an area. According to the results above, the value of Evenness in burned area (E' = 0.85) is higher than unburned area (E' = 0.42).

Fern and Fern allies

Fern and fern allies that have been found in burned and unburned area of Klias Forest Reserve are belong to various species and families. The checklist produced is the result of fieldwork carried out in the burned and unburned area. A complete list of fern and fern allies will be shown in the Appendix B.

Table 5. Summary of the floristic composition

Floristic composition	Burned area	Unburned area
Number of individuals	3715	1339
Number of species	7	9
Number of families	7	6
Shannon-Weaver Index	1.66	0.88

In the table above, the floristic composition between burned area and unburned area has been compared. The number of individuals recorded in burned area has the greater number compared to unburned area which is about 73.5%. There was more fern species in unburned area. But in term of the number of individuals and Shannon-wiener index, burned area has a larger number compared to unburned area.

Discussion

Floristic Pattern

Floristic pattern of fern species in both areas has different composition in term of number of individuals, number of species and number of families. From the data that has been obtained, *Stenochlaena palustris* (Lemiding) was found abundantly in both areas (burned and unburned area). This is because, *Stenochlaena palustris* (Lemiding) is able to grow in vary conducive habitat including disturbed forest like burned area or wetland like unburned area. *Stenochlaena palustris* (Lemiding) is also one of the fern species which is able to adapt to different kind of environment for them to grow and spread. They even can produce the fertile fronds during period of dry weather.

Based on the analysis of a data set, the burned area has a larger number of individuals and family rather than species compared with unburned area. It means that the unburned area has a higher of fern species richness compared to the burned area. This can be explaining by the condition after a

forest fire occurs in burned area. After a forest fire, the land is more open and bare with a surface layer of ash rich in minerals.

This is the ideal condition for fern's spores to germinate and grow, thus starting up new colonies (Greenaway, 1991).

Dominance Pattern

According to the data that has been collected, *Stenochlaena palustris* (Lemiding) has the highest value of Importance Value in both burned and unburned area. It also means that *Stenochlaena palustris* (Lemiding) is an important fern species in terms of the physical structure of a community. The Importance Value also represents the percent fraction of the total fern species composition of both burned and unburned area (Mojiol, 2006).

The results that were obtained have shown the differences of the fern species of burned and unburned area in term of relative frequency, relative density and relative coverage. The value of relative frequency, relative density and relative coverage of fern species in both areas is different due to the differences in population densities among the fern species within the community.

From the results, in burned area, *Pterium caudatum* (Tropical bracken) has the highest number of relative cover while in unburned area *Asplenium nidus* (Bird's nest fern) has the highest number. This is because *Pterium caudatum* (Tropical bracken) *Asplenium nidus* (Bird's nest fern) has a wide frond and its frond covered most of the plot. *Stenochlaena palustris* (Lemiding) and *Nephrolepis auriculata* (Boston fern) were found in the most of plots have been established in burned area while in unburned area, *Stenochlaena palustris* (Lemiding), *Lypodium flexuosum* (Ribu-ribu gajah) and *Asplenium sp.* were found in the most of the plots. These species were found in most of the plot because they were invasive species.

Measure of Diversity

The value of the Shannon-wiener index obtained from empirical data usually falls between 1.5 and 3.5 (Magurran, 2004). For the value that is below 1.5 or greater than 3.5 means that the diversity of the area is not equitably distribute. Beside that, the value of Shannon index also presented the degree of uncertainty (Magurran, 2004). This measure combines the number of species present (richness) with the relative proportion of individuals represented by each species (evenness).

From the result, the value of Shannon-wiener index in burned area is H'=1.66. It means that the burned area has equal densities of each species and there is a high degree of uncertainty in predicting the next organism that will be seen in the ecosystem. While in unburned area, the value of Shannon-wiener index is H'=0.88. So, the unburned area has a high degree of certainty in

predicting the next organism, meaning there are few chances of crossing paths with anything else (Magurran, 2004).

The value of evenness can be deriving from the Shannon index value. It is the measure which can used to compare the actual diversity value to the maximum possible diversity in one space. The value for evenness constrains from 0 to 1.0. A sample of equal numbers of individuals of the same species has a value of 1 (Magurran, 2004). The evenness value in burned area is 0.85 and in unburned area the value of evenness is 0.42.

Burned area has a higher value of E' because the total number of individuals in the burned area is quite evenly distributed between the fern species. In unburned area, most of the individuals are *Stenochlaena palustris* (Lemiding), with only a few other fern species present. The unburned area is therefore considered to be less diverse than burned area. A community dominated by less species is considered to be less diverse than one in which several different species have a similar abundance.

Fern and fern allies

A large number of the terrestrial fern species (such *Stenochlaena palustris, Nephrolepis auriculata, Pterium caudatum, Pteris ensiformis* and *Davallia denticulata*) were found in burned area. However, in unburned area, epiphytic fern species were found the most (*Asplenium nidus, Pyrrosia lanceolata, Asplenium sp., Platycerium coronarium* and *Goniophlebium sp.*).

This suggests that the terrestrial fern species have a different ecology needs from epiphytic fern species. The terrestrial fern thrives best in more open area or disturbed area in exposed. Beside that, after the forest fire which is occurred in burned area, it has encouraged the stimulation the germination of seeds of terrestrial fern. While the epiphyte fern is abundant on light shade and commonly found under the forest canopy. The ideal condition for epiphyte fern to grow well is warm, damp climate and enough light for photosynthesis (Greenaway, 1991). Epiphyte fern needs other plants for mechanical support. Since the unburned area has many trees compared to the burned area, so there is more epiphyte ferns in unburned area. Most of the fern species found in both areas is a common fern species as compared to other places for example in Tawau Hills Park and Sayap-Kinabalu Park Sabah which is studied by Jaman and Latiff (1995) and Lanjak Entimau, Sarawak by Mojiol *et al.,* (2009).

Conclusion

A total number of fern species in burned area is 7 species belongs to 7 families with 3715 number of individuals. In unburned area, there were 9 species of fern species were found belongs to 6

families. The number of species greater in unburned area compared to burned area but the Shannon index in burned area is higher (1.66) than in unburned area (0.88). This indicates that the species richness (number of species) in unburned area is greater but in term of species diversity (the species richness and relative abundance) the burned has the highest number.

The fern species has much significance whether in economy and ecology. Fern also used as source of food and extracts of different parts and their decoction as medicine for various ailments. For instance, *Stenochlaena palustris* (Lemiding) can be cooked or eaten as vegetables. Beside that, the fern species has a high value in medicine, for example *Lypodium flexuosum* (Ribu-ribu gajah) is used to treat gonorrhea disease. Some ferns can play a role in soil erosion control (*Nephrolepis* auriculata) because it has a spreading root system. Beside that, fern also famous for ornamental use, for example *Asplenium nidus* is used as a decoration and landscaping.

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APPENDIX A: Data from the inventory

The abundance of fern species (density, coverage, frequency)

a) Burned area of Klias Peat Swamp

Species	No of individuals	Density (n,/ha)	Coverage (per ha)	Frequency
Stenochlaena palustris	939	1878	974.9	0.88
Nephrolepis auriculata	834	834	972	0.88
Pterium caudatum	833	1666	1004.6	0.75
Pteris ensiformis	750	1500	785.6	0.63
Lycopadiella cernua	190	380	201.8	0.38
Davallia denticulata	120	240	139.7	0.38
Lypodium flexuosum	49	98	50.2	0.25
Σ=	3715	6596	4128.8	4.12

b) Unburned area of Klias Peat Swamp

Species	No of individuals	Density (n,/ha)	Coverage (per ha)	Frequency
Stenochlaena palustris	620	1240	709.6	0.75
Nephrolepis auriculata	318	636	342.1	0.375
Lypodium flexuosum	145	290	264.6	0.75
Asplenium nidus	75	150	1881.5	0.625
Pyrrosia lanceolata	69	138	216.7	0.5
Asplenium sp.	65	130	256.8	0.75
Platycerium coronarium	27	27.5	159.1	0.5
Goniophlebium sp.	14	28	33	0.5
Histiopteris incisa	6	12	5.7	0.25
Σ=	1339	2651.5	3869.1	5.01

APPENDIX B: Fern Descriptions in Klias Peat Swamp Forest (KPSF)

Fern	Description
	Scientific name : *Asplenium nidus* Local name : Bird's Nest Fern Family : Aspleniaceae Characteristics : It forms large simple fronds with the fronds growing to 50-150 cm long and 10-20 cm broad. They are light green with a black midrib. The habit of this fern epiphytic or terrestrial (Anon, 1999). Habitat : Found in unburned area of KPSF
	Scientific name : *Asplenium sp.* Local name : Paku Langsuyar Family : Aspleniaceae Characteristics : It is an epiphytic fern with eaves that may either be shaped like straps or be extremely fine and delicate in a moderate size. It has shiny greens fronds. It is naturally forming basket organic debris Habitat : Found in unburned area of KPSF
	Scientific name : *Davallia denticulata* Local name : Paku Terutup Family : Davalliaceae Characteristics : It is a small sized terrestrial ferns. It has rhizome long creeping bearing roots on short lateral branches at the base of the fronds, densely covered with non-clathrate. Its fronds are copiously divided (Anon, 1999) Habitat : Found in burned area of KPSF
	Scientific name : *Goniophlebium sp.* Local name : - Family : Polypodiaceae Characteristics : It is has a long and wide thin frond and rounded base. It also has a dark coloured frond. It is an epiphyte commonly seen perching on tree branches in lowlands, oil palm plantation or secondary forest (Anon, 1999) Habitat : Found in unburned area of KPSF.

Fern	Description
	Scientific name : *Histiopteris incisa* Local name : Paku Pakis Family : Dennstaedtiaceae Characteristics : It is a terrestrial fern that can be found scrambling on other plant (Hanum *et al*., 2005). It has continuous sori along edges of lamina, veins anastomosing where sori protected by the reflexed margin of the lamina only. Habitat : Found in unburned area of KPSF
	Scientific name : *Nephrolepis auriculata* Local name : Boston fern Family : Nephrolepidaceae Characteristics : It is a terrestrial fern which grows in open places and often lowlands (Bidin & Jaman, 1995). It has bright green fronds and each span one foot in width and four feet in length. Habitat : Found in burned and unburned area of KPSF
	Scientific name : *Pteris ensiformis* Local name : Paku padang Family : Pteridaceae Characteristics : It a terrestrial fern with a short rhizome, erect, apex of rhizome and base of stipe covered with lanceolate-triangular brown scales. Its fronds tufted, erect and lamina outline broadly deltoid. Habitat : Found in burned area of KPSF
	Scientific name : *Platycerium coronarium* Local name : Tanduk Rusa/Staghorn fern Family : Aspleniaceae Characteristics : It is an epiphyte with rhizome short and covered with nest-fronds. Its fronds strongly dimorphic; stipe very short or wanting; nest-fronds sterile, erect, broadly based, deeply cordate, papery with age and humus-collecting. Habitat : Found in unburned area of KPSF

Fern	Description
	Scientific name : *Pterium caudatum* Local name : Tropical bracken Family : Dennstaedtiaceae Characteristics : It is a large terrestrial ferns with the rhizome wide-creeping underground with fronds arising from the branches. It can grow in poor soils and help prevent soil erosion with their vigorous and extensive system of rhizomes Habitat : Found in burned area of KPSF
	Scientific name : *Pyrrosia lanceolata* Local name : Bulu ayam Family : Polypodiaceae Characteristics : It is long creeping epiphyte. It has simple fronds, fleshy-coriaceous and densely covered with stellate hairs below. The stipe is long and the stellate-hairy, sterile fronds ovate-elliptic to lanceolate-linear (Hanum *et al*., 2005). Habitat : Found in unburned area of KPSF
	Scientific name : *Stenochleana palustris* Local name : Lemiding Family : Blechnaceae Characteristics : It is a scrambling, long creeping fern, or high climbing epiphyte with base rooted to the ground. The frond is pale green (reddish brown for young frond) and it has 30-80 cm long (Anon, 1999). Habitat : Found in burned and unburned area of KPSF
	Scientific name : *Lycopadiella cernua* Local name : Paku sesorok Family : Lycopodiaceae Characteristics : It is a terrestrial fern. It has indeterminate rhizomes and rooting. The stems are erect, simple or branched. It has sporophylls and vegetative leaves dissimilar, sporophylls ephemeral and usually subpeltate (Anon, 1999). Habitat : Found in burned area of KPSF

Fern allies	Description
	Scientific name : *Lypodium flexuosum* Local name : Ribu-ribu gajah Family : Schizaeceae Characteristics : It is one of the climbing fern. The fronds of adult are scandent with a twining rachis and have very short lateral branches bearing additional leafy branches (Anon, 1999). The surface is usually sculptured. Habitat : Found in burned and unburned area of KPSF

Forest Fire in Indonesia and Its Contribution to Climate Change

ISRAR ALBAR AND SOLICHIN

Abstract

Serious land and forest fire in Indonesia occurred in 1982-1983, 1987, 1994-1995, 1997-1998, 2002 and 2006. In 1997/1998, land and forest fire destroyed area of 10 million ha which also released 2.6 Gt carbon to the atmosphere. This fire episode has economic, environmental, ecological, social, and other dimensions in their impacts. Indonesian Ministry of Environment identified the impact of climate change in the sign of season changing which indicated by flood and storms during rainy seasons; drying period; increasing of daily temperature and disappearing of small islands. The Reducing Emissions from Degradation and Deforestation (REDD) mechanism has potential solution for above mentioned problem. The Merang REDD Pilot Project (MRPP) develop a concept to manage and protect biodiversity and carbon stocks in a pilot area in the Merang Peat Swamp Forest in South Sumatra through integrated forest carbon management activities for the benefit of local communities as well as the environment.

