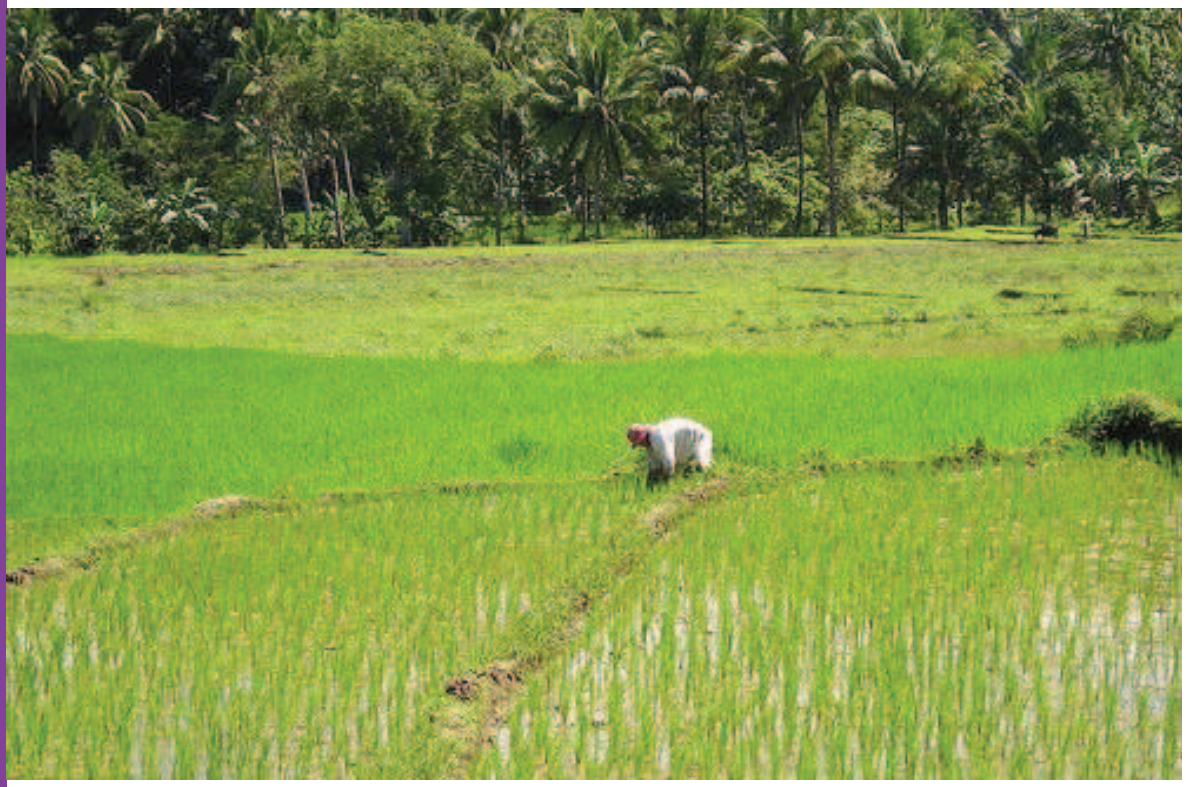
Proceedings

PROCEEDINGS OF THE 10TH INTERNATIONAL CONFERENCE OF THE EAST AND SOUTHEAST ASIA FEDERATION OF SOIL SCIENCE SOCIETIES

Soil, A Precious Natural Resource: Agricultural Ecosystems, Environmental Health & Climate Change

October 10 – 13
Cinnamon Lakeside Hotel
Colombo, Sri Lanka



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Soil, A Precious Natural Resource: Agricultural Ecosystems, Environmental Health & Climate Change

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Soil Science Society of Sri Lanka

Papers and posters presented
at the 10th International Conference of
the East and Southeast Asia Federation of Soil Science Societies
Cinnamon Lakeside Hotel
Colombo, Sri Lanka
10-13 October 2011

ISBN 978-955-8124-13-0

Published by:
Soil Science Society of Sri Lanka
P.O. Box 10, Peradeniya
Sri Lanka
e-mail : soilscisoc@gmail.com; web : http://www.ssssl.org/

Printed by:
Audio Visual Unit
Department of Agriculture
Peradeniya
Sri Lanka

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LAND DEGRADATION AND ECOSYSTEM RESTORATION IN INDONESIA

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Introduction

Rapidly increasing population over the last several decades, especially in the developing countries, bring about strong pressures to their natural resources. With inadequate inputs in agriculture, both technological and management, land degradation occurs rapidly and hampered ecosystem functions and quality of land resources. The same degradation phenomenon is taking place not only in terrestrial land, but also in wetland and marine ecosystems.

