Proceedings of Workshop on

Environmental Protection and Regional Development

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PARTICIPANTS: Ten (10) invited faculty staffs from SLER program's partnership universities.

TIME: **1:00 pm - 6:00 pm, Monday, 21st February 2011 (Break: 2:45 – 3:00)**

- ***Presentation and Q&A***: 20 minutes. Each oral presentation is allotted **15 minutes** followed by a **5-minute** Q & A period
- ***Panel discussion***: 60 minutes

VENUE: Rm. **305**, Grad. Sch. of Env. & Inf. Sci, Bldg. 1.

ORGANIZER: Leadership Program in Sustainable Living with Environmental Risk **(SLER)**, Yokohama National University, Japan

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The workshop is a crucial part of the SLER program's short-term course training program for seven invited students from six partnership universities. The SLER program educates graduate students enrolled at both YNU and overseas partnership universities to become future environmental leaders who will take the initiative and leadership to manage environmental risks by protecting environmental & natural resources and contributing to regional development in the developing nations in Asia and Africa.

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Leadership Program in Sustainable Living with Environmental Risk

YNU 横浜国立大学
YOKOHAMA National University

TIME	NO.	OPENING/PRESENTATIONS	PAGE
1:00-1:05		Opening (*SLER Academic Staffs*)	
1:05–1:25	1	**Identifying Biodiversity Hotspots in Northern Thailand** ***Dr. Yongyut Trisurat with Dr. Damrong Pipatwattanakul*** Kasetsart University, **THAILAND**	**1-11**
1:25–1:45	2	**The Media and Environmental Risk in Malaysia** ***Dr. Nik Norma Nik Hasan*** Universiti Sains Malaysia, **MALAYSIA**	**12-22**
1:45–2:05	3	**Soil Biodiversity Approach for Reducing Land Degradation** ***Dr. Ainin Niswati,*** University of Lampung, **INDONESIA**	**23-30**
2:05–2:25	4	**Model of Zero Waste System on Small Scale Tapioca Industry** ***Dr. Udin Hasanudin***, University of Lampung, **INDONESIA**	**31-39**
2:25-2:45	5	**Does Economic Growth Conflict with Environmental Health?** ***Dr. Roberto Rañola,*** University of the Philippines Los Baños, the **PHILIPPINES**	**40-45**
2:45–3:00		**Break**	
3:00–3:20	6	**GIS-based Risk Mapping and Assessment Framework of the Laguna Lake Watershed Region in the Philippines** ***Dr. Rogelio N. Concepcion, PhD*** University of the Philippines, the **PHILIPPINES**	**46-53**
3:20–3:40	7	**Assessment of GMOs** ***Dr.Samuel Kiboi,*** Universty of Nairobi, **KENYA**	**54-64**
3:40–4:00	8	**Addressing the Failures of Public Policy by Passing to a Non-Hierarchical Coordination System Through Taxation and Education: The Case of Forest Resources Management in Madagascar** ***Dr. Bruno Ramamonjisoa,*** University of Antananarivo MADAGASCAR	**65-71**
4:00-4:20	9	**Geology and Mineral Resources in Madagascar: The Environmental Impacts of their Exploitation** ***Dr. Raymond RAKOTONDRAZAFY*** University of ANTANANARIVO, **MADAGASCAR**	**72-78**

Soil Biodiversity Approach for Reducing Land Degradation

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Abstract: Indonesia is one of the most important areas of tropical forests worldwide that have great potential for the future development of agriculture. However, most of these soils have low inherent fertility and many have become degraded. Land degradation has been a problem because of its adverse impact on agronomic productivity, the environment, and its effect on food security and the quality of life. Factors affecting the degradation are agricultural activities, deforestation and removal of natural vegetation, over-exploitation of vegetation for domestic use, overgrazing, and industrial activities. Productivity of soil decrease because of lack of physical, chemical, and biological properties of soil. One of important approach that can be done is by biological management such as, utilization of plant biomass either as mulch or mixed into the soil, reduce tillage, cover crop, or crop rotation that can enhance soil biodiversity. Soil biota is powerful for many kind of agro ecosystem process such as chemical engineers, biological regulators, and ecosystem engineers. Moreover, soil biodiversity will service many things in below and above ground such as soil structure, soil organic matter and fertility, regulation of carbon flux and climate control, regulation of the water cycle, decontamination and bioremediation, pest control, and human health.