Forest Fire in Indonesia

Over the last two decades, large scaled, devastating, uncontrolled forest and land fires in Indonesia have significantly disturbed the land and forest resources as well as the environment. Caused by smoke and haze pollution, the devaluation of resources, economically and ecologically, together with the quality deprivation of environment are among the predominant impacts of these catastrophes. The occurrence of this fire would still continue in the future, because the communities are still using fire for site-preparation in land cultivations. Additionally, the situation has been exacerbated as most existing lands and forests tend to become more vulnerable to fires when a prolonged extreme dry weather known as El Niño occurs in a shorter time interval.

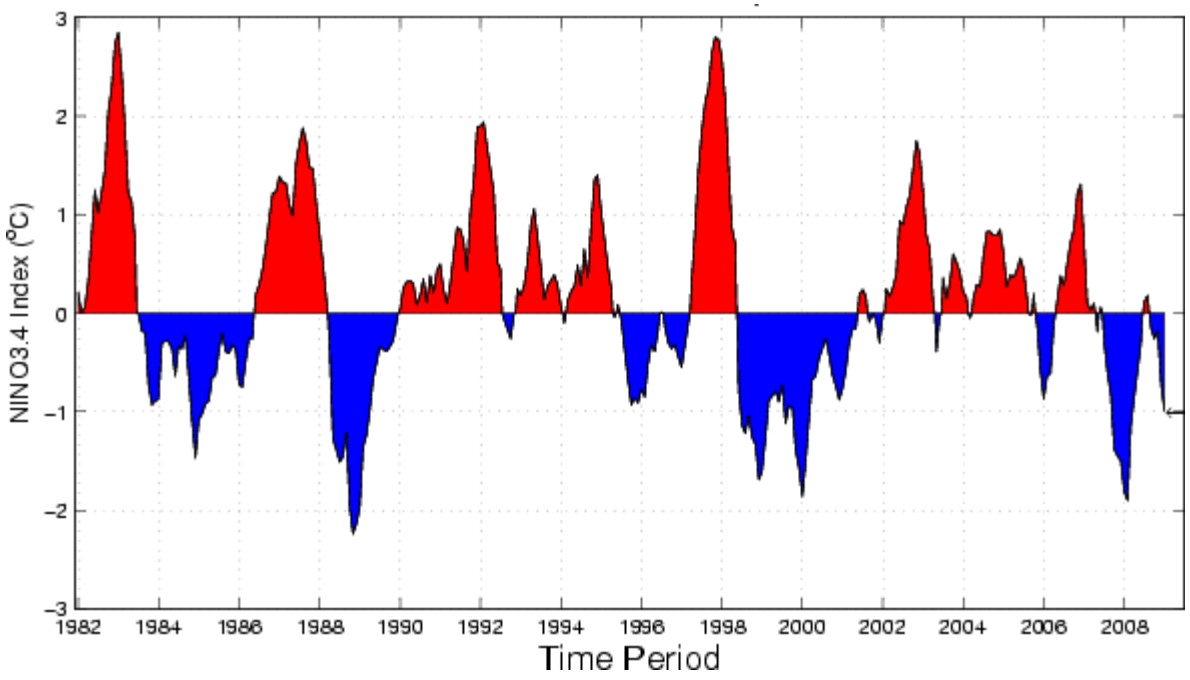

Figure 1. Historical sea surface temperature, indicating El Niño (red) and La Nina (blue) occurrences (The International Research Institute for Climate and Society)

Fire was not a common threat to a humid rainforest ecosystem. Changes in forest cover from into other human-induced degraded lands bring about risk of fire occurrence in the tropical ecosystem. Unsustainable exploitation of forests since early 1970s has led to a vast destroyed area of forest in the islands of Sumatra and Kalimantan. Open and destroyed forests allow the sunlight to penetrate onto forest plane, and creating a drier micro-climate during a prolonged dry season. Debris from logging residues and standing dead trees increase the amount of fuel, which amplify the fire intensity in degraded forests. In 1997/1998, more than 6 million ha of logged-over forests in Indonesia were affected by fires (Tacconi, 2003).

A combination of human activities and extreme drought are identified as the major factor of the recent forest fires in Indonesia. In this case, human activities include traditional slash-and-burn agriculture, large-scale-land-clearing for forestry and estate crop plantations, as well as commercial logging operation. Furthermore, the extreme drought was caused by a periodic climatic phenomenon known as El-Niño. The combination of two factors, to some extends, has caused changes in forest vegetation's structure, composition and environment. These changes have further made forests more vulnerable to fires, and therefore they may have enabled more widespread fires than in the past.

Forest and land fires also destroy the habitat for biodiversity. The fires eliminate plants and animals resulted forest degradation that leads to a decrease in the survival rate of the species. The newest release reported by Ministry of Forestry, there are conflicts between human and animal such as elephants *(Elephas maximus)*, tiger *(Panthera tigris)* occurred in Riau and Jambi provinces. The fires in 1997-1998 resulted in 33% population decline of the Orangutan *(Pongo pygmaeus)* in Borneo (Rijksen and Meijaard, 1997). The impact of climate change in Indonesia is identified by Indonesian Ministry of Environment in the field of : the sign of season changing which indicated by flood and storms during rainy seasons that gradually increase; drying period; increasing of daily temperature and disappearing of small islands (KLH, 2008).

GHG Emissions from Peat Fires

Economic interests describes as a prominent reason of peat land fires. Most of the communities who live within or nearby degraded peat lands are poor and have little profitable options of livelihood. Peat lands are fragile ecosystem, therefore, they will no longer resource-able ecosystems, if they were unsustainably utilized. In southern area of Sumatra, paddy rice cultivation called "*sonor*" is one of the major sources of fires ignition. At the end of a long dry season, *sonor* farmers usually set fires along the brink of peat domes without considering the possibility of triggering a wide-spread fires. The fires very often spread and eventually become uncontrolled below-ground peat fires. Illegal loggers also play roles in creating fire-prone conditions, for example setting up fires for cooking, throwing cigarette butts everywhere, and lighting fires to clear shrubs and bushes for better accessibility.

Fire occurrence is very likely to occur in degraded peat lands. Cutting the trees make the sunlight directly penetrate onto the planes, making it drier than before. Most of degraded peat lands in Sumatra and Kalimantan were severely burned in 1997/1998. About 75% of total carbon were produced from burning peat (ADB, 1999). It was estimated about 442 million tons of carbon emitted to the atmosphere. This is equal to 30% of annual global average emissions from land-use change cover over period of 1989-1995. In 2006, about 100,000 hectares peat lands in South Sumatra were burned, releasing more than 21 million tons of carbon to the atmosphere solely from peat land in 2006 (Solichin, 2007). An analysis using The Moderate Resolution Imaging Spectroradiometer (MODIS) and *National Oceanic and Atmospheric Administration* (NOAA) dataset was conducted to estimate carbon released from fire season 1997 in Musi Banyuasin (Muba) District. About 38,000 ha or logged-over peat forests were affected by fires and releasing 33 million tones of CO2 (Moder, 2008).

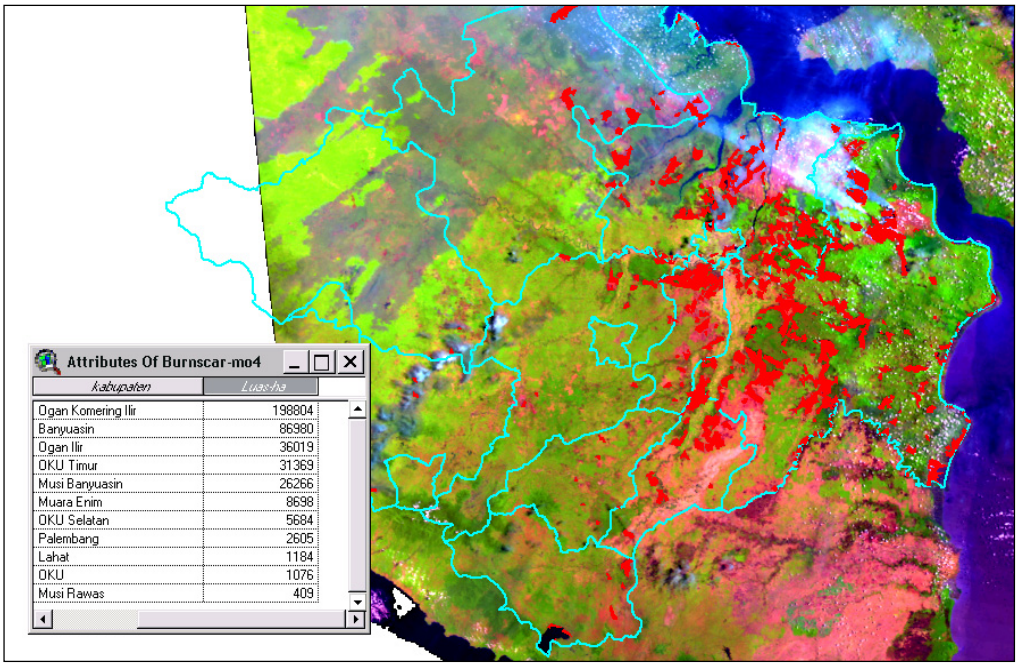

Figure 2. Burnscar map at Ogan Kemiring Ilir, South Sumatra.

Given the huge contribution of peat fires to carbon emissions, protecting remaining tropical peat swamp forests should also reduce considerably green house gas emissions. Bali Action Plan from the thirteenth Conference of the Parties (COP) to the The United Nations Framework Convention on Climate Change (UNFCCC) held in Bali from 3 to 15 December 2007 allows implementation demonstration activities to REDD, before it is fully implemented in 2012. The government of Germany has committed to support Indonesia in preparing for the implementation of REDD. Some projects, related to carbon trading, have been initiated by the Government of Indonesia (c.q. Ministry of Forestry) in cooperation with the Gesellschaft für Technische Zusammenarbeit (GTZ) on behalf of Federal Republic of Germany. This will be a landmark in changing the strategy in protecting tropical forests, while at the same time reducing emissions from land use and forestry sectors as well as providing incentives for local communities and governments.

Merang REDD Pilot Project

Merang REDD Pilot Project (MRPP) is a 3 years (2008-2011) pilot project funded by the German's Ministry of Environmental and Nuclear Safety (BMU). The purpose of this project is to develop a concept to manage and protect biodiversity and carbon stocks in a pilot area in the Merang Peat Swamp Forest through integrated forest carbon management activities for the benefit of local communities as well as the environment. Four major components which will be the concerns of this

project: (1) Monitoring of peat lands and forest carbon, (2) Rehabilitation of degraded peat lands, (3) Community-based forest protection, and (4) Facilitation of local goverment to be ready for carbon trading.