Indonesia is a huge archipelago that has quite diverse natural resources with many unique ecosystems. Recently, environmental degradation turned out to be very important issue as indicated by increasing intensity and extent of flooding and landslides during rainy seasons; drought, decreasing land productivity and forest fire during dry seasons; increasing loss of biodiversity of forests, agricultural lands, wetlands, mangroves, and right down to the marine ecosystems.

Efforts have been made to conserve and to restore the ecosystems for sustaining the function of ecosystems in supporting living organisms, including the human being. However the results are yet not significant. Therefore, efforts are still needed to be enhanced, especially in increasing law enforcement. Besides that, international collaboration, especially in research programs is essential.

This paper would like to describe the condition of Indonesian natural resources in brief, land degradation and efforts in reducing environmental degradation, including ecosystem restoration in order to have feedback for sustaining environmental management in Indonesia.

Indonesia in Brief

Indonesia, stretching from 94º 45' to 141º 05' E longitude and 6º 08' N to 11º 15' S latitude, is bordered in the west and south by Indian Ocean, in the east by the Pacific Ocean, and in the north by the South China Sea. This country is a huge archipelago extending for 4,500 km between the Asian and Australian continents. It consists of more than 17,000 islands, of which only about 6,000 are inhabited. The five main islands are Sumatra, Kalimantan, Java, Sulawesi and West Papua (formerly called Irian Jaya). Indonesian total area is about 9.8 million km^2 whereas the land area is about 1.9 million km^2 (1/5 of the total area) and the sea area, including the exclusive economic zone, is about 7.9 million km^2 (4/5 of the total area).

In general, Indonesia has a tropical monsoon type climate, featuring slight changes of seasons and temperatures, low winds, a high degree of humidity and periodically heavy rainfall. Temperatures are largely uniform throughout the year, i.e. between 22 until 27 ºC, with a uniform relatively humidity between 70 to 90 percent. The climax vegetation on this part of Indonesia is therefore a typical rainforest vegetation (FAO-UNEP, 1994).

Complexity of topography and also complexity of geology, climate and vegetation, Indonesia has various types of soils. In the order level of Soil Taxonomy, Indonesia has 10 orders, namely Histosols, Entisols, Inceptisols, Vertisols, Andisols, Alfisols, Mollisols, Ultisols, Oxisols, and Spodosols.

Various types of soils indicate that Indonesia include many type of ecosystems, because soil characteristics that determine the type of soil are the interaction results of some land ecosystem parameters. Generally, Indonesia has land and marine ecosystems, whereas the land ecosystems include wet land and dry land ecosystems. Those ecosystems could be differentiated into some sub-ecosystems. Various types of ecosystems in the tropical and humid climate of Indonesia are responsible for luxuriant vegetation of tropical rain forests containing timber and other forest products. Within the forests a large variety of epiphytes, lianas and many kinds of flowers, including the large number of orchids, various kinds of bamboo, rattan, and palm trees, etc. For the last several thousands of years, most of Sumatra, Kalimantan, Sulawesi and West Papua areas had been covered by dense and inaccessible rain forests.

The characteristic features and the high number of general and endemic species within this region make the flora of Indonesia completely different from the floras of the neighboring continents, Asia and Australia, as well as from those of topical areas. The richness of the Melanesian region of which Indonesia represents the major portion, is reflected in the accommodation of close to 40,000 species of plants or about 10 to 12 percent of the

estimated number of plant species in the world. Those tropical rain forests are home of various fauna species. According to Tobey and Dutton (2002) 12 percent of mammals, 17 percent of birds, and 17 percent of reptiles and amphibians species of the world are found in Indonesia. Unfortunately, this country is now facing harsh destruction of its natural treasuries

Land Degradation

In the terrestrial area, it is realized that the environmental balance in the tropical region is related to the conditions of landscape that determine capability of land. The land use or land-cover type should be suitable with the land capability. If it is not, the environment degradation is unavoidable.