Key Word: Agriculture ecosystem, land degradation, Indonesia, soil biodiversity

Introduction

Indonesia has a large upland area of about 79 million ha, most of which is distributed in the islands of Sumatera, Kalimantan, Sulawesi, and Papua. However, a large part of the land available for agricultural expansion has highly weathered soils, dominated by a 1:1 type clay with a low cation exchange capacity and a high oxide content. They have a low pH (acidic), a low nitrogen, phosphate, potassium, and organic matter content (Santoso and Sukristiyonubowo, 1995). The lack of development and of appropriate farming technology has caused soil degradation, which has generally been worsened by the low economic status of most upland farmers. Land degradation has been recognized as a global problem because of its adverse impact on agronomic productivity, the environment, and its effect on food security and the quality of life. Productivity impacts of land degradation are due to a decline in land quality on site where degradation occurs (e.g. erosion) and off site where sediments are deposited. The major causes of degradation are inappropriate land use and poor management including intensive tillage and cropping system. Many efforts have been conducted for reducing land degradation in order to increase land productivity with ecological approaches. Land productivity is defined here as the capacity of agricultural lands to produce biomass on a sustainable long-term basis under the constraints of each agro ecological zone (FAO, 2003).

Although we all know that the land is very important for human life, but only the last few decades the attention of land resources, among others, consist of life in the soil and their biodiversity began to emerge, particularly in the exploration community of soil organisms, and in the search functions of each soil organisms in ecosystem processes, especially nutrient cycle (Bardgett, 2008). The soil ecologists and biologists became interested in the importance of the role and function of soil organisms and their interactions in the production of agricultural crops, plantations, and forestry. Also new today are aware that soil organisms and ecosystems are also closely associated with global climate change (global climate change). This paper presents current conservation farming techniques by approaching with development and maintained of soil biodiversity and suggests research needs for future development.

Land Degradation

The soil is a natural resource, non-renewable in the short term or very difficult to renew and expensive either to reclaim or improve following erosion by the abrasive forces of water and wind or by chemical or physical deterioration of its properties. The intense and ever increasing pressure on land and water resources throughout the world leads to land degradation and pollution, which in turn may result in decreasing biological productivity and declining biodiversity.

The factors that influence land degradation as follows: (a) agricultural activities, such as insufficient or excessive use of fertilizers, shortening of the fallow period in shifting cultivation, use of poor quality irrigation water, absence or bad maintenance of erosion control measures, untimely or too frequent use of heavy machinery, etc. degradation types commonly linked to this causative factor are erosion, compaction, loss of nutrients, salinisation, pollution (by pesticides, fertilizers), (b) deforestation and removal of natural vegetation, (c) over-exploitation of vegetation for domestic use, (d) overgrazing, and (e) industrial activities: includes all human activities of a (bio)industrial nature: industries, power generation, infrastructure and urbanization, waste handling, traffic, etc. (van Lynden and Oldeman, 1997). All above activities, removing all plants at above ground often negatively affected trophic levels of the decomposer functional food web in the soils.

As in other countries of Asia and Africa, several studies have been conducted on soil degradation in Indonesia that caused by land use changes and intensive farming practices without considering the environmental damage. Lumbanraja et al. (1998) and Syam et al. (1997) described changes in land-use in West Lampung (South Sumatra). Between 1970 and 1990, the area under primary forest decreased from 57% to 13%. In 1970, 9% of the area was under slash-and-burn agriculture but in 1990 there was no land under shifting cultivation left. Lowland coffee plantations were absent in 1970 but occupied 40% in West Lampung in 1990. In North Lampung, Imbernon (1999) described land-use changes between 1930 and 1996. Dense forest covered about 80% of the area in 1930, but no more forest was left in 1996. Most changes occurred between 1969 and 1985, following the transmigration programme and the development of agricultural plantations. The factors affecting the land used changes in West Lampung was reported by Verbist et al. (2005).

In watershed of Nopu, Sulawesi, Hidayat et al. (2008) stated that rainforest conversion into agricultural land caused soil and water loss about 3.190,5 Mg yr^{-1} and 115.441 m^{-2} yr, respectively. The phenomenon occurred in other watershed too. In Progo Sub-watershed Central Java about 69% of total research site (5,119.15 ha) highly degraded and application of stone terrace + *Setaria spacelata* grass strip on a 5 cm height dike at terrace lips + tobacco stem mulch with dose of 14 Mg ha^{-1} (Suyana et al., 2010).

In addition to land degradation caused by land use changes or agricultural practices, the acceleration of soil degradation was also caused by forest fires that often occur in Indonesia, particularly in Sumatra and Kalimantan. In detail, Stolle and Lambin (2003) reported the incidence of forest fires in four provinces and inter-annual in Sumatra Island.

Effects of Land Degradation on Productivity

Most of Indonesia's fertile mineral soils with a high base saturation and/or flat topography are already being used for cultivation. However, intensification with high dosage of fertilizers was usual for farming system with consequently increasing of production have been ‘levelling off’. Since these acid soils are highly weathered, their inherent fertility is usually very low and fragile. Successful permanent use for agriculture has so far been largely limited to tree crops, mainly rubber, oil palm, and sugarcane. Long-term use of these acid soils for annual crops invariably leads to soil degradation, as has occurred in many transmigration schemes where farmland has been abandoned and taken over by *Imperata* grass. Nutrient depletion as a form of land degradation has a severe economic impact at the global scale, especially in soil compaction is a worldwide problem, especially with the adoption of mechanized agriculture. It has caused yield reductions and also increased green house gas such as CO_2, CH_4, and N_2O.