Assessment on carbon storage and emissions both on soil and above ground will be conducted to estimate carbon release or sink in baseline and project-based scenarios. Monitoring of forest changes through permanent sample plots and remote-sensed data will be conducted to quantify the carbon stock and emissions during the project period. Therefore, analysis on baseline and project-based scenario will have high accuracy.

Restoration of degraded and deforested area is a crucial component to improve carbon sequestration through forest growth and additionally reduce carbon release from oxidation and fires. Community involvement is a key factor in this rehabilitation program. The project will increase capacity and awareness of the local community on rehabilitation program. A community nursery will be established in the villages to meet the project demand on forest seedlings. Planting and tending will also involve local communities.

Prevention and forest protection activities should be conducted through communities and assigned institutions to prevent forest fires and other illegal activities in the area. Community forest rangers will be established in each settlements or hamlets near the project area. They will be trained in putting out fires, by using map, Global Positioning System (GPS), and they will be equipped with basic equipments. During fire seasons, all community rangers have to be ready for fire prevention and control activities.

They are also responsible for reporting any illegal logging activities within the project area. They have further obligations to carry out awareness campaign, to stop or at least using fires responsibly in land preparation, to protect the nature, and to reduce their dependency on forest which could caused forest degradation. In return, they will get additional incentives, for example supports for the establishment of integrated farming system, capacity building in the non-timber forest product (honey, rattan, etc), or development of community-based forest management.

Conclusion

From the above-mentioned data, the devastating fires in 1982/1983 and 1997/1998 have economic, environmental, ecological, social, and other dimensions in their impacts. These impacts could be onsite and offsite of the fires. The extent of impacts would depend on the frequency and intensity of fires, fuel load, type of forests, and climate. These factors have created adverse impacts even outside the affected areas, both nationally and internationally. These include health, transportation,

tourism industry, economy, commercial logging, agriculture, biodiversity, human activity, soil, global climate change and trans-boundary smoke-haze pollution.

Recognizing the magnitude of the adverse impacts of the recent forest and land fires, a comprehensive measure on forest fire control is inevitable. This measure is directed towards strengthening the role and capability of the Ministry of Forestry as a responsible institution at national level, the Provincial Forest Services, District Forest Services and other forestry-related organizations at provincial and district levels respectively in overcoming forest and land fire problems. Eventually the measure is aimed to support the achievement of sustainable forest resources management in the country.

It is also important to deal with the underlying causes of forest fires, which are mostly related to local livelihood and awareness. Facilitation of village group establishment, capacity building, involvement in project activities and implementation of bio-right concept will improve community awareness of the importance of forests and at the same time generate incentive for alternative income.

REDD mechanism has potential solution for above mentioned problem. It is not necessary that timber is the only product of the forests that has major values. Surely, standing living trees have many values than standing dead trees. The trees are not only seen as wood product, but also as carbon storage and sequester, wildlife habitat, hindrance of the sun penetration to forest floor, and thus keeper of wetter micro-climate. Moreover, local community involvement is an essential prerequisite to avoid emissions, either from inside the project area or outside project area (leakage).

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IMPACT OF CLIMATE CHANGE ON AGRICULTURE, POULTRY PRODUCTION AND SOCIO-ECONOMIC ASPECTS

Impact of Climate Change on Agriculture: Nature Conservation Aspects of Genetically Modified Crops in the Philippines

AUREA MARIE M. SANDOVAL

Abstract

Climate change and global warming have been projected to have significant effects on conditions affecting agriculture. The Philippines as a developing country is highly vulnerable to climate change impacts given its topography, low level of economic development and exposure, and poor access to resources. This being so, several mitigating measures have been stepped up, one of which is through the use of biotechnology. Specifically, the use of genetically modified crops has posed a number of challenges in terms of their consequent impact on climatic changes.

There are now higher level biotechnology research projects in the Philippines such as transgenic banana and papaya studies, delayed ripening of papaya and mango fruits, Bt corn, bacterial blight resistant rice, Bt cotton, and marker-assisted breeding in coconut. There likewise have been numerous opportunities for biotechnology in the country such as increased plant yield, genetically improved plants, marker technologies and microbial products. However, there are environmental issues playing a primary concern regarding genetically modified foods such as unintended harm to other organisms, reduced effectiveness of insecticides, increased use of herbicides, gene transfer to non-target species and widespread crop failure. Constraints such as difficulty in assessing new technologies, the presence of anti-biotechnology groups, bio-safety guidelines and difficulty of commercial release of GMOs have posted implications on the use of these.

On final analysis, it is important that the challenges, opportunities and constraints faced by biotechnology, particularly GMOs, be addressed especially during this critical time of climate change impacts.

Introduction

Climate change, triggered by global warming, is a creeping, very slow-start phenomenon, hardly noticeable in our daily lives. We only start suspecting some changes taking place in the global system when we notice some species vanishing, shore lines advancing, global average temperature

increasing, and ice caps melting. Global warming is likewise projected to have significant effects on conditions affecting agriculture. Several factors such as average temperature increase, change in rainfall amount and pattern, rising atmospheric concentrations of carbon dioxide and pollution levels, change in climatic variability and extreme events connect climate change and agricultural productivity (Fischer, 2002). All these have implications on land use systems, livestock, fertility, and quality and yield of crops. At the same time, agriculture has been shown to produce significant effects on climate change, primarily through the production and release of greenhouse gases, and by the alteration of the earth's land cover. Climate change and agriculture are thus interrelated processes, both of which take place on a global scale.

Impact of Climate Change on Agriculture: the Philippine Setting

The Philippines, as a developing country, is highly vulnerable to climate change impacts. It is a climate hotspot, vulnerable to some of the worst manifestations of climate change. Like other Asian countries, adaptive capacity of human systems is low and vulnerability is high largely due to its topographical features, low level of economic development and exposure, exacerbated by poor access to resources (Amadore, 2007). The threat of climate change impacts are shown to amplify the different socio-economic burdens of Filipinos such as hunger, health care and water scarcity. The country's vulnerability to severe weather events, such as harsher storms, droughts and extreme precipitation are found to worsen the existing disparity of living standards between the rich and poor. This has further been observed to marginalize indigenous peoples such as the T'boli of Mindanao and the Badjaos of the Sulu Seas whose customs and livelihood are deeply rooted in the well-being of the environment, devaluing their "contribution to the conservation and protection of biological diversity and ecosystems" crucial for the prevention of climate change.

As an archipelago with the second largest coral reef cover in the world and with a very long coastline, the Philippines is being threatened by the large-scale impacts of climate change on the ocean, the effects being felt in coastal areas, island ecosystems and low-lying communities. The Philippines is also one of the top mega-diversity countries in the world. Unfortunately, it is also considered as one of the world's top biodiversity hotspots (Amadore, 2007). Due to increasing human population and resource demand, habitat destruction and unsustainable development, climate change impacts are now constituting an additional pressure that could exacerbate the high rate of species extinction and current degradation of the Philippine ecosystem.

Nature Conservation Aspects

Nature knows no political boundaries. What applies to the range of plants and animals applies equally to many environmental and conservation issues. The consequences of over-exploiting nature are more often than not, felt in other countries as well, through climate change impacts. The Philippines for one is not spared of this. At no other time have the impacts of climate change become more apparent in this country. This being so, means of mitigating these impacts have been stepped up through several measures, one of which is through the use of biotechnology. From the start, the Philippines has been faced with a number of challenges, opportunities and constraints in agricultural biotechnology, specifically the use of genetically modified crops and their consequent impact on climatic changes that have been observed to be occurring in these past few years.

Biotechnology in the Philippines

The Philippines has a land area of 30 million hectares and a current population of over 80 million. In 1997, the combined areas devoted to agriculture was 10.3 million hectares, with coconut being the most widely planted crop, followed by rice, corn, bananas, pineapple and others. Rice and corn are the leading products in terms of production and area used for planting these. More than 70% of the population is directly or indirectly dependent on agriculture, however significant increases in population have placed tremendous pressure on agricultural lands. Most prime lands are now being converted into resettlement areas and for use by industries. This has severely decreased the 10.3 million hectares in 1997 used for agricultural purposes.

The Philippines started its Biotechnology program in 1980 with the formal creation of the National Institute of Molecular Biology and Biotechnology (BIOTECH) at the University of the Philippines (U.P) at los Banos, Laguna. In 1995, three other biotechnology institutes were established within the U.P. system – U.P. Diliman (Industrial Biotechnology), U.P. Manila (Human Health Biotechnology) and U.P. Visayas (Marine Biotechnology).

The biotechnology institutes at U. P. los Banos continue to provide leadership in agriculture, forestry, industrial and environmental biotechnology. Other research institutes such as the International Rice Research Institute (IRRI), Philippine Coconut Authority (PCA), Cotton Research and Development Institute (CRDI), Bureau of Plant Industry (BPI) and the Bureau of Animal Industry (BAI) are also involved in biotechnology research and development.

The type of research undertaken in the Philippines in the 1980s and 1990s focused mainly on conventional biotechnology. Today, however, greater amount of work is being done on molecular

markers and the development of Genetically Improved Organisms (GIOs) with useful traits. There are now higher level biotechnology research projects being funded by the government, such as:

a. transgenic banana and papaya resistant to banana bunchy top virus and papaya ring spot virus, respectively

b. delayed ripening of papaya and mango

c. Bt corn

d. Bacterial Blight Resistant Rice (BB rice)

e. Bt cotton

f. Marker-assisted breeding in coconut

g. Coconut of high lauric acid content

In 1997, the Agriculture and Fisheries Modernization Act (AFMA) became law. Its main objective was to modernize Agriculture including infrastructure, facilities and research and development. AFMA recognized Biotechnology as a major strategy to increase agricultural productivity. It has been operating through the National Research Development and Extension network systems of 13 commodities and 5 disciplines including rice, corn, root crops, coconut, plantation crops, fiber crops, vegetables/spices, ornaments, fruits/nuts, capture fisheries, aquaculture, livestock and poultry and legumes. All these include biotechnology in their RDE agenda. Its main goal is to harness the potential of this technology to increase productivity of all the commodities in the agriculture and fishery sectors. Biotechnology thus plays a major role in the Philippines in the selection and breeding of new varieties of plants and animals and in the production of genetically modified crops with resistance to harmful pests and diseases, for accurate diagnosis and control of diseases, for bioremediation of the environment, and for bio-prospecting. It is envisioned that the benefits derived from all these biotechnologies will reach the small farmers and fishermen. While modern countries have long been using Genetic Engineering in the production of crops, the Philippines has yet to fully adopt GMO technology in enhancing yield, variety and quality of crops in the agriculture sector.

The First GM Crops in the Philippines

The Philippines is the first country to allow the first biotech food crop to be commercially planted in Asia. It has gone full blown in promoting and allowing the commercialization of genetically modified crops since the approval of Monsanto's MON 810 Bt corn. In October 1991, the National

Bio-Safety Committee of the Philippines (NBCP) was established as the highest regulatory body with regard to the introduction, use and transfer of GMOs and Potentially Harmful Exotic Species (PHES). The NBCP where the Department of Agriculture is a member is mandated to undertake the study and evaluation of existing laws, policies and guidelines on biotechnology and recommend measures for its effective utilization and prevention of possible pernicious effects on the environment. Guidelines have been issued relevant to the proper handling, propagation and other protocols that cover GMOs. These guidelines established several criteria for evaluating work on GMOs under containment or laboratory control, which included transformation protocols, genetic and physiological analysis of the donor organisms and GMOs, adequacy of the facility and laboratory to ensure that no viable genetic material escapes, and the proper disposal of used materials from the experiment. In supplementing efforts to ensure the safety of the environment from the possible effects of GMOs, President Gloria M. Arroyo, during the start of her term, adopted a clear pro-GMO stance through an official Policy Statement on Modern Biotechnology, pushing for the "safe use" of genetic engineering. Governed by A. O. #2 (2002), the Department of Agriculture approved in December 2002, the propagation and importation of Bt corn – the first genetically modified crop approved for field testing in the country. Bt corn is a variety of corn where a specific gene of *Bacillus thuringiensis* (Bt), a common soil bacterium used safely since the 1900's by organic gardeners and farmers worldwide as biological insecticide, is inserted to produce a protein that protects the corn plant from Asiatic corn borers, the number one enemy of corn. This pest infestation causes up to 80% yield loss as borers feed on the stems, leaves and corn ears even before the crop matures. The Department of Agriculture thus claims that Bt corn can increase corn yields and reduce production costs by eliminating the need for commercial pesticides, giving promise of better incomes to corn farmers. Bt corn is now planted in about 30,000 hectares of land in the Philippines and with this, it is predicted that corn yield could rise to more than five million tons from 4.6 tons (Sarian, 2009).