According to the land capability classification system of Klingebiel (1958), which was based on the limitation intensity, Indonesia has various classes of land which every class has its own capability. Soepardi, (1983) indicates that only 13.4 percent (class I to IV) or about 24.9 million hectares of land are capable for agriculture with adequate additional soil technology. The class V (40.3 percent or 76.0 million hectares) could be used as agriculture land, since permanent limitation could be eliminated with special technology such as drainage improvement. If the limitation cannot be eliminated, they are only suitable for conservation forest. The remaining areas (class VI, VII, and VIII, or about 88.1million ha) are only suitable for forestry and conservation forests. If the land class V estimated could be reclaimed about a half of the area, the total forest land should be about 126.4 million ha, therefore it was realistic if the government stated in 1986 that the area of forest status was about 140.8 million ha, nevertheless this number was revised to 120.4 million ha in 2000.

Report of FWI and GFW (2001) stated that in 1997 the actual forest cover remains 98 million ha or about only 82 percent of the total forest area that has been stated in 2000, or only about 77.5 percent of total land that should be remained as forest according to the valuation of land capability. Decreasing forest cover due to deforestation is related to some activities such as logging both legal and illegal, development of industrial forest plantation, development of plantation such as oil palm, rubber, coconut, cacao etc. Conversion of forests to other land uses by neglecting land capability produces forest degradation and land degradation

Decreasing area of forest cover, increasing area of degraded forest and bare forest land affect to the water cycle in the regions, as indicated by increasing intensity and extent of flooding and drought, erosion and sedimentation. In addition, the decrease of forest cover areas also induces to change some climatic parameters. Study of Mulyanto *et al*. (2003) in the wetland area of Sumatra indicates that the annual average temperature tends increase with rates 0.067ºC and average monthly precipitation decreases considerably in the last 20 years.

Deforestation also induces forest fire, because the degraded forests are vulnerable to fire (Schindler *et al*., 1989). In Indonesia, forest fire occurred in almost all main islands Kalimantan, Sumatra, Java, Sulawesi and West Papua (formerly called Irian Jaya). Forest fire occurs in highland forests, lowland forests and wetland forest. Moreover fire does not destroy only forest area but also bushes and grasslands, plantation and agricultural areas, and wood industrial areas, with significantly large areas.

Impacts of the forest fire include the increase area of forest bare land, carbon release that contribute to the increase the concentration of CO_2 in the atmosphere, and may be also decreasing of the bio-diversity. In the case of peat land, the forest fire induces peat burning that creates peat subsidence.

Efforts on Ecosystem Conservation and Restoration

It is realized that natural resources such as soil, water and atmosphere are the most important pillars of live support system. They link up together, to develop ecosystems such as forest, mangrove, marine ecosystems etc, where these ecosystems have relationships one to another. Land degradation induces to ecosystem deterioration would reduce the supporting capacity for living organisms, including human being. Based on that consciousness, efforts on land and ecosystem conservation and restoration have been start and implemented. Efforts have been made by establishment of some government regulation. In addition universities have also play, especially in researches. Laws have been set up in order to conserve and to restore ecosystems. There have been some statutes (*Undang-undang*), government regulations (*Peraturan Pemerintah*), presidential decisions (*Keputusan Presiden*) and ministerial decisions (*Keputusan Menteri*) to manage natural resources in a sustainable manner. Besides that, Indonesia is actively joint in international convention and consensus.

All those legal aspects and activities indicate that the government has strong attention on ecosystem conservation and restoration. Although the regulations have been set up, their implementations are still need to be enhanced.

Some universities, such as Bogor Agricultural University, take a leading role in education and research in order to characterize the ecosystems and to find approaches, methods and technologies for ecosystem conservation and restoration and sustainable ecosystem management. In addition, universities also get involved in action plan for the implementation of research output and outcome. Referring to the recent conditions, where

intensity of the environmental degradation is still high, it seem that the role of the universities still requires to be enhanced, therefore international collaboration, especially in research programs is necessitated.

Conclusions

Indonesia is huge archipelago that has quite various natural resources with a lot of unique ecosystems. Recently, environmental degradation turns out to be a very important issue as indicated by increasing intensity and extend of flooding and landslides during rainy seasons; drought, decreasing land productivity and forest fire during dry seasons; increasing loss of biodiversity of forests, agriculture lands, wetlands, mangroves right down to the sea ecosystems.

Efforts have been made to limit land degradation and to restore the ecosystems for sustaining the functions of ecosystems to support living organisms, including the human being. However the results are still limited. Therefore, further action should be taken in this regard and especially on increasing law enforcement. Besides that international collaboration, especially in research programs is necessitated.

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