Several scenarios can be used to reduce this environmental damage. In Sumberjaya, Lampung, Afandi et al. (1999) reported soil erosion caused by land use changed. The measurement during eleven months showed that the mixed-coffee garden produced the highest sediment yield (719.7 g m^{-2}), and the lowest sediment yield was derived from secondary forest area (0.08 g m^{-2}). The sediment yield from clean-weeded coffee system was around 93.4 – 279.7 g m^{-2} and multi-strata system indicated a low sediment yield (2.3 g m^{-2}), although mixed-coffee garden showed a very high yield of sediment, natural vegetative strips trapped 99.7% of the sediment.

Reducing Land Degradation by Biological Soil Management

Every activity in managing farmland has to be harmoniously related to the other activities. For example, the amount and type of fertilizer applied should match the soil, the cropping pattern and the kind of crop. In turn, the cropping pattern has to be adjusted to the availability of water, farm labour, and funds for investment. Therefore, there is no single soil management program that will fit all farms. The best program for a farm depends on the kind of soil, the amount of money available or allocated for farming, the level of risk the farmer is willing to take, and the knowledge and skill of the farmer. This suggests that soil management activities should be matched with crop management to achieve a sustainable integrated farming system.

Hennessy (2004) provide rotation strategy to reduce land degradation. Soil fertility can be enhanced by legume production. Incorporating cover crop organic matter residue into the soil can improve fertility and reduce erosion. Pests and diseases are important reasons for rotating. Cover crop and mulching technology can be used to increase below- and above-ground biodiversity so as resemble natural ecosystem.

For soil with highly weathered, a basic principle of soil rehabilitation is to increase the level of soil organic matter and plant nutrients, in order to improve the chemical, physical, and biological properties of the soils. Application of organic matter as a mulching or incorporating into soils will increase below ground biodiversity as well as above ground is also planted with non-monoculture plantation. Niswati et al. (2009a; 2009b) and Yusnaini and Niswati (2008) have been clarify that application of organic material into soil, practices of no-tillage system increased the number and biomass of earthworm.

Soil Biodiversity, Ecosystem services and Land Productivity

Good management of soil biodiversity is the root of sustainable agriculture. In the future agriculture productivity is not only for food, housing, and clothing but also for bio energy. As soil biota can have both positive and negative effects on agricultural production. Soil biota can be divided into three broad functional groups called chemical engineers (bacteria, fungi and Protozoans), biological regulators (nematodes, pot worms, springtails, and mites, which act as predators of plants, other invertebrates or microorganisms, by regulating their dynamics in space and time.), and ecosystem engineers (insects, earthworms, ants and termites, ground beetles and small mammals, such as moles and voles, which show fantastic adaptations to living in a dark belowground world) (Mudgal et al. 2010).

Sustainable agricultural production systems are to be realized, there should be clarification of the impact of land management change, including agricultural intensification and other trends, on both the short- and long-term functioning of soil ecosystems. This requires the development of appropriate indicators to improve understanding of land use and soil-biodiversity interactions and to assist in monitoring and assessing the trends and impacts, both in terms of degradation and restoration of an agricultural ecosystem. To date, there has been little progress in developing indicators of biodiversity. This is because of the low level of scientific knowledge and understanding regarding biodiversity, in particular of ecosystem processes and functions

There is a need for strengthening capacities and coordinating activities in order to promote integrated agro-ecosystem approaches and the conservation, sustainable use and enhancement of soil biological functions. In particular, improved information flows and better cooperation are needed among actors, institutions and development organizations (farmers, extensionists, researchers, policy-makers and soil, crop, livestock, environment specialists).

Soil biodiversity have a role for every ecosystem services such as, soil structure, soil organic matter and fertility. Soil organisms are affected by but also contribute to modifying soil structure and creating new habitats. Soil organic matter is an important 'building block' for soil structure, contributing to soil aeration, and enabling soils to absorb water and retain nutrients. Plant biomass production also contributes to the water cycle and local climate regulation, through evapo-transpiration. Other services from soil biodiversity is regulation of carbon flux and climate control, regulation of the water cycle, decontamination and bioremediation, pest control, and Human health.

Current threats to soil biodiversity majority comes from of human activities Therefore we have to reduce the soil degradation by repairing and maintaining this damage by letting vegetation grow and the biomass have to incorporated into the soil as an organic material inputs to belowground communities and by putting pressure on the remaining open soils for performing all the ecosystem services.

Conclusions

The sustainable function of natural and agricultural ecosystems is dependent on the contribution of soil organisms to a wide range of ecosystem services. These services have been conceptually organized as those associated with the provision of goods, the regulation of ecosystem processes, and those essential to life on earth. The future researches on the agriculture system need to maximize using the potency of soil biota for restoring the land degradation and optimum management of above-ground biomass as an organic material incorporated into soil for sustainable humans living.

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