Notwithstanding the benefits from Bt corn and the positive experience with GM crops of developing countries, quite a number of scientists, environmental activists, public interest groups and professional associations insist that GM crops run against the natural evolution of crops and have not yet been proven as safe to humans and the environment. Furthermore, it is feared that once GMOs are released to the environment, their possible harmful effects would be irreversible, adding to this the fact that GM crops will foster dependence of farmers on multinational companies that produce the seeds. They have been criticizing biotechnology corporations for pursuing profit without concern for potential hazards, and the government for failing to exercise adequate regulatory oversight.

Environmental issues play a primary concern regarding GM foods. Unintended harm to other organisms, reduced effectiveness of insecticides, increased use of herbicides, gene transfer to non-target species and widespread crop failure have been observed to be the bases of environmental issues vis-a-vis GM crops.

Although GMOs have been unpopular among some environmentalists and consumers, the DA has argued that declaring B+t corn as unsafe has yet to be established. It insists that testing for toxicity, allergenicity and nutritional values have been thoroughly conducted. Added to this is the more than 50 international organizations declaring GM crops (including Bt corn) as safe and non-threatening to humans and the environment. Other advantages observed are the following: pest resistance, herbicide tolerance, disease resistance, cold, drought and salinity tolerance, and nutrition.

Current Developments on GMOs in the Philippines

Bt Corn

Bt corn seeds have been sold at a minimum of P4,500 for a package of 23 kg bag that can be planted to a hectare compared to a little more than P2500 price of ordinary hybrid corn seeds of the same amount. Expectedly, Monsanto and the Department of Agriculture have claimed that Bt corn has significantly increased corn yield across the country. However, monitoring done by MASIPAG and SEARICE in Iloilo and North Cotabato, respectively, showed that Bt corn performed poorly, is more susceptible to fungal diseases and yielded much lower than ordinary hybrids.

BB Rice

The National Committee on Biosafety of the Philippines (NCBP) has approved the joint application of the Philippine Rice Research Institute (PhilRICE) and the International Rice Research Institute (IRRI) to conduct limited field trials of their genetically engineered bacterial blight resistant rice (BB rice) in Munoz, Nueva Ecija and Los Banos, Laguna. Both trials showed that the conventionally-bred bacterial blight resistant rice performed better than the genetically engineered BB rice. This type of rice is projected to be the first genetically engineered rice to be allowed for commercial use in the Philippines. Proponents expect less consumer and public concern on the health and environmental impacts of BB rice since the source gene that codes for bacterial blight resistance engineered into rice came from a wild rice relative and not from a totally unrelated species. This reason, however, has not held water to those who do not advocate the use of GMOs . This is because genetically engineered BB rice still uses the same recombinant DNA technique that relies on the use of gene promoters, gene terminators and gene markers, all of which come from totally unrelated organisms such as viruses and soil organisms.

Bt Cotton

Plans of importing into the country genetically engineered Bt cotton seeds by the Bureau of Agricultural Research (BAR) of the Department of Agriculture (DA) have been underway, in collaboration with a Chinese private company called Bio-Century Transgenic. This Bt cotton variety, patented in china, was engineered to express double insect resistance to cotton bollworm plus proteinase inhibitor (CpTI). Proponents of these claim that Bt cotton would be a good substitute industrial crop for farmers planting tobacco which has been declining in the international market. There are at present around 20,000 hectares of land across the country planted to hybrid cotton varieties (Resist Agrochem, 2004). The Department of Agriculture which has started field trials, has been optimistic that Bt cotton can easily meet the biosafety requirements set by the NCBP and that this will not be meeting strong public resistance since it is not meant for food and is not produced by a transnational corporation. Bt cotton proponents have likewise been hoping that the Philippines can replicate the experience of China in Bt cotton cultivation which resulted to increased yields. The Philippines imports about 95% of its cotton requirements, which could be greatly reduced with intensified production of Bt cotton. Two non-government organizations, MASIPAG and SEARICE however countered that the agro-climatic situation in the Philippines is very different from China, thus it would be unrealistic to assume the same result from the introduction of Bt cotton. They highlighted the environmental consequences resulting from the commercial cultivation of this crop such as pest resistance, effects on non-target and soil organisms, including the socio-economic dimensions involved all needing serious consideration.

Challenges

As the country recognizes the tremendous potential that can be achieved from biotechnology, several challenges are being faced:

1.Increase productivity

Due to unabated population increase leading to escalating food demands, conversion of prime agricultural lands into other uses has placed the agricultural sector under tremendous pressure. Coupled with poor soil fertility, pest and disease incidence and abiotic stresses such as drought caused by El Nino and climatic factors like typhoons, the challenge is to use biotechnology to increase productivity and yield on farms using minimal inputs.

2. Global competitiveness

Trade liberalization has resulted to the country receiving cheap agricultural products from other countries, widening its balance of trade. The challenge is to use biotechnology to produce local

products which are highly competitive with those from foreign sources. This would be able to promote export of quality products while reducing imports.

3. Biosafety and Risk assessment

Although the Philippines has one of the strictest biosafety guidelines in the world in terms of undertaking R & D for field testing, the challenge is to improve and better implement current biosafety guidelines. Protocols are needed to assess the risk of GIOs and to manage any identified risk factors. The challenge is for the Philippines to further develop its capability to undertake risk assessments based on scientific evidence.

4. Regulation of biotechnology products

Due to the necessity of regulating the commercial release of new products, all regulatory bodies should have implementing policies and guidelines. The challenge is to create guidelines to regulate commercialization of GIOs.

5. Transfer of Technology/Commercialization

Unless products of research are transferred to end-users and/or commercialized, they will not create any measurable impact. The challenge is to transfer products to users, particularly to small farmers and fishermen. This requires the proper packaging of the products.

6. Trade-related Issues

Transgenic crops and other GIO products may become trade-related issues due to trade liberalization. With this, new genetically improved crops will be expectedly imported into the Philippines. The challenge is therefore there to create public awareness of the benefits and risks of any new product.

7. Intellectual property protection

There are issues arising on intellectual property protection by patents and plant variety protection. This is because the process, products and genetic materials used in biotechnology R and D have propriety considerations. The challenge is for the country to strengthen its IPR laws to provide protection to researchers, discoverers and investors.

Opportunities for Biotechnology

1. Increased yield of plants

Biotechnology provides the opportunity for researchers to improve plant growth, development and yield by providing for the basic needs of the plant such as biofertilizers and biocontrol agents.

2. Genetically improved plants

There is tremendous potential for improved crop plants – those containing genes that provide pesticidal properties, resistance to herbicides, tolerance to pests, disease and stress, or combinations of these properties. These can considerably reduce production costs.

3. Marker Technologies

These technologies may help speed up the selection and production of more effective hybrids specifically in rice, corn, banana and coconut.

4. Microbial products

There are numerous opportunities available for the use of micro-organisms for biofertilizers, biopesticides and bioremediation of the environment.

5. Bioprospecting

The Philippines is one country with rich genetic resources waiting to be tapped for food, fibre, enzymes and drugs. It is expected that new beneficial genes would be discovered in the numerous diverse species of plants, animals, micro-organisms and marine organisms. The challenge is to save and use judiciously the rich biodiversity of the country which makes it one of the hotspots of biological diversity in the world. Aside from this, the rich biodiversity of the country offers many opportunities in the search for novel genes and gene products.

6. Introduction of Foreign Technologies

The importance given to R & D in biotechnology under AFMA makes it possible for foreign technologies to be introduced.

7. Joint R & D Collaboration

Very good opportunities are in place with a collaboration between Philippine and overseas researchers.

Constraints

1. Difficulty in Assessing New Technologies

   Researchers in the Philippines have not really been able to access state-of-the-art technologies, hampering the development of the local biotechnology industry. They are thus repeating work done elsewhere, rather than being able to adopt current technologies.

2. Anti-biotechnology Groups

   Individuals in the academe and government service as well as some non- government organizations do not support biotechnology. They have likewise been instrumental in convincing legislators to enact resolutions imposing moratoria on research and commercialization of GIOs.

3. Bio-safety Guidelines

   Biosafety guidelines in the Philippines continue to be one of the strictest in the world even as those countries from which these were patterned have relaxed as a result of new technical data and familiarity in dealing with new products.

4. Commercial Release

   New genetically improved products have a difficulty being commercialized in the country. This is because the regulatory bodies cannot issue the required permits or licenses. The regulations allow only limited field trials of genetically improved organisms. Aside from this, the regulatory bodies lack the proper guidelines and institutional support to regulate the new products. This is a major constraint because any potentially useful new product cannot be commercialized after the field trials.

Philippine Government Policies on GMOs

The National Bio-Safety Committee of the Philippines (NBCP) was established through Executive Order 450 as the highest regulatory body in the Philippines with regard to the introduction, use and transfer of GMOs and Potentially harmful Exotic Species (PHES). It is mandated to undertake the study and evaluation of existing laws, policies and guidelines on biotechnology and recommend measures for the effective utilization and prevention of possible pernicious effects on the environment. NBCP has actually already issued guidelines relevant to the proper handling, propagation and other protocols covering GMOs. Included here are transformation protocols, genetic and physiological analysis of the donor organisms and GMOs, adequacy of the facility and

laboratory to ensure that no viable genetic material escapes, and the proper disposal of used materials from the experiment. 1998 guidelines established the criteria for evaluating the planned release into the environment or field-testing of GMOs. Under said guidelines, the DA conducts tests to determine the safety of plant products for release into the environment through either field testing or propagation and importation of food products.

Philippine Current Policy Efforts

The DA-Biotech Program is the entity that supervises the policy researches on biotech development in the Philippines. It launched an inventory of policy research projects that concentrated on biotech priority areas, prospects, bio-safety, IPR, socio-economic evaluation and policy analysis of the commercialization of GM technology.

The following are recommendations on the major policy research areas:

a. Biotech priorities and policies in the Philippines

b. Funded policy development studies on Biotechnology

c. Cost Implications of GM Food Labelling in the Philippines

d. Institutional analysis of Biotech development in the Philippines

End Note:

Whether we are researchers, policy makers, industry people or academicians for that matter, it is imperative that the challenges, opportunities and constraints faced by biotechnology, particularly GMOs, be addressed especially at this critical time of increasing population, globalization, trade liberalization, and concerns with biosafety, regulation, intellectual property and climate change impacts.

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Impact of Climate Change on Poultry Production and Nutrient Supply in Indonesia

NURHAYATI

Abstract

Poultry production and nutrient supply are affected by some factors including climatic factors such as temperature, humidity and precipitation. Those factors could decrease poultry performance, productivity and reproduction. Climate changes need to manage housing system to maintain optimal temperature and reduce of heat stress. It is costly. In Indonesia**,** El Niño and La Niña decreased feedstuff production and increase feed price. A lot of poultry farmers bankrupt and more people could not access the qualified food. It might be one factor causing food and nutrient insecurity in Indonesia. However, climate change still giving opportunities for poultry farmers. Feed poultry with locally grown soya and maize could reduce feed cost and reduce poultry food miles.

Introduction

Indonesia is the largest and widest archipelago country in the world and known as a tropical maritime continent country. It consists of 17,508 islands stretches near the equator from a latitude of 06°08 N to 11°15 S, and a longitude of 94°45 to 141°05 E. It includes 3.1 million km2 (or 62 per cent) of territorial waters, almost 2 million km^2 (or 38 per cent) of land, and 81,000 km of coastline. The country is divided into 33 provinces; where the western part is more wet and eastern part is more dry.

In June 1997 Indonesia unexpectedly was pounded a serious economic, politics and social crisis and disaster. It affects both micro and macroeconomic variables. The exchange rate influences almost all economic variables. They include the GDP, general prices (inflation), the employment rate, the interest rate, and the wage rate. It resulted more unemployment due to some big companies bankrupt and resulted to the decreased household income and increased poverty incidence. More people can not get sufficient food and nutrition anymore due to food price increase but their salary is constant. It put pressure on the future food security. Food security also decreased significantly. It

occurs not only in the rural areas but also in the urban areas where the vulnerable society was the most seriously affected population. The current financial global crisis causes the situation become worst and worst. Food price more increases and shortages. Animal protein intake decreased significantly (Table 1). Factors for this crisis include also climatic factors, the rising cost of inputs especially oil and oil-based products, and the switch of land use from production of food to biofuels.

Table 1. Animal protein consumption in Indonesia prior the crisis (1980 – 1996) and after 2002

Year	Consumption per capita per year (kg)			
	Meat	**Eggs**	**Milk**	**Total**
1980	3.92	1.44	4.36	9.72
1981	4.00	1.50	3.08	8.58
1982	4.12	1.58	4.17	9.87
1983	4.32	1.66	3.88	9.86
1984	4.64	1.84	3.90	10.38
1985	4.95	1.88	3.31	10.14
1986	5.37	2.13	3.43	10.93
1987	5.27	2.20	3.38	10.85
1988	5.40	2.10	4.20	11.70
1989	5.69	2.12	3.72	11.53
1990	5.70	2.31	3.44	11.45
1991	5.99	2.40	4.46	12.85
1992	6.78	2.73	4.39	13.90
1993	7.40	2.69	4.23	14.32
1994	7.83	3.16	4.75	15.74
1995	7.90	3.33	6.99	18.22
1996	8.41	3.49	5.72	17.62

2003	7.60	5.65	2.92	16.08
2005	5.18	6.23	3.18	14.59
2006	4.13	5.66	3.36	12.15

Source : Directorate General of Livestock (2007)

Food Security Crisis and Climate Change

Food security crisis is not only related to the problem of food production. The Indonesian government defines food security stated in Constitution No. 7/1996 as a condition where there is sufficient food for every household and it is reflected by sufficient food, both in quantity and quality, safe, evenly distributed and can be accessed by the people. World Bank (1986) stated that the situation where more people cannot access to sufficient food for healthy and active life can be defined to food security crisis. It means that definition of food security has four dimensions; physical and economic access, sufficiency (availability), security (sustainability) and time. IFPRI (1995) stated that food security crisis can be because of three central ingredients or pillars of food security; food availability or adequate food production, economic access to available food, and nutritional security, which often depends on the availability of non-food resources such as child care, health care, clean water, and sanitation. However, Thomson and Metz (1997) differs food security at three different levels of aggregation; at national level, on a time scale and from a nutritional point of view. The BMZ (1998) distinguishes between three dimensions of food and national security; food availability, food access and food utilisation. Surono (1999) reported that there are four dimensions of food security those are food availability, food accessibility, vulnerability and sustainability.

Food availability is solely related to agricultural production that is influenced by climate change. Climate change is already affecting agricultural systems in several regions of the world, while agricultural practices also contribute to climate change. IFPRI's Director General, Joachim von Braun (2008) reported that many poorer developing countries are in tropical and sub-tropical regions that are vulnerable to global warming and in semi-desert areas threatened by water scarcity. It is predicted that by 2080, agriculture output in developing countries may decline by 20% due to climate change and yields could decrease by 15% on average. IAASTD (International assessment of agricultural knowledge, science and technology for development, 2008) reported that climate change can permanently damage the natural resource base on which agriculture depends. Some negative impacts are already visible in many parts of the world. Water scarcity and the timing of water availability will increasingly constrain production. Climate change will require

a new look at water storage to cope with the impacts of more and extreme precipitation, higher seasonal variations and increased rates of evapo-transpiration in all types of ecosystems. Extreme climate events (floods and drought) are increasing and are likely to adversely affect food and forestry production and food security.

Impact of Climate Change on Poultry Production Development in Indonesia

There are some climatic factors those have impact on poultry production and then on nutrient supply for the human. There are 5 factors those have big impact on poultry production. First factor is increasing the average temperature. An increase in average temperature results lengthen the growing season in regions and will adversely affect feedstuff for poultry and crops for human. It will also increase soil evaporation rates, and increase the chances of severe droughts (dryness in more places). Besides affect feedstuff availability, increase average temperature could stress the poultry. Stressing to the poultry due to increasing temperature would decrease poultry performance, decrease their resistance against diseases and finally decrease their production and reproduction. The second factor is change in rainfall amount and patterns. Changes in rainfall amount and pattern have an effect on soil erosion rates and soil moisture, both of which are important for feed and crop yields. The IPCC predicted that precipitation will increase in high latitudes but decrease in most subtropical land regions. It is around 20 percent (IPCC, 2007). Changes in rainfall and precipitation also affect to microbial activities. Some pathogenic microbial grow faster under higher temperature and humidity and greater precipitation (Rosenzweig et al., 2000). It could influence to the poultry and would reduce poultry resistance. The third factor is raising atmospheric concentrations of carbon dioxide. Increasing atmospheric carbon dioxide levels, driven by emissions from human activities, can act as a fertilizer and enhance the growth of some crops such as wheat, rice and soybeans. Increasing carbon dioxide concentration in the air will be one of a number of limiting factors for enhance crop growth. Other limiting factors include water and nutrient availability. The fourth factor is pollution levels. Since ozone levels in the lower atmosphere are shaped by both emissions and temperature, climate change will most likely increase ozone concentrations. The last but not least factor is change in climatic variability and extreme events. Changes in the frequency and severity of heat waves, drought, floods and hurricanes, remain a key uncertainty in future climate change. Such changes are anticipated by global climate models, but regional changes and the potential affects on agriculture are more difficult to forecast.

In Indonesia, since 1996 there are several pressures to poultry production and development including wild and native chicken. The impacts were not only to the company, community but also to the biodiversity. Some pressures were climatic factor. The first pressure was dryness caused by El Nino pounding in 1996/1997 and was most badly in eastern Indonesia. El Nino resulted on

decrease agricultural production included feed such as maize and rice bran. Feed price increased due to the limited feed availability. Farmer could not buy feed for poultry and their poultry production could not be marketed. The second pressure in 1998 was monetary crisis started by dropped exchange rate Indonesian Rupiah to US Dollar, increased inflation. Firm monetary up resulted a lot of national banking and agricultural company included poultry industries in Indonesia bankrupt due to that mostly feed poultry was imported and the price dramatically increased. In that situation, people decided that was more benefit to burn their poultry than kept them. The third pressure was the Indonesian political crisis started by student and people struck in all provinces. They did not only demonstrated but also burnt and destroyed infrastructures. Unemployment and poverty incidence increased, hence, household income, people afford and malnutrition decreased. People who lived in the village tried to survive through keeping and consuming local, native and wild poultry production. They kept poultry traditionally without buying the rations and feedstuffs. They caught and hunted wild chicken illegally from the forest either to get meat or to sell. It had resulted on decrease wild chicken population. The fourth pressure occurred in 2003 up to the present time was avian influenza. This disease impacted to the public willingness on consuming poultry products. People boycott to buy poultry products to prevent their family members from the infection. Poultry product price decreased rapidly even though result of surveillance of Livestock Services and some instances in Jambi showed that avian influenza were detected in wild poultry, it was not detected in domesticated poultry. The other pressure was **La Niña in 2006**. **La Niña** translates from Spanish as "the girl-child". La Niña defined to the extensive cooling of the central and eastern Pacific Ocean. In Indonesia (particularly eastern Indonesia), La Niña (sometimes called an anti-ENSO (anti-El Niño-Southern Oscillation) events are associated with increased probability of wetter conditions such as increased convection or cloudiness and decreased temperature in some part area. It influenced the agricultural system and production. The last pressure was the economic crisis global. The crisis resulted increase feed price especially fish meal, corn and soybean meal. Poultry products price again increased significantly and again more people could not access and consume animal protein even though the production increase especially poultry population that biggest contribution to meat production (Table 2 and 3).

Table 2. Poultry Population in Indonesia in 2003 – 2007 (000 head)

Year	Native chicken	Broiler Chicken	Layer Chicken	Duck
2003	277.357	847.744	79.206	33.863
2004	276.989	778.970	93.416	32.573
2005	278.954	811.189	84.790	32.573
2006	291.085	797.527	100.201	32.480

Source : Directorate General of Livestock (2007)

Table 3. Poultry Meat and Eggs Production in Indonesia 2003 - 2007 (000 ton)

Year	Meat				Egg		
	Native chicken	Broiler chicken	Layer chicken	Duck	Native chicken	Layer chicken	Duck
2003	298,5	771,1	48,1	21,2	177,0	611,5	185,0
2004	296,4	846,1	48,4	22,2	172,1	762,0	173,2
2005	301,4	779,1	45,2	21,4	175,4	681,1	195,0
2006	341,3	861,3	57,6	24,5	194,0	816,8	193,6

Source : Directorate General of Livestock (2007)

Climate Change: Opportunities and Challenges for Poultry Production

All changes in the world will be opportunities and challenges; will cause pro and contra reactions and so on. It is similar to climate change. There are still opportunities because of climate change for poultry farmers. World grain (including grain for animal feed) supply has been affected by severe weather conditions such as notably drought and floods those could be associated with climate change. However, change of climatic factors in some part of the world will be benefit to grow soya and maize as main feedstuff sources. Farmers can feed their poultry with locally grown soya and maize. It will reduce feed costs and reduce poultry food miles. Then, meat products may increase in price and with feed prices possibly decreasing. It is due to the potential for soya yield to increase by 10% as a result of rising CO2 levels poultry farming may become more profitable.

Another opportunity is introducing new crops and increasing crop yields due to the climate change could increase CO_2 on plants and affect CO_2 fertilization. Even though some studies found that the

effects of elevated CO_2 on plant growth and yield depend on the photosynthetic pathway, species, growth stage, and water and nitrogen management practices (Jablonsky et al., 2002; Kimball et al., 2002). Ainsworth et al. (2004) and Gifford (2004) reported that crop yields are expected to increase around 10 – 20% for C_3 crops and 0 – 10% for C_4 crops under unstressed conditions.

Besides opportunities, climate change also mean challenges for increasing poultry production and improving poultry product quality. High temperature will influence the poultry performance. Therefore, housing systems need to be managed to maintain optimal seasonal temperatures and reduce the risk of heat stress. It means increased investment in ventilation and cooling systems. High temperature decreases reproductive capacity. More dramatic events such as storms, extreme temperature increase stress and may affect productivity.

Therefore it is suggested that farmers have to reconsider building/housing design with equipment to cope extreme climate, use renewable energy to power poultry sheds, and utilize biomass boilers or anaerobic digestion of poultry litter. For Indonesian farmers, I could not optimistic that these suggestions could be applied due to farmers keep their poultry traditionally, extensively and no proper house for the poultry.

Conclusion

It is concluded that climate change have positive and negative impacts to poultry production. The climate change could be opportunities and challenges for the poultry farmers. Nutrient supply especially poultry protein depends on the poultry production but nutrient consumption is depending on our realization.

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Social Equilibrium in Consumption of Energy

SIAWUCH AMINI

Background

This papers aims at introducing some hypotheses related to the social disequilibrium on the base of current systems of energy consumption for a plenary discussion. The imbalanced energy consumption in the world is not only the source of environmental disasters and catastrophes, but in a long-term consideration a base for social conflicts and social unrest at global and national level what are the major strategies for the world energy consumption which can help to avoid the environmental pollution on the one side and help to decrease the global and regional conflicts based upon a justified energy consumption worldwide.

The bio-energy consumption seems to be a solution for the mentioned global problem. It can under certain technological condition and in a long-term perspective replace the non-renewable energy resources in many areas of the world. However, the problems do not promise a success in the next future due to limited technological possibilities on the one side and the competition of food and energy production on the other side, especially in the production of biomass.

"…where ever we look at and what ever we observe, we face the same dichotomy: the development of new techniques and tools, which are potentially promising to solve the ecological problems of our time and bring the balance to our social activities on the planet on the one hand and the disabilities of our organized social institutions to use those techniques and tools in such a way to be operational… on the other hand". This is what Guattari, used to say some 15 years ago (Guattari, 1994; P. 71).

Fossil energy consumption

The table below shows the importance of the energy sources. According to the US Energy Information Administration's 2006 estimate, the estimated 471 EJ total consumption in 2004 was divided as follows, with fossil fuels supplying 86% of the world's energy:

Table 1: The importance of energy sources

Fuel Type	Average power in TW	Energy/year in EJ
Oil	5.6	180
Gas	3.5	110
Coal	3.8	120
Hydroelectric	0.9	30
Nuclear	0.9	30
Geothermal, wind, solar, wood	0.13	4
Total	15	471

The table shows that still the major energy consumption relay on fossil energy. The geothermal, wind, solar and wood energy together are about 1% of the whole energy consumption. What are the reasons for the small share of this kind of energy to the total energy consumption in the world (Technical; Derivates from fossil energy in chemical and pharmaceutical industry, economical: costs of production of one unit of energy with different resources, social: access to energy and consumoption and political indicators)?

There are more than three reasons that make the consumption of energy a subject to critical issue:

Definitions

EQUILIBRIUM is the specification of a system to recur to a dynamic stability due to disturbances affected by external factors, taking simultaneously changes of the system into Consideration.

SOCIAL EQUILIBRIUM is the sustainable appropriateness and function of a care system in a society to provide food shelter and income for people (Levi, W.)

The approach is to achieve a co-evolutionary process of the protection of the resources on the one hand and care for the appropriate satisfaction of the needs of people on the other hand.

The co-evolutionary process however remains an utopia if the process goes after the same pattern of economy and the appropriate technical changes in terms of utilization of safe bio-energy do not take place in the next future.

The following figure demonstrates the issues of stability on the base of current international discussions.

- *Stability of resources, especially non-renewable energy resources (Oil, Gas, coal, nuclear…)*
- *Environmental stability (environmental pollution) by externalities, specific and general effects*

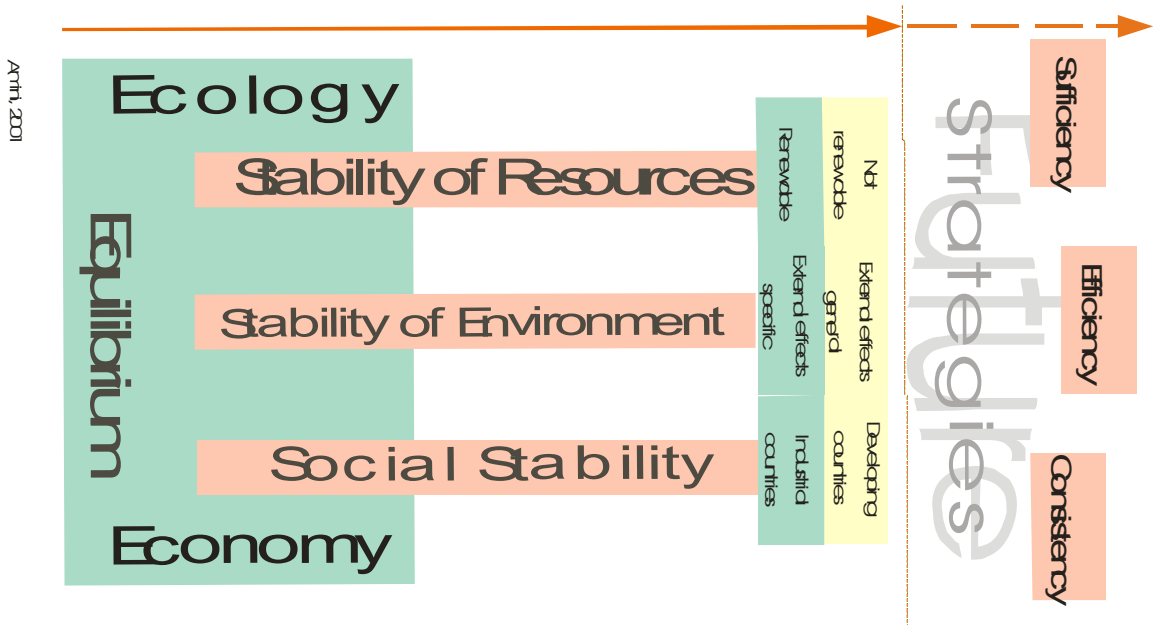

Figure 1: Social stability in terms of energy consumption and distribution.

1. Stability of Resources:

All organisms need a permanent flow of energy for survival. Since the man has left the natural conditions, the ecological conditions have change dramatically and irreversibly. The cultural revolution has increased our distance to the perspective of social equilibrium in terms of consumption of non-renewable resources. The forest has historically delivered a concept of equilibrium since many centuries and has given us the feeling of security in future technological possibilities. However, since seventies (Limits to Growth) we are aware of the limitations to the transfer of forest conception to other resources. Even in case of solar energy which is an infinite energy source the results are not encouraging, although great progress in this regard has been made. For a 1000 Mw- energy production, we need collectors on an area between 25 and 100 km^2 with

corresponding materials and costs. Water and wind energy are infinite resources, but the technological problems have remained unsolved by permanent increased need for energy.

In 2005 nuclear power accounted for 6.3% of world's total primary energy supply. The nuclear power production in 2006 accounted 2,658 TWh (23.3 EJ), which was 16% of world's total electricity production. In November 2007, there were 439 operational nuclear reactors worldwide, with total capacity of 372,002 MWe. A further 33 reactors were under construction, 94 reactors were planned and 222 reactors were proposed.

The utilization of non-renewable energy sources and in this case the nuclear energy has remained an interesting option: It is assumed that under certain conditions the utilization of nuclear energy (utilization of U-238) even for the next 1000 years is secure. The major problem here is the so called "nuclear Waste Management". At the moment the level of technology does not allow an adequate solution to this problem.

Table 2: Energy Budget of different country categories

Region	Energy Consumption (Quadrillion Btu)				Carbon Dioxide Emissions (Million Metric Tons Carbon Equivalent)			
	1990	1999	2010	2020	1990	1999	2010	2020
Industrialized Countries	**182.7**	**209.7**	**246.6**	**277.8**	**2,849**	**3,129**	**3,692**	**4,169**
EE/FSU	**76.3**	**50.4**	**61.8**	**73.4**	**1,337**	**810**	**978**	**1,139**
Developing Countries	**87.2**	**121.8**	**184.1**	**260.3**	**1,641**	**2,158**	**3,241**	**4,542**
Asia	51.0	70.9	113.9	162.2	1,053	1,361	2,139	3,017
Middle East	13.1	19.3	26.3	34.8	231	330	439	566
Africa	9.3	11.8	15.7	20.3	179	218	287	365
Central and South America	13.7	19.8	28.3	43.1	178	249	377	595
Total World	**346.2**	**381.9**	**492.6**	**611.5**	**5,827**	**6,097**	**7,910**	**9,850**
Sources: **1990 and 1999:** Energy Information Administration (EIA), *International Energy Annual 1999*, DOE/EIA-0219(99) (Washington, DC, February 2001). **Projections:** EIA, World Energy Projection System (2002).								

International Energy Outlook 2020

World Energy Consumption and Carbon Dioxide Emissions by Region, 1990-2020

2. Environmental Stability:

Even if we assume that the environmental pollution remain constant (in reality it must decrease to 50%), we would need a 60% reduction of the carbon-dioxide-emission (IPCC), a 70% reduction of N_2O, and an 80% reduction of SO_2, NO_x and NH_3. In case of duplicated population growth until 2050 (UN) and a four times increased need for energy consumption, we would need a 90% sacrifice of consumption until 2050 and in order to achieve a social equilibrium.

It is evident that this can not be achieved easily. The increased hunger, pollution, climate change effects and catastrophes in different areas of the world give us a poor perspective of future if we do not react radically.

3. Social Stability:

The major aspect of social equilibrium can be analyzed in terms of "equitable Development". Levi (95) raises the question of the "global Social Stability", which means the adequateness of a care system of resource bases of a society. Social stability refers to a minimum quality standard of life which is required to avoid social instability, social injustice and prevent social hardness and due to these to prevent the social revolutions. As the same time social stability is the guarantee for the development of democratic situation.

The achievement of a social harmony is only possible if the historical realities in the area of social conflicts and a justified distribution of the resources which are technically available in the time have been taken into consideration.

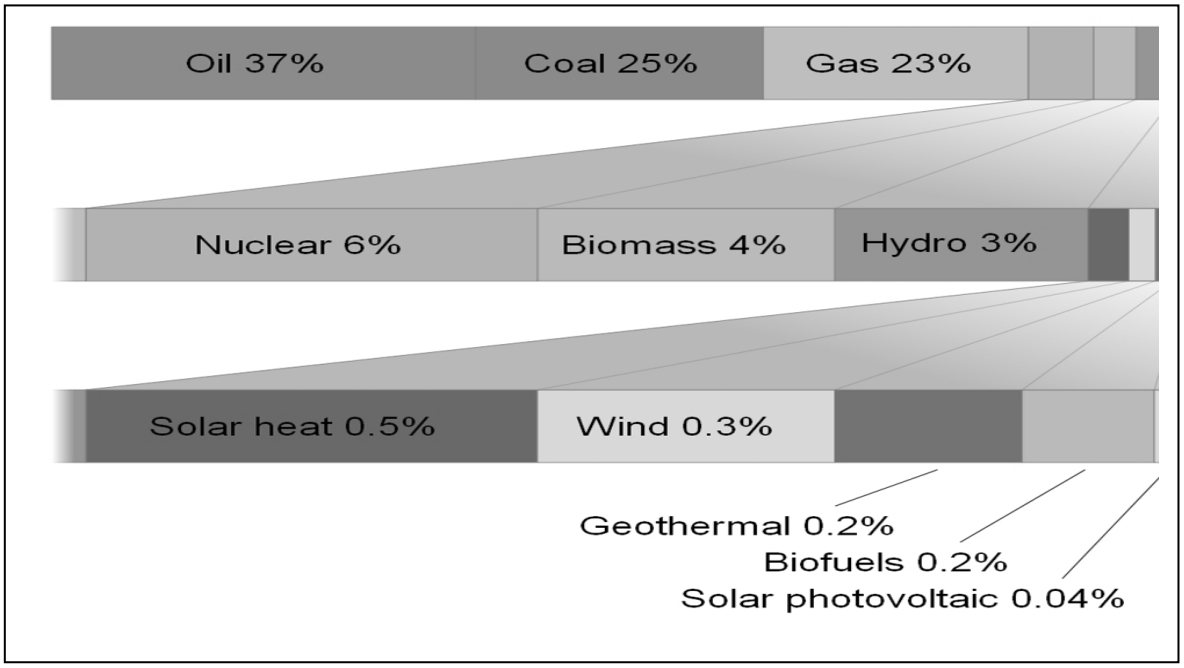

Figure 2: Different levels (%) of energy consumption

The annual global primary need for energy which is about 15 Terawatt (1 TWA=10^{16} Watt hours) must grow to 45 TWA in order to avoid social conflicts. This is a calculation by keeping the current imbalance of the global energy consumption in different geographical regions (per capita energy consumption is about 250 kWh in Ethiopia, about 75.000 kWh in USA and about 42.000 kWh in European countries).

The debates are not focussing on energy resources which are limited anyhow, but in relation with the increasing of the world population.

At the moment more than 1 Billion people consume annually and per capita less than 1000 kWh energy which is below the minimum of living standard. The population of China which is one fifth of the world population used around 90ies about 6000 kWh which has increased at the double size – if not more -since the economic boom in this country. It is still at the level of 35% of European p.a. energy consumption. India with another fifth of the world population consumes annually and p.c.about 3000 kWh energy.

If we assume the energy consumption at the level of 25% of the current European standard (10000 kWh) worldwide and assume the current existing distribution, we hypothetically will need three times more energy in the world to achieve the social stability.

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CLIMATE CHANGE, UNIVERSITY EDUCATION AND GERMAN ALUMNI NETWORKING IN THE DEVELOPING TROPICS

IGN-TTRC
Indonesian-German Network for Teaching, Training and Research Collaborations - Biodiversity

WOLFGANG NELLEN, DOREEN MEIER, SUSANNE JUNK

Abstract

Indonesia's wealth in biodiversity could be a main resource of income for the country. Though the human capital and the intellectual capacity by education are available, it is still difficult to make appropriate use of the natural resources. The IGN-TTRC-Biodiversity aims at implementing improvements on the levels of high school teaching, university training and research efforts by collaboration.

Background

The importance of biodiversity is insufficiently recognized. Not only the conservation of ecosystems that have substantial effects on the climate has to be considered, the conservation of species has an ethical value by itself and will help to understand evolution and the origin of life. On the practical side, biodiversity harbors a huge amount of biological information that may be used for the benefit of human kind. With every species that is lost, part of this valuable information may disappear forever. Indigenous understanding of medical, agricultural or other uses of natural products is available but mostly stored in traditions. Developed countries begin to exploit this knowledge by bioprospecting. To obtain a fair share from potential revenues generated by bioprospecting, legislation has implemented rules on how to deal with the ownership of natural products, may it be plants, microorganisms etc. In the end, income from the mere presence of e.g. a plant in Indonesia will be marginal in comparison to marketing a product. It should therefore be a long term goal to foster research and development in the country in order to participate appropriately in the profits.

Even though Indonesia has the intellectual capacity, it has not yet reached the point to pursue research and development activities on a broad scale. Consequently, the country is not in the

situation to negotiate with foreign research institutions and companies on an equal level. We have identified several areas where efforts are required and, if appropriately implemented, promise substantial improvements.:

1. there is a lack of young students who are aware that biology is a hi-tech interdisciplinary science of utter importance. Biological sciences lack prestige and there is insufficient incentive to work in this field.

2. training of young scientists has to be improved, concentrating on interdisciplinary education including e.g. physics, chemistry, bioinformatics in addition to the traditional and modern biology subjects.

3. connections to German researchers have to be improved in order to better exploit the options for obtaining additional qualifications in German research institutions and universities (e.g. PhD projects).

4. returning young scientists should be clustered and organized in research networks according to their expertise in order to improve research productivity.

5. productive Indonesian research groups have to participate in national and international science networks to improve chances to successfully apply for international grants in cooperation with e.g. German partners.

6. productive Indonesian research groups should produce small spin-off companies that act as start-ups for development and commercialization of products e.g. from bioprospecting.

7. cooperation between local spin-off companies and Indonesian as well as foreign (e.g. German) research institutions will eventually lead to primary products, improve self-confidence, expertise and the options to negotiate on research and development with companies on an equal level.

Centralized as well as decentralized measures are required to reach these goals. The IGN-TTRC is, so far, a small initiative that may provide a humble contribution but may also act as a crystallization point to initiate and foster further action.

Though small and supplied with very limited funds, the IGN-TTRC attempts a comprehensive approach on all levels noted above. At this point, Science Bridge, an NGO dedicated to science education on the high school and undergraduate level, is organizing the IGN-TTRC and carrying out most of the activities. Science Bridge is based at Kassel University, Germany and has more than 10 years of experience in teaching and training molecular biology, biochemistry and related disciplines at schools and universities. Science Bridge is connected to other teaching and training

labs in Germany and in Europe. It is a member of several teaching and training networks and plays a substantial role in some scientific societies in Germany. By its close association to the genetics department at Kassel University, Science Bridge has excellent contacts to researchers in the field of molecular biology, genetics, biochemistry, biophysics and bioinformatics in Germany and abroad.

1. Improving awareness of life sciences at high schools

Science Bridge has long standing experience in teaching practical courses in modern biology at high schools. Experiments have been established that can be carried out with groups of up to 24 high school students either in the university laboratory or in the class room. Lab protocols, PowerPoint presentations and further teaching material can be made available in English. Indonesian collaboration partners are required to help with translations into Bahasa Indonesia. Biological material like bacterial stocks will be supplied. Depending on the experiments that are included into the program, equipment in the range of 6.000€ to 20.000€ will be required. Running costs per course are in the range of 100€ for up to 24 participants. Science Bridge will carry out training courses in Indonesia (training of trainers) whenever possible. So far, such courses have been offered in Manado, Padang and Jakarta. In the future, Science Bridge will support partner universities to obtain funding for equipment. Partnership with local schools is encouraged.

We believe that bringing high-tech experiments to schools will make students aware that biology is a demanding interdisciplinary science that is worth to pursue. We expect that more excellent students will enroll in the biology curriculum at universities and provide a more solid basis for the further steps of the IGN-TTRC program.

2. Improved training of university students

German students frequently consider biology as “soft science” in contrast to physics and chemistry. Exceptional high school students preferentially study the latter two subjects because they believe they are more demanding. We believe that the situation in Indonesia is not much different. Therefore, the university curriculum should make clear from the beginning that biology is traditionally an interdisciplinary science that requires field work, biochemistry, biophysics, bioinformatics and molecular biology. The technical aspects of all sub-disciplines should be pointed out. Science Bridge experiments mentioned in topic 1 can be easily adjusted to the undergraduate level and provide lecturers with teaching material. According to the requirements of the curriculum, experiments may specialize on molecular biology, bioinformatics, biochemistry or cell biology. The experimental concept is designed in a way to connect various sub-disciplines of biology and to emphasize its interdisciplinary nature. Laboratory equipment in the upper range of

that mentioned in topic 1 is required. To increase experimental options and to provide first possibilities for research projects, equipment worth 30.000 to 40.000€ would be desirable.

We expect that more students with a high intellectual potential could be recruited to the biology curriculum. Contact with demanding scientific work and first research experience should motivate students and increase their interest to later contribute to research and development in life sciences.

3. MSc extension / PhD preparation program

Indonesia has a huge number of very divergent universities. Each of them probably has highly talented students some of which may not be recognized. Successful and motivated students frequently seek for further education e.g. a PhD degree abroad. Though many of them are undoubtedly qualified, their training is not always equivalent to European standards. In Germany as well as in other European countries it is extremely difficult to evaluate applicants from the distance. Some research institutions and universities have a "good name" and applicants from there may have better chances. The lack of insight into the Indonesian university system, the lack of personal contacts between faculty in Indonesia and in Germany and the problem to identify excellent students substantially reduces the acceptance of Indonesian applicants for PhD student positions in Germany.

A jointly developed and executed MSc extension /PhD preparation program could simultaneously solve the problems: heterogeneity of education in different universities can be adjusted, by joint teaching and training, Indonesian and German faculty gain insight into education standards, mutual trust and personal contacts. More consistent evaluation standards will be established to identify excellent students and last but not least, students in the program are exposed to European teaching and training methods that they have to face when accepted in a European PhD program.

The concept of the MSc extension/ PhD preparation program is to set up two consortia: one of Indonesian universities and one of German universities. Jointly, these will prepare a one year curriculum that will be taught by lecturers from both countries. A central facility (university or research institution) in Indonesia will be chosen as a location for the program. Excellent MSc students from the participating universities will apply for the extension program and the approx. 30 best will be selected. After the one year curriculum we expect that at least half or more of the students will qualify for PhD studentships or stipends in the participating German universities or in other German institutions.

4. Support of returning scientists

When young scientists who revived their PhD or similar advanced training in Germany return to Indonesia, it is of high importance to put their acquired expertise into action. They need financial and infrastructural support as well as the integration into an active scientific community. Clustering returning scientists in groups of similar or complementing expertise is difficult due to the Indonesian science system (young scientists are obliged to return to their home institution). Exchange contracts between Indonesian institutions and networks of returning scientists may partially solve the problem. An additional advantage of clusters of expertise would be the efficient use of funds: four or five young researchers can jointly use lab equipment thus saving costs and, at the same time having more and better instruments available. In conjunction with topic 2 and 3, these local research groups will have motivated students available that can participate in and contribute to the research projects. In collaboration with the DAAD, it is the aim of the IGN-TTRC to help establish such groups, provide support in grant applications and maintenance of connections to German research institutions. University research has a relatively low reputation in Indonesia and the income of scientists is low in comparison to their education and their potential impact on society. The WUSKI program will provide returning experts with topping-up salaries to give an incentive for application of the acquired knowledge.

5. Participation in national and international research consortia

The successful establishment of expert groups will enhance scientific productivity and make Indonesian researchers more attractive for collaborative projects. So far, many collaborative projects are not working on equal level: Indonesian partners supply material, research areas (e.g. nature reserves) and local infrastructure while a substantial part of the high technology investigations are carried out in the institutions of the foreign partners. It is the aim of the IGN-TTRC to shift more and more of the technology and the expertise for sophisticated research to Indonesia. This should improve independence and increase the contribution (and thus the shared profit) of the Indonesian partners.

Though basic research has high priority to provide a solid foundation for future applied science, formation of small spin-off companies should be encouraged. Business in the life science sector has so far been neglected in Indonesia and there are immense opportunities to establish a national market. The IGN-TTRC will seek for support on the governmental level in Germany and Indonesia to establish SMEs (small and medium sized enterprise) in Indonesia.

Conclusions

A broad, multi level approach is required to improve expertise, capacity and research activities in life science in Indonesia. Since the intellectual resources are available and attractive projects are just waiting to be tackled, a major task will be to focus and coordinate the expertise. Simultaneously, the significance of life science, exemplified by biodiversity within the country, should be emphasized in order to maintain and increase know-how and

expertise. Considering competition with more developed countries, Indonesia will not be able to market complete products from e.g. bioprospecting on a short-term schedule. However, by intelligent approaches, intermediate products could be developed and provide a basis for entering the international market. Now is the time to establish the scientific infrastructure that is required to achieve these ambitious goals.

A Decade of Alumni Networking - A Unique Success Story

INGRID HOWE

Background

Networking has become tremendously important in recent years. Information and communication technology has been developed to a world-wide key technology. This technology makes efficiency and cost reduction in economy, extra-school learning and the creation of new ideas in almost all areas of life possible. Networking enables access to many kinds of information independent from its location. The digital revolution will continue and influence economy, society and education in the near future.

Rapid increase of the number of programs in universities concerning alumni-networking is remarkable in the last decade. German universities are systematically establishing institutions for maintaining contact with their graduates. Concern has grown rapidly about graduate employment and work in European countries as well. At the same time, the number of surveys on graduates employment and work has increased substantially. In the European Journal of Education (Vol. 35, No. 2, June 2000), a selected number of such surveys about different European countries has been published.

Alumni Networking

Since 1999, DAAD has financially supported German Universities to organize, establish and execute systematically alumni networks of the former graduates from German Universities coming from abroad. For this reason, the Centre for Tropical and Subtropical Agriculture and Forestry (CeTSAF) of the University of Göttingen, the Institute for Socio-cultural Studies, University of Kassel - Witzenhausen (ISOS) and the Institute for Cooperation in Developing Countries (ICDC), University of Marburg have established a consortium to organize symposia – cum – workshops in the Egypt- Arab –Region, South-East Asian Region and Latin America with their alumni.

The main objectives of these symposia are

- To establish and maintain a database of German Alumni
- To facilitate the exchange of ideas and scientific experience between scientists from the region and German scientists and to secure long-term contacts between German universities and higher education institutions in the region;
- To establish a mutual alumni network in institutions of higher education in the region.

The establishment and the execution of the professional alumni network in the above mentioned regions was based upon the existing data base on the graduates from the Universities of Göttingen and Kassel – Witzenhausen as well as Marburg. This includes the up-dating the data and improvement of scientific exchange and communication between graduates and their German partners via organisation of professional seminars and symposia.

Corresponding follow-up meetings have taken place in Cairo 1999 and 2001, in St. Catherine and Bogor 2000, in Los Banos 2001 and in Peru 2001, in Vietnam and Monterrey 2002. In all these symposia the themes of the scientific conference were formulated in such a way as to enable interdisciplinary and problem-oriented contributions and discussions among the alumni from different countries, universities and disciplines. Furthermore, the scientific symposia were established to enable interdisciplinary groups to co-operate in establishing and maintaining of alumni-networks. During the symposia, questionnaires were distributed among the participants to be filled in to support databases and collect information about the career planning of the alumni.

Practical Experiences of Networks

The regional Alumni-Networks have started as emergent networks. At a policy level, DAAD together with the host universities were interested to clear up whether it is possible to plan strong alumni networks in a complex system of graduates from German Universities in different regions of the world. For the graduates from German Universities, the establishment of the above mentioned networks were opportunities to define individual interests of the alumni at an emergent node level. The “invisible hand” of DAAD and the Consortium (CGKM) cared for the establishment and maintenance of the regional networks for now exactly 10 years. During those years following Networks were established in different regions (Fig. 1)

Figure 1. Alumni-Network Regions of the Consortium of the Universities Göttingen, Kassel and Marburg

Egypt – Arab Region:

GEAR: Germany – Egypt – Arab Region Alumni Network

Southeast Asia:

SEAG: Southeast Asia – Germany – Alumni – Network

Latin America:

ReCALL: Red Científica Alemania-Latinoamérica

Iran:

GIAN: German-Iranian Alumni – Network

East Africa:

REAL: Regional East-African Alumni Network

Since 1999:

- About 1800 Alumni participated in international conferences and meetings
- About 600 papers were presented in those meetings
- 450 presented papers were published in 22 proceedings
- About 70 German experts accompanied the conferences
- About 30 PhD-Candidates were submitted
- About 650 were members of the established Listserv

(see tab. 1)

Table 1: Data-base and estimated members of Listserv

Network	Database of Network	Estimated Members of Listserv
GEAR	541	122
GIAN	726	180
ReCALL	180	130
SEAG	324	210
total	1771	642

The Concept of the Alumni-activities

A dual conception of the Symposia-cum-Workshops has been developed by the Consortium to make the achievement of the all over goal possible. This conception implies the exchange of scientific exchange via conferences with interdisciplinary topics common to the Alumni with the disciplinary, culturally and regionally diverse approaches. Furthermore, the Alumni-networking conception tries to improve the establishment of local networks by using different tools, like the Newsletters, publications, scientific cooperation, establishment of an information system via homepage and internet and finally establishment of local offices.

One of the most important functions of the first established alumni networks was to open an atmosphere of mutual trust in partly extra-ordinary affected scientific communities by radical distrust (e.g. Iran; Armenia…). Only on the base of years of patiently and carefully organized meetings on the base of trust, the new quality networks was achieved

However, we could generally criticize that in those networks the nodes were cognitive structures but also social structure. They were emergent in the sense that they were not programmed and managed – although negotiated through explicit and implicit power- at the node but at the system level. The management in this context was rather to achieve improvement of efficiency and efficacy at the cognitive and system level than at the rational choice level of participants and graduates.

Independent from this critical approach the regional networks were the real bases for starting a different layer of the networks on the base of intended programmatic and leaving the level of important but not necessarily sustainable triviality of the regional networks.

The new layer of quality was intended and managed differently. In case of **REAL** (Regional East African Alumni-Network), **GIAN** (German-Iranian Alumni-Network) and in the meanwhile a series of subject-oriented networks, like **GAInBiNet** (German International Biodiversity Network, **GAFooN** (German Alumni Food Network), **GAForN** (German Alumni Forest Network), **GAENSAR**(German Alumni Ecosystem Network in Arid and Semi-Arid Regions) and a number of mini-workshops, the focus was to achieve a rational choice of the actors (Alumni) as selected groups with special interests and with active involvement and empathy. The new quality could partly mobilize potential of actors in the frame of transaction theory.

The transformation from the general Alumni Networks to specific subject-oriented sub-networks shows the achievement of a layer that is not only based upon the rational choice of the participants but also based upon a new quality of communication between and within the networks and University Leaders and German partners, and finally the DAAD.

Facts about the Alumni-Network-Conferences and Topics

No	Year	Network	Event	Topic
1	1999	GEAR	Symposium cum Workshop	Egypt, Cairo: Sustainable Agriculture and Rural Development in Egypt
2	2000	GEAR	Symposium cum Workshop	Egypt, St. Catherine: Egyptian Agriculture in the Future: Challenge for Science, Economy and Society
3	2000	SEAG	Symposium cum Workshop	Indonesia, Bogor: Sustainable Development in Context of Globalization and Locality: Challenges and Options for Networking in Southeast Asia
4	2001	DAAD / CeTSAF	Symposium cum Workshop	Costa Rica: Aus- und Weiterbildung lateinamerikanischer Fach- und Führungskräfte und nachhaltige Entwicklung: Herausforderungen und Chancen für regionale und überregionale Zusammenarbeit
5	2001	SEAG	Symposium cum Workshop	Philippines, Los Banos: Resource Management: Private Public Partnership and Knowledge Sharing
6	2001	DAAD / SEARCA / CeTSAF	Symposium cum Workshop	Philippines, Los Banos: The Role of DAAD-SEARCA Fellows in Poverty Alleviation
7	2001	GEAR	Symposium cum Workshop	Egypt, Cairo: Environmental Pollution in Egypt: Consequences for Humans, Animals and Plants
8	2001	ReCALL	Symposium cum Workshop	Peru, Lima: Environment and Sustainable Use of Natural Resources in Latin America: Challenge for Interdisciplinary Co-operation
9	2002	SEAG	Symposium cum Workshop	Vietnam, Hanoi: The Role of Dialogue and Networking: From a Transitional to an Industrialized Society
10	2002	ReCALL	Symposium cum Workshop	Mexico, Monterrey: Resource Utilization: Globalization and Local Structure
11	2003	GEAR	Symposium cum Workshop	Jordan, Amman: Interdisziplinärer und interkultureller Dialog: Chancen für gemeinsame nachhaltige Entwicklung
12	2003	SEAG	Symposium cum Workshop	Thailand, Chiang Mai: Food Security and Sustainable Resource Management in a Market Economy - Challenges and Options

No	Year	Network	Event	Topic
13	2003	ReCALL	Symposium cum Workshop	Brasil, Recife: Globalization and Poverty - The Role of Science
14	2003	GIAN	Symposium cum Workshop	Iran, Teheran: Sustainability of Resource Utilization: Globalization and Local Structures
15	2004	ReCALL	Symposium cum Workshop	Talca, Chile: International Scientific Co-operation in Higher Education: Participation, Partnership and Perspectives
16	2004	GIAN	Symposium cum Workshop	Iran, Isfahan: Towards Sustainable International Cooperation in the Field of Environment, Human Resources Development and Higher Education in the Era of Globalization
17	2004	SEAG	Symposium cum Workshop	Cambodia, Phnom Penh: The Role of German Alumni in Rural / Regional Development and Entrepreneurship
18	2004	All Networks	Summerschool	Germany, Göttingen - University of Kassel-Witzenhausen, Germany CGKM Alumni Summer School 2004 Excellency in Organisation and Execution of International Alumni Network
19	2005	GIAN	Symposium cum Workshop	Iran, Rasht: Environmental Pollution: Regional and Global Co-operation on Monitoring, Management and Abatement Strategies
20	2005	SEAG	Symposium cum Workshop	Indonesia, Jogjakarta: (In-) Equity and Development: The Role of Science and Technology
21	2005	GEAR	Symposium cum Workshop	Syria, Homs: Future of Agriculture in the Arab Region: Challenge for an Environmentally Friendly and Sustainable Agriculture and Veterinary Medicine
22	2006	GEAR	Symposium cum Workshop	Egypt, Luxor: Sustainable Food Security and Environmental Protection
23	2006	ReCALL	Summerschool	Germany, Göttingen: Information Requirements for the Sustainable Management of Renewable Natural Resources
24	2007	GIAN	Symposium cum Workshop	Iran, Tehran: Higher Education and Development in Knowledge Based Society: Towards Enhancing Quality and Relevance in Medical & Professional Education
25	2007	ReCALL	Symposium cum Workshop	Bolivia, La Paz: Sustainable Rural Development of Uplands in Latin America

No	Year	Network	Event	Topic
26	2007	GIAN	Winterschool	Germany, Göttingen: Quality Assurance in Higher Education: Preconditions for an Effective Cooperation & Collaboration between Iranian and German Universities
27	2008	GIAN	Symposium cum Workshop	Iran, Tehran: Knowledge Management in Higher Education: Entrepreneurship Universities
28	2008	ReCALL	Symposium cum Workshop	Ecuador, Quito / Riobamba: Biodiversity and Global Change in Latin America
29	2008	GAForN	Symposium cum Workshop	Malaysia, Kuala Lumpur: Close to Nature Forestry - Practices for Asia-Pacific Towards the Millennium Development Goal Challenges
30	2008	GAINBINet	Summerschool	Germany, Göttingen: Managing Biodiversity in Developing Countries, alle Netzwerke, Gründung des Biodiversitäts-Netzwerkes
31	2009	GAFooN	Symposium cum Workshop	Costa Rica, San José: Global Changes and the Impact on Food Security and Food Safety in developing countries
32	2009	GAINBINet	Symposium cum Workshop	Mexico, Merida: Biodiversity and Climate Change: Adaptation of Landuse Systems
33	2009	GAForN	Summerschool	Germany, Göttingen: Future Forestry: Reconciling Competing Demands and Meeting the Challenges of Global Changes
34	2009	GAForN	Symposium cum Workshop	India, Dehradun: Multi-Purpose Forestry: Managing and Enhancing Ecosystem Services and Production Functions of Forests, Woodlands and Trees Outside the Forests
35	2009	All Networks	Summerschool	Germany, Göttingen and Hamburg: Tropentag 2009 - Conservation and Management of Biodiversity in the Tropics

Alumni- Communication and News

Regional Alumni Network

www.alumni-network.de
www.tropenzentrum.de

Mailing-Lists (listserv):

GEAR

GIAN

ReCALL

SEAG

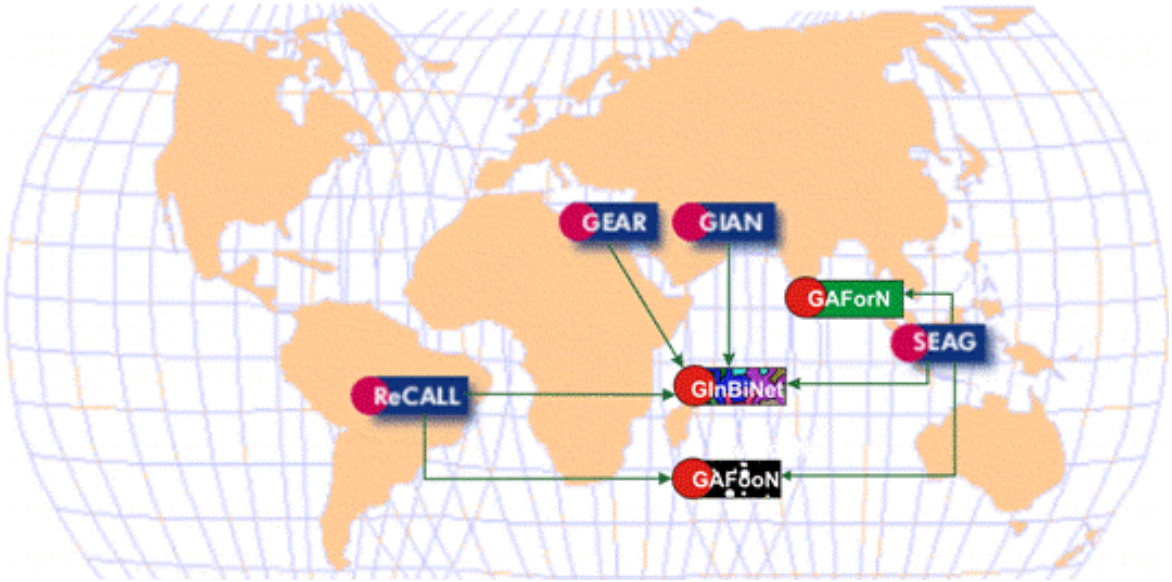

Figure2: Alumni-Network Homepage; www.alumni-network.de

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